ENCYCLOPÆDIA BRITANNICA



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"LET KNOWLEDGE GROW FROM MORE TO MORE AND THUS BE HUMAN LIFE ENRICHED"

ENCYCLOPÆDIA BRITANNICA

A New Survey of Universal Knowledge

Volume 22

TEXTILES to VASCULAR SYSTEM

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TEXTILES to VASCULAR SYSTEM

TEXTILES, the general name applied to the products of the weaver, the derivation of the word being from L. *texere,* to weave. For details *see* the articles under the various fibre headings, such as wool, cotton, silk, flax, jute, synthetic fibres and cellulose. *See* also SPINNING; WEAVING; CARDING; COMBING; CLOTH FINISHING; DYEING; etc.

TEXTILES AND EMBROIDERIES. Inasmuch as "textile" is a general term for all woven fabrics, and "embroidery" is the ornamentation thereof, it is well, in treating the history and development of the two subjects, to consider the two together.

EUROPE AND THE NEAR EAST

Weaving was one of the earliest crafts, if not actually the earliest, practised by primitive mankind. Whether its invention goes back to a time when men were still nomads we cannot say; but at the stage of human development when lake-dwellings were erected threads were already woven into fabrics. Implements for preparing the threads, and fragments of the fabrics themselves, have been found on such sites. There is nothing to show that these stuffs were enriched with a pattern. The first attempts in that direction were probably made by the application of pigments or some sort of simple embroidery.

The east is the natural home of patterned fabrics. The Chinese were the first cultivators of the silkworm for the textile threads it provides. Recent excavations have shown that the valley of the Indus is the native home of the variety of the cotton plant still cultivated for weaving purposes. To the valley of the Nile has long been attributed the origin of linen weaving.

Egypt and the Crimea.—The earliest patterned stuffs known to exist are some linen stuffs from Egypt of the 15th century B.C. (*see* TAPESTRY). In them pattern-weaving has reached a highly developed stage. For the thousand years which follow we again have nothing in the way of patterned stuffs. The next in chronological sequence come from the graves of Greek colonists in the Crimea, and are now in the Hermitage museum at Leningrad. They are mostly of wool, with woven, painted or embroidered ornamentation. The patterns include figures on horseback, warriors, goddesses, chariots, animals, birds, vines, flowers, anthemion ornament, scrolls, diapers and stripes. A few fragments are of linen; there is one silk stuff of uncertain age, and some of the embroidery is in gold thread. For the most part the graves are of the 4th and 3rd centuries B.C., but some are earlier and others later. Stuffs of late Graeco-Roman times from the burying grounds of Egypt share the common features of Graeco-Roman art then spread around the shores of the Mediterranean. Linen is the principal material, but coloured woollen threads, particularly in purple, are generally used for the ornamentation, and as time passes the whole fabric is sometimes of wool.

For early Christian textiles we are still dependent upon Egypt. The Cross, plain or jewelled, and sometimes of the looped form borrowed from an Egyptian hieroglyph, first appears in the 3rd or 4th century, to be followed by Alpha and Omega, the dove and other emblems. A little later, subjects from the Gospels and the Old Testament are found. By this time two significant changes have come about. Embroidery tends to replace woven ornament, and silk becomes a common material.

Persia and Syria.—From Persia came the first silk threads used in the west. From the beginning Persia held the monopoly of the import trade in raw silk from China, and this it long kept. The earliest known Persian textiles belong to the time of the Sassanian kings, who ruled from A.D. 211 until the Mohammedan conquest toward the middle of the 7th century. No silk fabrics of that time are now known to exist in Persia, but their nature may be learned from contemporary rock-cut reliefs, representing the royal exploits and amusements. Textile-patterns shown in these are so characteristic, and so faithfully rendered, that with their aid a number of silk stuffs from various sources may be identified. Chief among them is a green silk with a dragon of peculiar design evidently derived from the art of ancient Babylonia and Assyria. It is identical with that on the robe of the Sassanian king Chosroes II in rock-cut reliefs at Tak-i-Bostan near Kirmanshah. The same relief identifies as Sassanian a silk stuff with cocks in roundels, found in the Cappella Sancta Sanctorum in Rome in 1905. Other stuffs of this group are in the cathedral treasury at Sens in France, in the treasuries of Sion and Saint Maurice d'Agaune in Switzerland, and at Aachen in Germany.

Fragments have also been found in the buried sites of the Gobi desert region in Central Asia.

A few other silk stuffs of the period are more obviously imbued with the spirit of Greece and Rome, and these may have been woven in Syria The chief among them, with a pattern of Nereids riding on sea-monsters, is in the church of Notre-Dame de Valère at Sion in Switzerland Another remarkable example, with a leopard attacking a bowman, is in the treasury of Sens cathedral.

One of the finest of all existing early silk stuffs has a pattern of large circles with representations of the Annunciation and the Nativity. It was found in the Cappella Sancta Sanctorum in Rome, and it is now in the Vatican museum Another fragmentary silk of great interest, at Sens, represents the story of the patriarch Joseph A few silk stuffs with Christian subjects have been found in Egypt, as well as a far larger number of Persian origin Among the latter, those with bowmen on horseback shooting arrows behind them are typically Persian.

Sassanian influence persisted long after Persia had been overrun by the Mohammedans It is very plainly seen in two remarkable silk stuffs which were carried to Germany in early mediaeval times. One is in the church of St Ursula at Cologne It shows a Sassanian king riding on a griffin and slaying a mythical beast In the other, found in the neighbourhood of Trèves, a Sassanian king holds aloft a lion cub which he has snatched from a lioness. This exploit is told of Bahram Gor. The silk is now in the Berlin museum The most remarkable Persian silk weaving of these times was found in the year 1920 in the church at Saint Josse-sur-Mer near Boulogne, whence it was transferred to the Louvre. It has a large design of elephants, and a string of Bactrian camels for a border An inscription in Arabic characters indicates the province of Khurâsân as the place of origin, and approximately the year A.D. 960 as the date.

Byzantines.—Very little silk weaving (*q v.*) was done in Europe before the secret of silk-cultivation was learned. Both Aristotle the Greek in the 4th century B C., and Pliny the Roman in the 1st century A.D , give an account of the silkworm. Aristotle seems to have gained some knowledge from the soldiers of Alexander the Great, and apparently he had heard of wild silk, but neither he nor Pliny knew much about the matter. Heliogabalus (A.D. 218–222) is said to have been the first emperor to wear a robe entirely of silk, and Aurelian (270–275) declined to allow his wife a silk mantle because of its high cost.

Silk-weaving was already carried on at Constantinople in the 4th century, but the industry cannot have been of much importance until the eggs of the silkworm were surreptitiously brought over by Persian monks from China in the reign of Justinian (527–565), as Procopius relates, and the long-guarded secret of the Chinese was exposed.

Constantinople was situated at the junction of two continents, and as it was the *entrepôt* of the trade between Europe and Asia, the influence of the East was paramount there. The emperors maintained their own weaving school in the capital, and some of the stuffs were intended solely for the use of the emperor and the court We learn a little about this from Liutprand, bishop of Cremona, who went to Constantinople in the year 968 He bought some silk stuffs there for Otto I , but five purple stuffs were confiscated by the officers of the customs, on the plea that they were only to be worn by the Byzantines. The bishop protests that he had seen as good stuffs in the West, brought by the merchants of Venice and Amalfi, and he asks why he, a bishop and an emperor's ambassador, should be treated as no better than a Venetian merchant.

Three very remarkable Byzantine silk weavings are of such historical importance that a brief description of them must be given. The first was found in the shrine of St. Anne in the abbey church of Siegburg Two lions in profile advance towards one another. Between them is a Greek inscription to the following effect: "Under Romanus and Christophorus, our most Christian rulers." These two emperors ruled jointly at Constantinople from 921 to 931. The two lions with the intervening inscription cover a length of about five feet. Perhaps it was a stuff of this kind which formed the subject of Liutprand's complaint The second silk is similar, but the inscription refers to Constantine and Basil, whose joint rule lasted from 976 to 1025. It was found in a church in the Lower Rhine district, and pieces are now in the Berlin, Düsseldorf and Crefeld museums

The third fabric was placed over the body of the Emperor Charlemagne in his shrine at Aachen. It has a pattern of large circles, each enclosing an elephant, strongly conventionalized and bearing rich jewelled trappings Along the bottom there is an abbreviated inscription giving the names of certain officials This stuff is later than the time of Charlemagne, it probably belongs to the end of the 10th century For boldness of design and general splendour these three silk fabrics, woven on the imperial looms of Constantinople in the 10th century, are among the chief mediaeval stuffs we now possess Weavings of this character probably came to an end with the sack of Constantinople by the Latins in 1204.

Sicily and Spain.—It is remarkable that Mohammedan textile art flourished nowhere as it did on European soil, and partly under rulers who were the enemies of Islam The first Arabic incursions into Sicily took place in the 7th century, and during the course of the 9th century the island fell definitely under Mohammedan rule Silk and gold stuffs were woven in Sicily in the 10th century, but they cannot be distinguished from those woven in other Mohammedan lands In the year 1060 the Normans arrived in the island, and the Mohammedans were finally subjugated Weaving went on very much as before, though with greater magnificence and luxury, if we may judge from the two imperial robes produced at Palermo in the years 1134 and 1181 (described later). The lining of the great mantle is woven in silk and gold thread with figures representing the Temptation in the Garden of Eden, trees, birds, interlacing bands and Arabic lettering. A similar stuff, with horsemen, animals, birds and serpents is in the tomb of Roger, Norman ruler of Sicily (1072–1111), at Palermo A brocade in pink silk, with a small pattern of gazelles, birds and trees in gold, formed part of the robe in which the emperor Henry VI. (d 1197) was buried at Palermo; there is a fragment of this stuff in the British Museum

The other great centre of Mohammedan weaving in Europe is Spain There the Arabs landed in the year 711, and within seven years they were masters of the whole peninsula except the northwest. By the 9th century the weaving of silk fabrics was established in Andalusia. A remarkable woven fabric, known as the "veil of Hishâm," bears the name of Hishâm II., khalif of Córdoba from 996 to 1021. The material is a thin gauze, and the inscription borders a stripe of ornament woven in silk and gold thread, similar to the contemporary weavings of Egypt. In the 12th and 13th centuries some remarkable silk and gold fabrics were woven, with pairs of animals or birds, often in circles. Before the end of the 14th century the peculiar type of arabesque ornament, relieved by bold lettering, associated particularly with the decoration of the Alhambra at Granada, began to be seen in silk fabrics. The colours are bright—red, yellow and blue predominating. Upon the final subjugation of the Moors at the end of the 15th century, and the re-entry of the whole peninsula into Christendom, the skill of the Mohammedan weavers was still employed for producing stuffs "oeuvrés à la moresque," but the influence of Italian design grew as the 16th century advanced. With the rise of the textile industry at Lyons French influence began to be felt.

Italy and France.—The great textile industry of Italy, though much influenced by oriental art, followed a more independent course than that of Spain. The soil and climate were favourable to the growth of the silkworm, and Italy became the chief centre of that industry in Europe. Looms were set up for weaving the thread into fabrics. As early as the 12th and 13th centuries silk weaving industries were found in the great cities of the north, such as Florence, Venice or Genoa. In the south they grew up as the political upheavals of Sicily led to the migration of craftsmen to more peaceful industrial centres In the 14th century Lucca became famous throughout Europe for its woven stuffs.

Silk weaving was also carried on at Venice, Genoa, Vicenza, Florence, Bologna, Milan, Turin, Siena, Naples, Catanzaro, etc. In the second half of the 15th century Florence had a large number of factories, sending stuffs to Rome, Naples, Genoa, Catalonia, Seville, Lyons, Avignon, Antwerp, Turkey and elsewhere. In the 18th century stuffs were still sent to Holland, Germany, Turkey

Barbary and South America. The Venetians, too, carried their operations far afield. It was claimed for them that they studied to suit the colours and quality of their fabrics to the markets for which they were destined, both in Italy, and "all over the world"

The foundation of the silk-weaving industry in France in the 16th century, and its subsequent enormous development, challenged the Italian monopoly. Italian weavers were attracted to France. At Tours there were numbers of Genoese, and in the early days of the industry at Lyons there were many Genoese and Florentines Weaving was also carried on in other French towns, but during the 17th century the highly organized industry at Lyons gradually grew until it outstripped the Italians and reached that eminence which it has since maintained throughout Europe.

Great Britain.—For many centuries Great Britain was provided with the silks it needed from abroad Henry VII, when he desired to give some vestments to Westminster Abbey, had specially woven for him at Florence at great cost some magnificent fabrics of red velvet and cloth of gold with a pattern of roses and portcullises. One of these vestments is still preserved at Stoneyhurst college.

In the 16th century much silk was worn in England, but very little was woven, and Italy was still the chief source of supply In the following century, in a speech from the throne James I. urged mulberry-planting for rearing the silkworm It was tried, and foreign weavers were brought in Silk culture did not prosper, on account of the late spring, but weaving went on, and there were already large numbers employed when the revocation of the edict of Nantes brought in many thousands more refugees connected with the silk industry Voltaire, who spent some years in England a generation later, speaks of an entire suburb of London (*ie*, Spitalfields) peopled with French manufacturers of silk Others settled in Soho, Long Acre or Seven Dials Weaving industries also grew up at Canterbury, Norwich, Sandwich and other provincial towns. It was claimed that the Canterbury stuffs equalled any foreign silk.

During the 18th century the brocades of Spitalfields followed pretty closely the work of Lyons, and it is not always possible to distinguish between the two. Although gold and silver thread were made in the parish of St Giles, Cripplegate, metal threads were not so freely used by the Spitalfields weavers, and patterns tended to be a little simpler. The industry has now left Spitalfields, and subsequent work in East Anglia, though shrunken in output, still maintains the same high standard of craftsmanship and materials.

Persia and Turkey.—When Persia emerged again from alien rule early in the 16th century under the Safidian dynasty, a new era for the arts was inaugurated The Shahs had their own establishments of craftsmen with a director-general, and overseers for the separate crafts Some followed the movements of the court, others were settled on the royal estates and in convenient centres The best materials were supplied, and there was no stint of labour or expense Under such conditions, some of the most remarkable stuffs ever woven were done in Persia.

The most sumptuous velvets, with human figures, birds and trees, often on a gold ground, were made. Brocades represented historical scenes, figures, landscapes, animals, birds and flowers. The floral patterns of Persian stuffs are unsurpassed anywhere in the world. During the 18th century and subsequently, foreign intercourse has led in some degree to the adaptation of European patterns.

What is geographically classified as "Turkish" art is not the indigenous art of the once nomad Turkish tribes who ultimately overran Asia Minor and south-eastern Europe and there established a heterogeneous empire It is the art of the conquered races under Turkish rule Nevertheless there does gradually emerge, in those lands a unified art, largely under Persian influence, but not altogether unaffected by the relations of the Ottoman Porte with Italy (particularly with Venice) in the 16th and subsequent centuries. A brocade in the Lyons Museum, with a pattern of pairs of lions within roundels, in gold thread on a red silk ground, has an Arabic inscription giving the name of Kai Kubád, the Seljuk Turk, sultan of Iconium (Konieh) in Asia Minor in the early years of the 14th century.

This important stuff shows some affinities with Byzantine art In the 16th century velvet brocades recalling the contemporary lobed or "Gothic" patterns of Italy but with a strong oriental bias, were woven in Turkey both for home use and for export

Embroidery.—Like all other crafts, embroidery had its origin in the daily needs of humanity The problem how to join two edges of a fabric together must have arisen very early, and even a seam, as so many oriental embroideries show, may be treated decoratively Once the needle was invented, whether a sharp fish-bone, a thorn, a pointed stick, or a metal wire, the natural instinct to pass the limits of mere utility and to indulge in decoration would make itself felt. A good deal of what has been said above about woven patterns is applicable to embroideries. A few embroideries, mostly in wool, though gold thread occurs as well, were among the stuffs found in Greek graves in the Crimea (*see* above) One in particular, of the 4th century B C, shows an Amazon on horseback. In later Roman times embroidery was practised very much in the same way as it is today, as examples from Egypt show.

Perhaps the most sumptuous of all mediaeval embroideries is the imperial mantle at Vienna. It is of red silk, with a lion springing upon a camel, worked in gold thread and silk and enriched with pearls and gems An Arabic inscription round the edge records that it was made at Palermo in Sicily in the year 1134. The design probably has reference to the capture of the island from the Arabs by the Normans, which had then recently taken place The imperial alb, also at Vienna, has a border of griffins in gold embroidery. An inscription in Latin and Arabic records that it was made at Palermo in 1181.

England was renowned for its embroidery ("opus anglicanum") in mediaeval times, and a number of remarkable English vestments are still preserved in England and on the Continent Embroideries of Elizabethan times show much beauty in design (*see* DRESS). A strong oriental bias, due to trade with the East, is found in the 17th century. The great flowering trees worked in wools are copied from Indian designs. The 18th century maintained the standard of earlier times, and much has been done of late years to encourage this beautiful craft.

French mediaeval embroidery has much of the sweetness and grace that we should expect to find Later work has reflected the various influences which have moulded French art. Early Spanish work has Mohammedan characteristics. In later times, embroidery in the peninsula runs parallel with the Italian, but there is a tendency towards greater elaboration and brighter colours. The influence of Italy became widespread through its pattern-books for embroidery and lace-work, copies of which were carried to other countries and sometimes reproduced. In the Netherlands the work of the great schools of painting which arose in the 15th century is reflected in embroidery. The embroidery of Germany and Scandinavia is largely domestic in character. In the islands of the Aegean, peasant embroidery has reached a stage of development hardly matched on the continent of Europe. The embroideries are mostly in silk upon linen, for dress and domestic use Different islands have their own distinctive patterns

In Turkey and Persia embroideries have followed a parallel course to woven fabrics, and similar motives are used. A great deal of embroidery in silk and metal threads upon linen scarves and towels was done in Turkey during the 19th century. Much white-work has been done in Persia.

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(A F. K.)

AMERICA

The textiles made in America during the colonial period were of a simple and domestic nature. They were the homely and unpretentious fabrics of a people settled in a new country whose efforts were turned towards utilitarian ends. It was never the policy of England to encourage textile manufacturing in America. The colonies were looked upon as markets for English goods and royal

governors were adjured to keep strict watch over attempts to establish rival colonial manufactures. Efforts were made, nevertheless, from time to time, often in response to repressive governmental measures; serge, for example, was manufactured as early as 1705 But all these materials, whether domestic or professional in their origins, continued to follow plain and serviceable lines. Under such circumstances, the ornamentation of textiles could be only of the simplest. It would be limited to the designs woven into linens or the bright colours or patterns utilized for woollen weaves.

The production of silk in the colonies was a cherished English project. It was designed to provide England with raw materials hitherto imported at great cost from abroad Attempts were made, therefore, both in the north and the south, and in Georgia particularly, unceasing efforts were put forth during the greater part of the 18th century toward the production of silk The enterprise never succeeded in gaining any great degree of success but it led in the century following to the establishment of the silk weaving industry in America.

Embroidery was the medium that supplied the decorative element lacking in textiles and with materials often of local manufacture, the American needlewoman worked patterns that followed the familiar lines of English models Crewel embroidery, with its designs drawn from India cottons, was a favourite and its bright coloured floral motives lent a pleasant note of colour to the colonial interior Turkey work, which simulated oriental carpet designs by knotting wool threads into canvas, was another accomplishment, and it was made from the middle of the 17th century, generally for furniture covering. The sampler also was an occupation in America as in England, of the young. Another prototype was the embroidered picture worked in wool on canvas. A notable and delightful example and one relating to the American scene is a series based on the design of a lady fishing and scenes on Boston Common Needlework also was taught as a polite accomplishment Advertisements may be found in 18th century newspapers of instructors in crewelwork, feather work, Dresden work, samplers, sprigging of muslin, shaded silks and worsteds on holland and canvas showing how great was the variety of needlework that was made in America at that time

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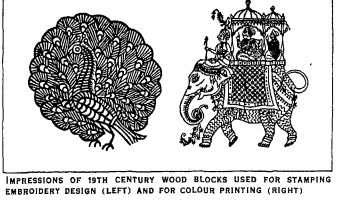
INDIA

Indian textiles have been famous from remote ages. Cotton was known to the Babylonians as *sindhu*, to the Greeks as *sindon*, and the natural inference as to its origin has been lately confirmed by the discovery at Mohenjo Daro, in the Sindh valley, of true cotton (*Gossypium*) fabric dating from the 3rd millennium B C It was not until the 13th century that the plant was introduced into southern Europe. Imitations of Indian cotton were first made in Manchester in the 17th century, but the imported material held its ground Numerous English names of cotton fabrics are of Indian origin: calico from Calicut, cramoisy from the *kermes* insect, chints from Hindī *chint*, *citā*, meaning spotted or variegated, bandana from *bandhnā*, the process of tie-dyeing, shawl from Hindī *šālā*. From the most ancient times plain and decorated cottons of all sorts have been used in untailored lengths to form the principal elements of wearing apparel—*dhotī* or lower piece, *dupaṭṭā* or scarf, and *pagrī* or turban, and the *sārī* (draped robe) or *ghagrā* (skirt) worn by women. Perhaps the most famous weaves are those of Dacca, including both decorated fabrics of some strength, and the filmy undyed muslins (*malmal*); the last named may be woven of yarn so fine as to require 250m. of it to weigh a pound.

Three varieties of silkworm are native in India (*tasar*, *muga*, and *eri*), but it is not certain that the true mulberry silkworm was ever cultivated there before its introduction by the East India Company in the 17th century. Typical of present day production are the brocaded silk gauzes of Benares.

Woollen shawls and blankets are commonly met with in the Punjāb, but the most famous woollen textiles of India are the shawls (*šālā*) and cloaks (*chogā*) of Kashmīr Kashmīr shawls should be carefully distinguished from the machine-made Scotch imitations known as Paisley shawls

The Kashmīr work is of two kinds, woven (*tuš* or *kanikar*) and embroidered (*amlkar*); the wool used is the under fleece (*pashm*)



IMPRESSIONS OF 19TH CENTURY WOOD BLOCKS USED FOR STAMPING EMBROIDERY DESIGN (LEFT) AND FOR COLOUR PRINTING (RIGHT)

of a goat The work is produced by a collaboration of at least four craftsmen, a designer, colour-designer, the man who plots the weave, and the actual weaver. Whether woven or embroidered, a Kashmīr shawl is almost always made of many small pieces. The Rampur *chādar* is a square shawl, cream coloured, without ornament or with embroidery of the same colour.

Dyeing.—Coloured garments of wool and silk are often referred to in the epic period and in literature. Some elaborate textile designs appear in the early reliefs, others in Gupta sculpture and the paintings of Ajanṭā, later on also in the paintings of the Gujarātī and Rājput and Mughal schools The most important Indian dyes are indigo (*nīl*), madder (Mañjiṣṭhā, "Manjeet") and *chaya* root. Synthetic dyes have now come into general use.

Indian dyes are applied in two ways, either to the warp and woof threads to be afterwards woven into self-coloured, patterned, or shot fabrics; or repeatedly to a finished textile, usually cotton, whenever it is washed, or a change of colour is desired The most remarkable work of the latter kind may be studied in the elaborate zigzag designs of the turbans of Kota and Alwar

Block Printing and Painting.—These processes range in complication from simple printing in black on white from wood blocks, through combinations of block printing in many colours combined with dye painting, to work entirely dye-painted by hand, and with or without the use of a resist. The technique is almost exclusively applied to cotton.

To give a very simple example of the process, a resist paste of lime and gum, or oil and beeswax, may be printed from wood blocks, the cloth is then dipped, and when the resist paste is subsequently removed, a white pattern on a coloured ground remains The art has reached its highest developments in Rajputana and Masulipatam. The most noteworthy productions of Masulipatam and Kalahastri in the south are the well known *palampores*.

Tinsel Printing and Painting.—In the "wax cloth" technique of Peshāwar a preparation (*roghan*) of oil just stiff enough to be drawn out into threads by the iron style which is used in making the design, is applied to the ground, then gold, silver powder or gold leaf is applied, and this naturally adheres only to the *roghan*, which is often mixed with powdered lime

The most exquisite and delicate tinsel printing is done in Rajputana, largely on fine muslins intended for *pagrīs* or turbans Here glue, gum, or lac is first printed from a wood block, and then gold leaf pressed onto the surface.

The special and highly developed technique of tie-dyeing (*bandhnā*, *cunarī*) is practised chiefly in Rajputana, Central India, Gujarāt, and in the island of Bali In this technique, a design is worked out, typically in spots, but also in squares or zigzags, by an elaborate process of tying up small portions of the cotton or silk fabric so tightly that the tied parts do not take up the

BY COURTESY OF THE DEPARTMENT OF FINE ARTS, BROOKLYN MUSEUM

PORTUGUESE NEEDLEPOINT

Tapestry of early 18th century Portuguese needlepoint. The design, which is in the *gros point* stitch worked out with polychrome silk threads on a ground cloth of canvas, commemorates the return of Ferdinand Pinto, a Portuguese adventurer and traveller, from the East. The choice of design is typical of the period. The tapestry, owned by Quiri Jones, is now in the Brooklyn Museum, New York
•the brilliant colour and the scalloped border, is characteristic of Portuguese work of this period.

TEXTILES AND EMBROIDERIES







PHOTOGRAPHS, (1) HERBERT G PONTING F R P.S , (2) BURTON HOLMES FROM EWING GALLOWAY, (3) PUBLISHERS PHOTO SERVICE

EMBROIDERERS AT WORK

1. Japanese embroiderers at work in Kyoto, Japan. These workers show great skill in rendering the pictorial effects favoured by their countrymen
2. Swiss embroiderers working on embroidery-frames outside a shop in Lucerne, Switzerland: Customers are thus enabled to see how the work is done
3. Hungarian needle woman displaying a sample of brightly coloured embroidery characteristic of that country. Heavy thread is used to create many of the effects produced

colour when the fabric is dipped The process must be repeated for every colour element in the design.

In the elaborate "Chiné" weaves (*paṭolas* and *ikats*) the characteristic feature is that the warp or woof threads, and often both, are individually and locally coloured by a tie-dyeing process before the warp is laid; the distribution of the colour on each thread is carefully calculated, so that the pattern will appear when the cloth is woven, without further manipulation. The term Chiné (Italian *alla Chinese*) is French, the fabrics having reached Europe from the East; but the technique is not Chinese. From the sporadic distribution of the method it may be inferred that it is a very ancient one, and perhaps of Indian origin. It extends to Turkey, and from Persia and Turkestan (Bokhara velvets and *dārāt* silks) through India (Gujarāt and the Dekkhan, but not in Ceylon) to the Malay peninsula (Tringannu), Sumatra, Java, Bali and Cambodia, and in a very simple form (*kasuri*) to Japan. Best known are the *paṭolas* (silk *sāṛis* worn at weddings) of Gujarāt (Cambay and Baṛoda); under this name, the material has also been extensively exported to Java and Bali, where it is much prized. Very fine and elaborate examples in which both warp and woof threads are dyed reproduce animal and floral motifs. The same technique is employed in the preparation of striped *khañjarī mashrus*, mixed silk and cotton fabrics used by Muslim women and made in the Punjāb, Benares and at Ayyampet in the Tanjore district, mainly for the Haidarābād market The gorgeous *ikats* of Sumatra are generally interwoven with gold thread. The double *ikats* of Tenganan in Bali are of cotton, and are used as coverings for temple offerings. Fine and large examples of cotton *ikats* are made in many other islands of the archipelago, the garments and shrouds from Sumba being the best. In Cambodia very beautiful silk *ikats*, known as *sampot hol*, are still made by traditional methods under the supervision of the Direction des Arts Cambodgiens at Phnom Pen.

Brocades.—These are textiles of silk in which the pattern is distinct from and supplementary to the weft, and thrown on its surface, small needle-like spools being thrust between the warp threads wherever the design requires; the term is generally used in connection with silk fabrics, but the method of weaving flowered muslins (*jamdānī*), the decorated cottons (*étirili*) of Ceylon, and the *kanikar* type of Kashmir shawls is essentially the same Silk brocades may be of pure silk (*amru*), or silk and cotton (*himru*) or interwoven with gold thread (*kimkhwāb*); these types pass into each other by gradual transitions, and the *kimkhwāb* ranges from types in which metal threads are very sparingly employed to pure cloth of gold or silver. Of pure silk brocades none is more beautiful than those of Surāt, which have floral sprays all over them and borders of conventional trees; the most exquisite of the *kimkhwābs* are those of Benares (already famous for its textiles before the Gupta period), Ahmadābād, and also Aurangābād.

The making of gold thread (*kalābatun*) for use in weaving and embroidery is still a flourishing industry, as much as 300,000 m. per annum being produced in Delhi alone. This is a highly specialized craft. Silver gilt wire is first drawn through fine holes in an iron plate until no thicker than a hair, then beaten flat on an anvil, then twisted round a silk thread foundation

Embroidery.—Only a very few of the most important types of Indian embroidery can be discussed. Embroidered garments and needles are mentioned already in Vedic texts, and although the use of untailored draped material is characteristic of Hindu culture, tailored garments have been in use from a remote period.

The *phulkāris* worn by Jāt women of the Punjāb and Rajputana are well known in Europe; they are used as hangings. These are executed in a darning stitch, done from the back, in white or yellow silk on coarse red cotton, in diapers or floral designs covering the whole ground; in good examples the stitches are very close and short, and the regularity of the design is secured by careful counting. Another type is carried out in cross stitch, with effects like those of European samplers.

Exquisite work in chain stitch is characteristic of the Punjāb, Rajputana, and Kach. In one type, known as *shishadār*, and used in embroideries for many purposes, small pieces of mirror glass, manufactured at Karnak, are introduced into the design, and bound down by stitching round them. In the Punjāb, the embroidered floor coverings are especially admirable; in Jaipur, hangings and shield cushions; in Kāthiāwār (Kach), the brilliantly designed and coloured women's skirts and children's caps with the long flap hanging down behind. Perhaps the finest of all chain stitch embroidery is met with on the *kamarbands* of Murshidābād or Azamganj in Bengal. Excellent examples in a bolder style are to be found in the betel bags of Ceylon, where the elaborate binding stitches are also of great interest

The beautiful *kasida* embroidery of Dacca in Bengal is done in gold coloured *muga* silk in darn and satin stitch on muslins. Finer and more elaborate is the *chikān* work of Lucknow, done in white or cream cotton on muslin, often in combination with drawn thread work Here the design is usually printed from a wood block in a colour that can be easily washed out, and the blocks used for this purpose should not be confused with those used for cotton printing with permanent dyes. Some of the work is characterized by the use of raised knots. The net embroidery, often spoken of as drawn thread, is really produced entirely by the needle, the strands of the fabric being pushed to one side by a kind of buttonholing, without the drawing of any threads, which is regarded as a slovenly imitation of the real process

Heavy embroidery in raised gold thread is mainly applied to elephant trappings, palankeen canopies, and the like; but much is now made at Delhi in forms adapted to European requirements. Applique work is found in Ceylon and Burma, quilting all over northern India, goffering in various places. (*See* also LACE; FAN; WEAVING.)

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(A. K. C ; X.)

THE FAR EAST

Woven Fabrics of China.—The origin of silk-weaving (*see* WEAVING) in China is lost in the region of myth and legend, and nothing remains to show what the earliest stuffs were like. The oldest Chinese patterned stuffs known to exist were unearthed by Sir Aurel Stein in the Lop desert, Chinese Turkestan, in 1914. The site lay on the route opened out by the Chinese for the silk trade with western Asia in the 2nd century B.C., and replaced by an easier route in the 4th century A.D. The stuffs are attributed to the 1st century B.C., during the Han dynasty, and they are undoubtedly influenced by earlier traditions. The patterns of dragons, griffins, animals, birds, scrolls and diapers are archaic in form, though at the same time they have a remarkable resemblance to later work. The next Chinese dynasty especially associated with the output of artistic wares is the T'ang (A.D 618–906). Considerable numbers of textiles attributed to this period have been preserved. The Chinese were then in contact with Persia both by land and sea, and this western intercourse is reflected in the art of the time It is conspicuously seen in a silk banner said to have been used by the Japanese Prince Shotoku (A.D. 572–623), and now removed from Nara (the old imperial capital) to the Tokyo museum. The design is a typical Sassanian

hunting-scene, with the king on horseback attacking a lion; the manner of representation is, however, Chinese and Chinese characters are introduced Many other silk weavings of this epoch are preserved in the royal treasure-house at Nara in Japan.

A characteristic type of Chinese weaving, done by the tapestry method in fine silks and gold thread, and known as k'o-ssu, is first met with under the T'ang dynasty. The specimens which have been found in the Gobi desert region differ remarkably little from those of modern times. The same very fine silk warp is used, and the weft of bright coloured silk enhanced by the use of gold thread. On the other hand there can be no reasonable doubt that these examples woven more than a thousand years ago were the heirs of a far greater antiquity—perhaps assignable in its origin to the dim period when Chinese handicrafts first assumed a civilized form The patterns are less archaic than those of the "Han" silks already mentioned, but they are similar in their scope —including dragons, symbolic "lions," phoenixes, and various animals, birds and flowers.

Under the Yuan dynasty, founded by a Mongolian conqueror about 1280, Marco Polo (besides other travellers from Europe) found his way across the Asiatic continent to China. He speaks of the silk brocades woven in many parts of that country. Numbers of Chinese silk and gold fabrics were brought to the West at that time and under the Ming dynasty which followed in the 14th century. Some are at Regensburg and Danzig and in other church treasuries of Europe Occasionally Arabic inscriptions are inwoven into these stuffs showing that they were intended for the use of a Mohammedan ruler of western Asia.

With the arrival of the Portuguese at Canton in 1517 a new era begins for Chinese textiles. "Chinoiserie" soon came into vogue in Europe, and the trading ships of Portugal, Spain, England, France, Holland and other countries brought home vast quantities of Chinese textiles often made specially for export. During this time the weaving of fine silk fabrics, uninfluenced in design by Western associations, went on as before. Dragons, phoenixes, clouds, waves and symbolical ornaments were reproduced on official garments, temple hangings and other stuffs. In China a landscape or a figure subject becomes a "pattern" almost as naturally as any other kind of ornamentation. Landscapes including rocks, rivers, boats, buildings, trees and figures were rendered by the tapestry-weaving process already described.

Woven Fabrics of Japan.—Textile art in Japan owes a great deal to the Chinese. The ancient royal treasure at Nara, already mentioned, contains some of the most remarkable early Chinese stuffs in existence

The inference that Japan was then very largely dependent upon the more ancient civilization of her neighbours for the richer sort of textiles is confirmed on more general grounds.

In the early centuries of the Christian era large numbers of Chinese weavers settled in Japan. They usually worked under Japanese control, and they became distributed throughout the country.

In the year 1584 a Japanese embassy arrived in Europe, visiting Pope Gregory XIII in Rome, and King Philip II in Spain. They brought with them silk weavings as presents, receiving in return velvets and brocades.

From this time onward European influence may be discerned here and there in the textiles of Japan. But before the 17th century was well advanced, Japan closed its doors entirely to the foreigner, until in 1858 the country was reopened to European and American trade by Com. Matthew Perry, U.S. navy.

Japanese textile-design displays an acute perception of natural forms, seizing the salient features and transforming them with a light touch to the fabric Ducks are shown floating on the rippling water, irises growing in the stream, fowls with their chicks, cranes on the wing, with these are landscape effects—lakes and streams, clouds, pine trees, castles and bridges Symbolic ornaments and small diaper patterns are also common Different methods of ornamentation are frequently combined in one fabric. A silk stuff may have a woven pattern helped out by printing and completed with a few deft touches of embroidery.

(*See* LACE; SCREEN: *Screens of China and Japan.*)

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TEXTUAL CRITICISM, a general term given to the skilled and methodical application of human judgment to the settlement of *texts*. By a "text" is to be understood a document written in a language known, more or less, to the inquirer, and assumed to have a meaning which has been or can be ascertained The aim of the "textual critic" may then be defined as the restoration of the text, as far as possible, to its original form, if by "original form" we understand the form intended by its author

Texts may be either *autographs* or they may be *transmitted* texts; these, again, being *immediate copies* of autographs or *copies of copies* to any degree

Autographs (which may be taken to include whatever, though not actually in the writing of its author, has been revised and attested by him) are not exempt from the operations of textual criticism. Editors of journals remove the slips of the pens of their contributors; editors of books, nowadays usually in footnotes, the similar lapses of their authors. With this branch of textual criticism, however, modern scholarship is not largely concerned. Not so with *immediate copies*

Textual criticism is called upon to repair the mischief done to *inscriptions* (texts inscribed upon stones) by weathering, maltreatment or the errors of the stonecutter Any great collection, such as the *Corpus* of Latin inscriptions, will show at once its activity and ability in this direction.

The chief field of textual criticism is elsewhere. The texts of the older authors which have come down to us were written for the most part not on stone but on papyrus, parchment or other perishable material Of these several copies had to be made, both by way of prevention against the wear and tear of use and as a means of satisfying the desire of other persons than the original possessor to be acquainted with their contents. Had the copies made of ancient writings been mechanical reproductions of the originals, such as the photographic facsimiles of modern times, there would have been little here for textual criticism to do. The ancient texts have not come to us in this way, but through copies made by the human hand directed more or less by the human intelligence Now a copy made thus can in no circumstances be a quite exact rendering of that from which it is copied or its *exemplar* A copy, *qua* copy, can never be the equal of the exemplar, and it may be much its inferior. This deterioration increases with the number of successive copyings Let us suppose that from a text which we will call "A" a copy has been made which we will call "B," and from this again a copy which we will call "C." If the copyist of "B" goes wrong once and the copyist of "C" twice in a hundred times, then, assuming that there is no coincidence or cancelling of errors, the relative correctness of the three texts, "A," "B," "C" will be 100 (absolute correctness), 99 and 97 02. If "C" had made his copy direct from "A," his percentage would have been 98. The importance of this must be borne in mind when we are dealing with *transmitted texts*, which have passed through many stages of copying.

The first step towards restoration of a text is the examination of the evidence upon which it is or is to be based. This begins with the investigation of its transmitted form. For this we have usually to rely upon *manuscripts* (mss.). By manuscripts we understand copies of the text made before the art of printing came into general use. These may be either *extant* or *non-extant*. The evidence of extant manuscripts must be ascertained by *collation* To collate a manuscript is to observe and record everything in it which may be of use towards determining what stood, in the source or the sources from which it is derived. A manuscript is not usually a clean or single piece of writing; it is commonly found to contain alterations by erasure, addition or substitution Such alterations may be due to the writer or writers of the ms., called the *scribe* or *scribes*, or to some other person or persons (for there may be several) called *correctors*. The relative importance of these corrections may be very different. Hence we must distinguish the different *hands* which have been at work on the manuscript. Account must also be taken of the number of lines

in each page, the number of pages in each quire, of gaps or lacunae in the manuscript, and so forth The work cannot be considered complete till all the extant manuscripts have been collated or at least examined When this is done we shall have the materials for pronouncing a judgment upon the text as *directly transmitted*. Perhaps there is only one extant MS. of the text, as in the case of the *Mimes* of Herodas and the *Annals* and *Histories* of Tacitus Then this part of our work is done But often we have to take account of a number of MSS whose respective claims to attention we must determine In the first place we shall discard all MSS derived by copying *from other extant MSS* If a MS is immediately or ultimately derived by copying from another MS, it cannot tell us anything that we do not know already if this copied MS is known to us But how can we tell that'a MS is so derived? It must be later than the other MS., *and* the similarity between them must be such as to permit of no other explanation. In the absence of explicit dates the relative age of MSS is often hard to determine, hence the criterion of unmistakable resemblance is one of especial importance. If the MSS. agree in singular though trivial mistakes, if they omit, apparently without motive, words and passages which other MSS preserve, we shall be safe in pronouncing that there exists a close bond of connexion between them; and if one of them shows errors which, though strange in themselves, are quite intelligible when we see what stands in the other, then we conclude that the second is that from which the first is derived. For the proper consideration of such points a personal examination, *autopsy*, of the MSS or of facsimiles of them, is often indispensable It was thought at one time that a MS of the Latin poet Propertius at Naples (*Neap.* 268) might have independent value as an authority for the text But its claims were disposed of when (amongst other facts) it was observed that at book IV 8, 3, the MS with which it most closely agreed (F, No 36, 49 in the Laurentian Library) had a gap at the beginning of the line and only the end words "vetus est tutela draconis," with the marginal note "*non potuit legi* in exemplari hoc quod deficit," ("what is missing could not be read in the original") and that *Neap.* 268 gives the line as follows, "*non potuit legi* vetus est tutela draconis"

Accident apart, *identity of reading implies identity of sources*. The source of a transmitted reading may undoubtedly be the author's autograph, but if not, then it is some MS in the line of transmission. The peculiar resemblances of two MSS, though not sufficient to warrant the derivation of either from the other, may be sufficient to establish some connexion between them. From the axiom which has just been cited it follows that this connexion can be due only to community of source, and we thus arrive at the idea of *families of MSS*. Suppose that a text is preserved in seven MSS., A, B, C, D, E, F, G If we find that of these A stands apart, showing no great similarity to any of the other six, while B, C, D on the one side, and E, F, G on the other, much resemble each other though differing considerably from the rest, we may express this by saying that B, C, D form a "family" descended from a hypothetical common "ancestor" which we may call X, and E, F, G another "family" descended from a hypothetical "ancestor" which we may call Y The readings of X which can be deduced from considering the agreements in B, C, D will be of higher antiquity and of greater external authority than any of the readings in B, C, D taken singly. And similarly for the readings of Y and those of E, F, G. Nor shall we stop here; but we shall further compare the readings of X and Y with each other and with those of A, and thus deduce the readings of a still more remote ancestor which we may call Z Z will be the *archetype* of all our existing MSS, and we may embody our results in a *pedigree* of manuscripts with Z as the first ancestor.

If we have done our work properly, the texts that we arrive at for X and for Y will be freer from error than the texts of the separate members of the families B, C and D, and E, F, G respectively, and that of Z freer from error than that authenticated by any existing MS.

The procedure, however, is by no means always so simple. That a text may be improved by the comparison of different MSS. is not a modern discovery. It has long been known, and the knowledge has led to the production of what are known as *conflated manuscripts* or *Misch-codices* These are MSS produced by "crossing" or "intermixture." In the following stemma M and N are "mixed" or "conflated" MSS, being formed by the blending of readings from the "pure" or "unmixed" codices A, B and D, E respectively Intermixture may take place to any extent; and the more of it there has been, the more difficult does it become to trace the transmission of a text. Whether crossing improves a given text or not depends ultimately on the knowledge and the judgment of the crosser; and these will vary indefinitely.

Non-extant Manuscripts.—Some of the most valuable of ancient MSS have disappeared since their discovery in modern times. When this has happened we have to rely upon mere copies, many times of inferior quality, or upon the information which old scholars have given us respecting them In this case what we have are not "collations," for the art of collation was not understood till the 19th century, but selections or "excerpts" of readings which we have reason to fear are often imperfect and erroneous. Further, it must not be assumed that all readings which are cited as being "*ex vetustis codicibus*" ("from ancient MSS.") are necessarily from older or better MSS than we now possess, or indeed from MSS at all. Scholars since the Renaissance have not always been above inventing codices to obtain currency for their own conjectures. The codices of Bosius (1535–80) are just as imaginary as the "old plays" which appear as the source of so many of the quotations that head the chapters of the Waverley novels, and suspicion rests on Barth, Lambinus and others

Some texts and portions of texts of ancient writers are now known only from printed books The metrical treatise of Terentianus is now preserved in the *editio princeps* (1497) alone All known MSS of Silius Italicus have a considerable gap in the 8th book, first filled up on the authority of Jac Constantius (1503), and not printed with the rest of the poem till the edition of Aldus (1523) By the methodical employment of these means we shall arrive at a text different from any existing one. It will not be the best one, possible or existing, nor necessarily even a good one. But it will be *the most ancient one* according to the *direct line of transmission*, and the purest in the sense of being the freest from traceable errors of copying and unauthorized improvements.

The invention of printing has naturally limited the province of textual criticism, and modified its operations The writer's autograph, if it is preserved after it has been through the hands of the printer, has seldom more than an antiquarian value. As a source for the text it is superseded by the printed edition, and if there is more than one, then by the latest printed edition which has been revised in proof by the author, or, in certain cases, by his representative; and the task of the textual critic is restricted to the detection of "misprints," in other words, of errors which the compositor (the modern analogue to the scribe) has made in "setting up" the manuscript, and which have escaped the notice of the proof-reader and the author or his representative. If, however, this revision has been neglected or incompetently performed, the number of such mistakes may be considerable.

Another question with which the textual critic of modern authors must be prepared to deal is the relative importance of different editions, each of which may have a *prima facie* claim to be considered authentic. Thus Shakespearian criticism must decide between the evidence of the first folio and the quartos; the critic of Shelley's poems must consider what weight is to be attached to the readings in the posthumous edition by Mrs. Shelley, and in unpublished transcripts of various poems Where there is great or complicated divergence between the editions, as in the case of Marlowe's *Faustus*, the production of a resultant text which may be relied upon to represent the ultimate intention of the author is well-nigh impossible. For the bettering of the *transmitted text* we can call in aids of a partial or subsidiary character which are known in general as *testimonia* Such are *anthologies* or collections of extracts. The oldest authority for an epithalamium of Catullus (62) is an anthology at Paris written in the 9th century. *Translations* from one language into another may help to fix the reading of the original, or this again that of the translation. In

Shelley's *Prometheus Unbound*, ii. 5, 54:

> Child of Light! thy limbs are burning
> Through the vest which seems to hide them

'limbs" is supported against "lips" (ed i.) by *membre* in the Italian prose version made by Shelley himself, and similarly in l 52 "looks" (not "locks") by the rendering *sguardi* In *direct quotations*, either of passages or single words, and either with or without the author's name, we must be sure that the writer is quoting exactly. *Parodies*, discreetly used, may prove of service in restoring the forȯ of what is parodied or this in restoring the parȯdy. So also *obvious imitations*, especially in a highly imitative literature such as Latin poetry.

The support which a reading gains from the evidence of the directly transmitted text *and* from the auxiliary testimonia may be called its *documental probability* To restore a text from the documental evidence available we must know and weigh the causes which tend to vitiate this evidence in its various kinds. We shall speak first of those which affect the *direct* transmission of texts These are either external or internal

External.—A text may become illegible through damp or constant thumbing; portions of it may be torn away; if it is in book form, leaves or whole quires may be detached and either lost or misplaced. When this has taken place on a considerable scale, the critic is helpless; but minor injuries may sometimes be traced and remedied. The weakest parts of a MS. book were the outer margins; hence the beginnings and the ends of lines, whether of verse or prose, were especially liable to injury. It obviously makes a difference upon which side of a leaf, whether on the verso or the recto, a line was written Hence the determination of the paging of the "archetype" or parent MS. (as was done for the archetype of Lucretius by Lachmann) has more than a merely antiquarian value. In ancient classical MSS the first letters of poems in verse and paragraphs in prose usually, and the initial letters of lines in verse occasionally, were written separately and by another person than the scribe (who was called the *rubricator*), and therefore were apt to be omitted. Other external circumstances may prejudicially affect a text. The copy from which Shelley's *Julian and Maddalo* was printed was written on very narrow paper, and the punctuation marks at the ends of the lines were frequently omitted

Internal.—These errors arise from the default of the scribe or copyist, and, in the case of printed books, the compositor. (For the convenience of the general reader these errors have been illustrated as far as possible from English authors and especially from the poems of Shelley [ed. Hutchinson].) They are very numerous. They may be roughly arranged according to the degree in which the volition of the copyist is absent or present, as involuntary or mechanical, semi-voluntary and voluntary; or again as they affect single signs (letters, figures or symbols), words, lines, or even larger units such as sentences or paragraphs.

Simple Errors of the Eye.—(*a*) Confusions of letters. These are very numerous, and different in different scripts or styles of writing (*see* PALAEOGRAPHY). Thus the Roman letters *E* and *F* are liable to be confused in capital script, but not in cursive *e, f; C, G*, in capitals; *c, e* in the cursive writing called Caroline minuscule; *c, t*, in the angular cursive of the 13th century and later. Texts which have had a long history will often show by the letter-confusions which they exhibit that they have passed through several distinct stages of copying. It is to be observed that two different styles of writing are often found in the same manuscript, the difference being utilized for the purposes of distinction. Thus in Greek cursive MSS. notes were often written in uncials. (*b*) Omissions of letters. (*c*) Shiftings of letters, sometimes by syllables. This is very common in half intelligent or half mechanical copying In printing we get the disarrangement of type which is known as "pie." (*d*) Confusions of symbols and abbreviations. (*a*) Examples of confusion of capital letters from Shelley's poems are: *Prometheus*, i. 553, "Mark that outcry of despair" for "Hark"; *Hellas*, 472, "Hold each to the other in loud mockery" for "Told." Of cursive letters: *Marenghi*, 130, "the *dim* ocean" for "the *dun* ocean"; *Letter to Maria Gisborne* 126, seq.:

> above
> One chasm of Heaven smiles like the *age* of Love
> On the unquiet world

for *"eye."* (*b*) *Translations from Goethe's Faust*, sc. ii 165, "eye" for "*eyne*" (in spite of the rhyme with 163). (*c*) *Prometheus*, iv. 575, "Neither to change, nor *flatter*, nor repent," for "*flatter* In Latin MSS we often find a mere jumble of letters. (*d*) Confusion of words through abbreviations is very common in ancient MSS, where they were much employed. At a famous place in the doxology of I Timothy iii. 16, the MSS. vary between ὃς (or ὅ) and Θεός. In uncial writing ΟC (ὃς) might easily be miswritten or altered to ΘC (Θεός) or vice versa.

Loss of Letters, Syllables, Words or Lines, through Similarity of Writing: Homoeography.—When similar letters or groups of letters stand next to each other, one of these is liable to be omitted. This is the simplest case and is called *haplography*. An example is Shelley's *Cenci*, v. 4, 136, "whose love *was* [*as*] a bond to all our loves " Similarity operates differently if the similar groups stand in different lines of the exemplar. Then the copyist's eye is apt to slip from the first of two similarly written groups to the second; and he will thus omit all that is between.

Omissions through Simple Negligence.—Groups of letters, words, syllables and lines are often omitted without any contributory cause. Short words or such as are not necessary to the sense are especially prone thus to disappear.

Examples of this are: Shelley's *Prometheus*, iii. i, 70,

> No refuge! No appeal!
> Sink with me [then],

Cenci i. i, 26,

> Respited [me] from Hell! So may the Devil
> Respite their souls from Heaven!

Repetitions: Dittography.—Letters, groups of letters, words and lines may be written twice (or even oftener) instead of once Other repetitions of words already written and anticipations of words yet to be written are also found, through the scribe's eye wandering into the preceding or the following context. Wherever the word or group of words repeated is not the one that he has just copied loss is liable to occur. *Dittography* is common enough in manuscripts, but is usually detected in reading proofs In the sole MS. of Cicero's treatise *De Republica*, 2, 33, 57, *secutus* appears as *secututus secutus*. Other kinds of repetition are Shelley's *Witch of Atlas*, 611 *seq.*:

> Like one asleep in a green hermitage,
> With gentle *sleep* about its eye-lids playing

(*sleep* for *smiles* has come from the previous line).

Confusions of Words.—Words are not only changed through confusion of single letters or abbreviations, but also through general resemblance or (a semi-voluntary change) through similarity of meaning. Shelley, *Prometheus*, ii. 2, 53· "There streams a plume-uplifting wind" for "steams " In Shelley's lines, "When the lamp is shattered," vv. 5–6,

> When the lute is broken,
> Sweet *tones* are remembered not

the printed edition had "notes" for "tones " In Mrs. Gaskell's *Cranford*, ch. xiv. (near the end), "The lunch—a hot savoury mutton-chop, and a little of the cold *loin* sliced and fried—was now brought in" is the reading of most if not all the editions; but *loin* should be "lion," the reference being to the pudding, "a lion with currant eyes," described earlier in the chapter.

The same character frequently attaches to *transpositions of words and parts of words*. The copyist does not as a general rule consciously intend a change, but he falls into one through the influence of dominant associations. He substitutes an order of words which, in respect of syntax, metre or rhythm is more familiar to him

Faulty Divisions of Words.—These will generally imply an exemplar in which the words were without any division or without a sufficient one. Under this head we may class errors which arise from the omission or the insertion of such marks as the apostrophe and the hyphen. Examples of *wrong division* of words are Chaucer's *House of Fame*, iii. 1,975, "Of good or misgovernement"

which should be "mis (*ie*, bad) governement"; Shelley's *Prometheus*, iii 2, 22, "Round many peopled continents" for "many-peopled," *ib* 26, "the light laden moon" for "light-laden" With this we may class *faulty division of sentences* Wrong punctuation is a common error and usually easy to correct. As an example of mispunctuation we may take Shelley's *Triumph of Life*, 188 seqq.:

> "If thou can'st, forbear
> To join the dance, which I had well forborne"
> Said the grim Feature of my thought "Aware
> I will unfold"

for

> said the grim Feature (of my thought aware)
> "I will unfold."

Grammatical Assimilations.—These are often purely mechanical errors, but they may be semi-voluntary or even voluntary, the copyist desiring to set the syntax right, as for example in Shelley's *Mask of Anarchy*, 280 seq.:

> the daily strife
> With common wants and common cares
> Which *sow* the human heart with tares,

for "*sows*."

Insertions (or Omissions) of Seemingly Unimportant Words.—These, inasmuch as they must often import some judgment on the sense of the passage copied, will be frequently semi-voluntary if not voluntary Examples are Shelley, *Prometheus*, iii 1, 5 "The soul of man like [*an*] unextinguished fire." So in *Triumph of Life*, 265:

> Whom from the flock of conquerors
> Fame singled *out* for her thunder-bearing minion,

"out" seems to be due to the compositor.

False Recollections.—The passage which a copyist is reproducing may suggest to him something else and he will write down what is thus in his mind instead of what is before his eyes There is a noteworthy instance in Horace, *Odes*, iii. 18, 11 seqq :

> festus in pratis vacat otioso
> cum bove *pagus*

where some MSS. give "pardus," a reminiscence of Isaiah xi. 6, "The *leopard* (*pardus*) shall lie down with the kid"

Incorporation of Marginalia.—The copyist may erroneously suppose that something written in the margin, between the lines or at the top or the foot of the page which he is copying, is intended to be placed in the text The words so incorporated may appear side by side with the genuine reading or they may expel it. In Horace, *Odes*, iii. 27, 47, "amati cornua *monstri*" (of the bull which carried off Europa), more than one MS has "cornua *tauri*," an explanation of *monstri* The celebrated passage about the three heavenly witnesses inserted in the Epistle of St. John (v. 2) seems to have been originally a comment explanatory of the text.

Transpositions of Lines and Passages.—This kind of transposition is really arrested loss. An accidental omission is discovered, and the person responsible, or another, places what is omitted in the margin, at the foot of the page or in some other part of the text, usually adding a mark to show where it ought to have been. The next copyist may easily overlook this sign and thus the passage may be permanently displaced.

Interpolation.—This is the deliberate alteration of an exemplar by way of substitution, addition or omission, but when it takes the particular form of omission it is naturally very hard to detect Interpolation then always has a motive The most frequent motive is the removal of some difficulty in the sense, expression or metre of the text, and especially obvious gaps or corruptions which the interpolator endeavours to fill or to heal Fraudulent interpolation, whether the fraud be pious or otherwise, does occur, but is comparatively rare. The removal or the mitigation of objectionable matter is also occasionally found Interpolation is then a voluntary alteration, but in practice it is often hard to distinguish from other changes.

The usual character of scribes' alterations is well illustrated by a passage in Bacon's *Advancement of Learning*, II. xix., "for these critics have often presumed that that which they understand not is false set down as the Priest that where he found it written of St. Paul *Demissus est per sportam* (Acts ix 25) mended his book, and made it *Demissus est per portam*, because *sporta* was an hard word, and out of his reading." Shelley in *Triumph of Life*, 201 seq , wrote:

> And if the spark with which Heaven lit my spirit
> Had been with proper *nutriment* supplied,

but the printed editions made it "sentiment "

Deliberate alteration is sometimes due to disapproval of what stands in the text or even to less creditable reasons There is an old and seemingly trustworthy tradition that some lines in Homer's "Catalogue of the Ships," *Iliad*, ii 553-556 and 558, were introduced there to gratify the vanity or ambition of the Athenians Insertions of this or of a similar character may be of almost any length, from a few words to a whole chapter or a complete poem Literary forgery has never set any bounds to itself, and the history of every literature will supply examples of entire works being foisted upon authors and personages of repute

Special Conditions Conducing to Corruption.—The chief of these is strangeness or difficulty in the matter to be copied Proper names, technical expressions, quotations from foreign languages, and frequent change of subject, are all likely to cause difficulty to a scribe and error in his work. Careful and continuous regard to the various kinds of errors and defaults that are found in transcription will enable us to judge whether a reading which it is suggested stood in the archetype of our text is likely to have been corrupted to the reading, or readings, which stand in the extant manuscripts or editions If it is, we say of this reading that it is *transcriptionally probable*.

Some precautions must be observed First we must rule out any proposal which assumes confusions of letters and abbreviations which are not attested for the particular tradition Secondly, since different scribes are prone to different kinds of error, we must ever bear in mind the particular failings of the scribes responsible for the transmission of our text as these failings are revealed in the *apparatus criticus*. Maxims of criticism to which we may here refer are that "harder readings are better than easier" and that "the shorter reading is generally the truer." The first maxim is indisputable, provided we understand by "harder" *harder to the scribe*, and by "easier" *easier to the scribe*. The characteristic of scribes' emendations or interpolations is that they are superficial Their mark is that at the time of their making they "combine the appearance of improvement with the absence of its reality" (Westcott and Hort, *New Testament*, i. p 27). The second maxim refers to the well known fact that accretions from marginalia, etc., lengthen and also weaken a text.

The virtues of a scribe are *honesty* and *care* (or in a single word *fidelity*) and *intelligence*. But it is rare to find these combined in a very high degree, and out of them we can least easily dispense with fidelity. Paradoxical as it may seem, the mechanical corruptions of a stupid but faithful copyist may tell us more than the intelligent copyings of a less faithful one. At certain epochs in the transmission of literature systematic efforts have been made to improve the transmitted texts, and these efforts have naturally been accompanied by a good deal of emendation both successful and unsuccessful Such an epoch was the revival of Latin and Greek learning in the 15th century, and a modern scholar would for that reason naturally prefer to have a manuscript to work on which was written immediately before this epoch to one which was written immediately after it. The fidelity of a scribe has to be judged chiefly by *internal* tests, and these are best applied to his work in passages where there is no reasonable doubt of the correctness of the transmitted text. But there are two tests of a more objective character that may be used—orthography, and indication of lacunae or other faults in his exemplar. A scribe who preserves in his spelling the traces of a bygone age is probably trustworthy If faithful in small things, he is likely to be faithful in great. A scribe again who scrupulously records the presence of a lacuna or illegibility in what he is copying, inspires us with confidence in the rest of his work.

As regards the use of *testimonia*, it may be observed to begin with that their value must depend on the trustworthiness of the texts of the writers from whom they are taken, and further upon that of the text used by the translator, the excerptor or the quoter, about which we can know nothing for certain, though we may sometimes make probable inferences In the case of quotations we must allow for failures of memory Many times in the course of his investigations the critic will be confronted with problems which cannot be resolved by considerations of transcriptional or documental probability

This leads us to consider *intrinsic probability*. By this is meant the likelihood that the writer of our text would at the time of writing have written, or not have written, a particular thing. Two questions which may be separated, though they are not entirely distinct, are here involved. What was the meaning of the writer? And how did he express it? The sense may be clear though the words may no longer be determinable A reading may be impugned on a number of grounds: that it gives no sense or an inappropriate sense; that it involves a usage or an idiom not current at the assumed time of writing, or foreign to the reputed author, or to the style in which he then was writing, that it involves some metrical or rhythmical anomaly; or that the connexion of thought which it produces is incoherent or disorderly. These charges cannot be played off against each other. It is no answer to the objection that a reading in some Roman poet makes nonsense to say that its Latinity is perfect or its metre excellent. But they may reinforce each other, and to such corroboration great weight must be assigned.

To set the meaning of a passage in a foreign language before us we must frequently have recourse to *translation*. But this method of representation is a very imperfect one; we may easily impose on ourselves and others by strained and ambiguous renderings A more subtle danger to which we are especially liable in the case of a dead language is that of our acquiescing in a sense which satisfies us but which would not have satisfied the ancient writer. Above all we must avoid applying our own standards of taste, style and morality to the judgment of the text before us The textual critic has no concern with what the writer ought to have thought or said, his business is solely with what he did say or think or might have said or thought. Among the legitimate reasons for suspecting the correctness of a text are patent contradictions in a passage or its immediate neighbourhood, proved and inexplicable deviations from the standards for forms, constructions and usages (mere rarity or singularity is not enough), weak and purposeless repetitions of a word (if there is no reason for attributing these to the writer), violations of the laws of metre and rhythm as observed by the author, obvious breaks in the thought (incoherence) or disorderly sequence in the same (double or multiple incoherence) Where the critic has ascertained the earliest form of a reading in his text, he will apply to it the tests of intrinsic probability. No part of a text can be considered exempt from this scrutiny, though for a very large part of it, it may be dispensed with.

After every such critical examination four conclusions are possible—acceptance, doubt, rejection, or alteration In other words, a critic may deliberately pronounce that what stands in the text represents what the author wrote or might well have written, that it is doubtful whether it does, that it certainly does not, or, in the last event, that it may be replaced with certainty by something that does. In the three first cases his judgment will be governed by considerations of intrinsic probability alone: but in the last it must regard transcriptional probability as well. No alteration of a text, or *emendation*, is entitled to approval unless, in addition to providing the sense and diction required, it also presents a reading which the evidence furnished by the tradition shows might not improbably have been corrupted to what stands in the text. These tests, and these alone, are emendations bound to satisfy; but others are often tacitly imposed upon them. Of this the transposition of lines is the most notable example. This kind of change is troublesome to estimate and inconvenient to adopt, as it involves placing passages where we are not accustomed to look for them; but to the question, did the author write the passage here or there? the matter of our trouble or inconvenience is wholly irrelevant There is, however, one class of cases in which no conclusion may be drawn, documental and intrinsic probability both failing us. This is where the alternative readings, neither of which can have come from the other, have equal external support and equal intrinsic merit Isolated discrepancies of this kind may be due to some accident to our text at a period now beyond our power to trace Numerous and striking discrepancies may be due to the fact that there was more than one edition or recension of it in early times, or to the author's leaving his work in such a condition that such discrepancies must inevitably gain currency. In the case of dramas, different acting editions will give rise to them

Up to this point all schools of textual criticism are theoretically at least in accord But here begins a divergence which has done more than anything else to discredit the study with the outside world It emerges because in all judgments on textual matters it is presupposed that they will be acted upon, that a reading accepted will remain in the text, a rejected one obelized, enclosed between brackets or removed, and in this last case something else substituted in its place. Now the "conservative" critic's chief concern is for the safety of the traditional and by preference the transmitted text. He urges very rightly that if alteration is carried beyond a certain point it cuts away its own foundation, and so all certainty is destroyed. His objective is the minimum of change And as the need of making a text compels some sort of decision in every case, the "doubtful" readings of the tradition, some of which on the evidence would be doubtfully accepted and others doubtfully rejected, will all appear with the accepteds in the text. As to alterations (emendations) that are less than certain, his attitude is clearly if somewhat crudely expressed in the dictum that it is better to leave in the text "what, if not the original reading, is at least the remains of it" The corresponding thesis of the opposite school would be that it is better to present to the reader something which the author might have written than something which he could not: or, in other words, that "stopgaps" should be preferred to débris

An editor of a corrupt and disputed text may reasonably adopt either of two methods of procedure. He may present the text in the purest form which the external evidence warrants, and place all plausible suggestions for its improvement in notes or appendices. The text will be faithful but unreadable, and his work will be that of an honest man but of a textual antiquarian, not a textual critic, since he declines the duty of "the restoration of the text, as far as possible, to its original form." By the other method the editor will provide all necessary information about the evidence for the text in the notes of his critical apparatus; but in the text itself he will give whatever in each case is supported by the balance of the probabilities. Each and every case he will decide on its own merits and without reference to decisions upon the other cases not now before him. Special consideration will be paid to "doubtful" readings, which will be distinguished in his work as "doubtfully accepted" or "doubtfully rejected" Legitimate doubt arises when the evidence *pro et contra* of documental and intrinsic probability is equal, or nearly equal, or when documental probability points strongly to one side and intrinsic probability to another. Illegitimate doubt is the uncertainty of the doubter as to whether he has examined the whole of the evidence. Such doubt is much more frequently felt than acknowledged, and its effect upon critical work is highly injurious. On the one hand, it is apt to take refuge in an uncritical acceptance of the traditional readings, and on the other hand to produce a crop of hesitant and mutually destructive conjectures which a reader naturally resents as a needless waste of his time.

The so-called "conservative text" is neither an antiquarian's text nor a critic's text, but a compromise between the two. When it is conscientiously obtained, it is arrived at by handicapping, more or less heavily, intrinsic probability as compared with documental probability, or by raising the minimum of probability which shall qualify a reading for admission into the text until it is in agreement with the notions of the editor. Both of these procedures are arbitrary in their principle, and liable to be erratic

in their application The text will suffer whichever course is adopted, and it will suffer the more the more conservative is the editor, as may easily be shown. Thus, if we suppose that of two editors of equal competence "A" requires a probability of four-fifths to admit a reading into his text and "B" a probability of three-fifths only, then in all the cases in which the probability lies between these two fractions "B" will be right seven times to "A's" three, while outside these limits there will be no difference between them.

Many persons appear to suppose that decisions upon doubtful points can be avoided by the expedient of leaving the traditional reading in possession of the text The rule is a simple one and easy to apply. But owing to the constitution of the human mind it has consequences which possibly they have not contemplated. The great works of classical literature are not studied as patho-logical specimens, and they will be studied the less the more they contain to repel and disquet the reader. If a corruption is left in a text when something might be substituted which would at least, as a "stopgap," give the sort of sense required, then one of two things must happen Either the sense of the passage is blotted out for the reader and the conservation of the corruption is tantamount to the expunging of the rest of the sentence, or else he will obtain the required sense by distorting the meaning of the other constituents of the context until they furnish it. So far so good: the requisite sense has been obtained, but the price has now to be paid And the price is that the reader's perception of the signification of the word or words so wrested is dimmed and impaired, and his power of discriminating and understanding them when he meets them again is shot with doubt and error.

It is a weakness of conservative critics to extol interpretation (or exegesis) at the expense of emendation. Some have even ventured to say that the successful defence of a passage in a text is a greater service than its successful correction. This is not true. The service to the text is the same, what was previously dark being now made clear. But the emendation deserves the higher praise as being in most instances the more difficult achievement The fault of the opposite school, on the other hand, is to disparage interpretation and to regard correction as the proper field of a scholar and gentleman. This bias is reflected in the maxim that "correction should precede interpretation," which is no more than a half-truth. For emendation must inevitably fail unless it express the meaning which the proper interpretation of the passage has shown to be required. Further, a corrector may propose the right word with the wrong meaning. Yet the custom is to give the credit of the emendation to him, and not to a successor who has seen what the right sense was and that this was the only word to express it; whereas the first scholar blundered once if not twice, first assigning the wrong sense to the passage and then selecting what (in most cases) would be the wrong word to express it. The proper course would be not to mention the first conjecturer or to mention him only for his error.

One of the most vexed questions of textual criticism, and one which divides scholars more perhaps than any other, is the question to what extent admitted imperfections and inconsistencies may properly be left in a text as due to the default of an author rather than of a scribe or compositor. No universal rule is here attainable. Each case must be considered on its merits; and the critic's procedure must of necessity be "eclectic"—an epithet often used with a tinge of reproach, the ground for which it is not easy to discover Two general considerations may be indicated If the autograph of a work is not accessible, there is no means of distinguishing between the involuntary errors of a scribe and the involuntary errors—"slips of pen"—of an author. For these are in fact only scribe's mistakes, the author being his own amanuensis

Passing over this class we come to one about which there may frequently be serious doubt. What is clearly erroneous or faulty may as clearly be intended, and therefore *not* to be removed by the critic In Chaucer's "Miller's Tale" (3,451, 3,457) *astromie* is used for *astronomie*, and *Noë* and *Noël* (Christmas) confused, "Nowélis flood" (3,451, 3,457), because the speaker is an illiterate carpenter In the "Prologue" to the "Parson's Tale" (10) there is, on the other hand, a mistake of Chaucer's own, which no judicious critic would think of removing, the constellation Libra being said to be "*the moon's* exaltation" when it should be *Saturn's*. But this error in an astrological detail would not warrant us in assigning to the poet the blunder about Jacob and Laban in the same tale (*see* above) Much depends on the precision with which an error can be corrected. wherever there are more plausible ways than one of doing this, the faulty reading must be allowed to remain. Collateral as well as direct evidence must be obtained If there is a number of instances where there is faultiness which is hard to remove, it is probable that the evil lies too deep for emendation The author's own carelessness may be to blame, or, as in the case of Virgil and Lucan, he may not have been allowed to put the finishing touches to his work

Certain lapses from grammatical correctness and metrical regularity that we find in the poems of Shelley are undoubtedly due to the author, though the number of these has been reduced (= Mr Buxton Forman has pointed out) with our improved knowledge of the sources of the text. Among such lapses we may instance *Prince Athanase* (287),

> The shadow of thy moving wings *imbue*
> Its deserts and its mountains;

"To a Skylark" (80), "Thou lovest—but ne'er *knew* love's sad satiety." The solecism in the Preface to the *Adonais*, "My known repugnance to the narrow principles of taste on which several of his earlier compositions were modelled *prove* at least that I am an impartial judge," would probably have been corrected by the poet if his attention had been called to it; but the two first ones, with others, cannot be thus regarded. We may detect occasional laxity also in his handling of his verse. Lines are left unrhymed, or the same word is used in place of another rhyming word.

Authority, as already hinted, has properly no place in textual criticism. For his facts a textual critic may, and often must, be beholden to others, but never for his opinions It adds nothing to the evidence for a reading that it has been approved by a Lachmann or a Madvig or rejected by a Stoeber or a Carutti: and an appeal to names on any such question confuses issues and deters inquiry. But inasmuch as there are many persons, including most makers of school editions, who prudently and modestly desire a better road to truth than their own investigations can discover and think thus to find it, it will not be amiss to observe on the one hand that the concurrence of a succession of editors in a reading is no proof and often no presumption either that their agreement is independent or that their reading is right; and on the other that, though independence may generally be granted to coinciding emendations of different scholars, yet from the general constitution of the human mind it is likely that not a few of these will be coincidences in error rather than in truth.

As time goes on, textual criticism will have less and less to do. In the old texts its work will have been performed so far as it is performable What is left will be an obstinate remainder of difficulties for which there is no solution or only too many In the newer texts, on the other hand, as experience has already shown, it will have from the outset but a very contracted field.

(J. P. P.)

THA'ALIBĪ [Abu Mansūr 'Abd ul-Malik ibn Mahommed ibn Isma'īl uth-Tha'ālibī] (961–1038), Arabian philologist, was born in Nishāpūr. His most famous work is the *Kitāb Yatimat ud-Dahr*, on the poets of his own and earlier times, containing valuable extracts (Damascus, 4 vols , 1887). Another work, the *Kitāb Fiqh ul-Lugha*, is lexicographical, the words being arranged in classes. It has been published at Paris (1861), Cairo (1867), and Beirūt (1885, incomplete).

For his other works *see* C Brockelmann's *Geschichte der Arabischen Literatur*, vol. i. (Weimar, 1898), pp. 284–286.

THACKERAY, WILLIAM MAKEPEACE (1811–1863), English novelist, only son of Richmond and Anne Thackeray (whose maiden name was Becher), was born at Calcutta on the 18th of July 1811 His father and grandfather (W R Thackeray) had been Indian civil servants. His mother was nineteen

at the date of his birth, was left a widow in 1816, and married Major Henry Carmichael Smyth in 1818 Thackeray went to school in Hampshire, Chiswick, and in 1822 to Charterhouse, still on its ancient site near Smithfield In 1828 he left school to join his mother and her husband at Larkbeare in Devon, near Ottery St Mary, which is the "Clavering St Mary," as Exeter and Sidmouth are the "Chatteris" and "Baymouth" of *Pendennis*

In February 1829 Thackeray went to Trinity College, Cambridge, and contributed lines on "Timbuctoo," the subject for the Prize Poem (the prize for which was won by Tennyson), to a little paper called *The Snob* James Spedding, Monckton Milnes (Lord Houghton), Edward FitzGerald, and W. H Thompson (afterwards Master of Trinity) were among his friends. In 1830 he left Cambridge without taking a degree. A visit to Weimar bore fruit in the sketches of life at a small German court which appear in *FitzBoodle's Confessions* and in *Vanity Fair*. In G H. Lewes's *Life of Goethe* is a letter containing Thackeray's impressions of the German poet. On his return to England in 1831 he entered the Middle Temple, and found material for some capital scenes in *Pendennis*. In 1832 he inherited a sum which, according to Trollope, amounted to about five hundred a year The money was soon lost—some in an Indian bank, some at play and some in two newspapers, *The National Standard* and *The Constitutional*. In *Lovel the Widower* these two papers are indicated under one name as *The Museum*, in connection with which Honeyman and Sherrick of *The Newcomes* are briefly brought in Thackeray's adventures at play were utilized on three occasions, in "A Caution to Travellers" (*The Paris Sketch-Book*), in the first of the Deuceace narrations (*The Memoirs of Mr. C. J. Yellowplush*), and in *Pendennis*, vol. ii. chap. v., in a story told to Captain Strong by "Colonel Altamont."

About 1834 Thackeray settled in Paris to study art seriously. He had, like Clive in *The Newcomes*, shown early talent as a caricaturist. His pencil was at its best technically in such fantastic work as is found in the initial letters of chapters, and in those drawings made for the amusement of child friends which were the origin of *The Rose and the Ring*.

In 1836 Thackeray married Isabella, daughter of Colonel Matthew Shawe. There were three daughters born of the marriage, one dying in infancy The eldest daughter, Anne Isabella married in 1877 (Sir) Richmond Ritchie, of the India Office. She inherited literary talent from her father and wrote several charming works of fiction, notably *Miss Angel* (1875), and subsequently edited Thackeray's works and published some volumes of criticism and reminiscences The younger daughter, Harriet Marian, married (Sir) Leslie Stephen in 1867 and died in 1875. Mrs Thackeray, to quote Trollope, "became ill and her mind failed her," in 1840, and he "became as it were a widower to the end of his days"; she did not die till 1892.

In 1837 Thackeray came to London, and became a regular contributor to *Fraser's Magazine*. In this in 1841 appeared *The History of Mr. Samuel Titmarsh and the Great Hoggarty Diamond*, a work filled with the wit, humour, satire, pathos, which found a more ordered if not a fresher expression in his later works. The characters are full of life; the book is crammed with honest fun; and for pure pathos, the death of the child stands in the company of very few such scenes in English fiction, but *The Great Hoggarty Diamond*, had to be cut short at the bidding of the editor. In 1840 came out *The Paris Sketch-Book*, much of which had been written and published at an earlier date. In 1838 Thackeray had begun, in *Fraser*, *The Yellowplush Papers*, with their strange touches of humour, satire, tragedy, and their fantastic spelling, and this was followed by *Catherine*, a strong story, founded closely on the career of a criminal named Catherine Hayes, and intended to counteract the then growing practice of making ruffians and harlots prominent characters in fiction. When *Pendennis* was coming out in serial form (1850) another Catherine Hayes, an Irish singer and famous *prima donna*, was much before the public Thackeray, thinking of the former and oblivious of the latter Catherine Hayes, caused a great outcry in the Irish press by coupling the name with that of a recently notorious murderer. He afterwards suppressed the passage but the incident is of interest because it explains the initial letter drawn by Thackeray for chap xv, vol. ii, of *Pendennis*. The drawing is in itself highly comic, but must seem quite meaningless without the key. There soon followed *Fitz-Boodle's Confessions and Professions*, and the *Shabby Genteel Story*, a work interrupted by Thackeray's domestic affliction and afterwards republished as an introduction to *The Adventures of Philip*, which took up the course of the original story many years after the supposed date of its catastrophe. In 1843 also came out the *Irish Sketch-Book*, and in 1844 the account of the journey *From Cornhill to Grand Cairo*, in which was included the excellent poem of "The White Squall" In 1844 there began in *Fraser* the *Memoirs of Barry Lyndon*, called in the magazine "The Luck of Barry Lyndon, a Romance of the Last Century." His latter career is founded on that of Andrew Robinson Stoney Bowes, who married the widow of John, 9th earl of Strathmore.

Thackeray became a contributor to *Punch* within the first year of its existence. John Leech, who was one of the earliest contributors, had been at Charterhouse with Thackeray and the two men were friends through life. He made his first hit with *Jeames's Diary*, begun in November 1845, and may be said to have established his reputation by the *Snob Papers* (1846), now known as *The Book of Snobs*. "*Punch's Prize Novelists*," another series which Thackeray contributed to the paper, contain some brilliant parodies of Edward Bulwer-Lytton, Lever, Disraeli and others Owing to differences in political opinion, his connection with *Punch* ended in 1851 Minor but admirable works of the same period are *Legend of the Rhine* (a burlesque of Dumas's *Othon l'Archer*), in George Cruikshank's *Table Book*, edited by Gilbert A Beckett, *Cox's Diary* (on which has been founded a well-known Dutch comedy, *Janus Tulp*), and *The Fatal Boots*. *Rebecca and Rowena* towers over every other burlesque of the kind. Its taste, its wit, its pathos, its humour, are unmatchable; and it contains some fine songs of a particular sort. In 1846 was published, by Messrs. Bradbury and Evans, the first of twenty-four numbers of *Vanity Fair*, the work which placed Thackeray as a novelist of the first rank It was completed in 1848, when Thackeray was thirty-seven years old. The charge of cynicism Thackeray has himself met at the end of the eighth chapter, in a passage which is the best commentary on the author's method.

Another accusation brought against the book was that the colours were laid on too thick, in the sense that the villains were too villainous, the good people too goody-goody, the best answer to that can be found by anyone who chooses to read the work with care Osborne is meant to be a poor enough creature, and one whose poorness of character is developed as he allows bad influences to tell upon his vanity and folly The good in him comes out in the beautiful passage describing his farewell to Amelia on the eve of Waterloo, in which passage may be also found a sufficient answer to the statement that Amelia is insipid and uninteresting. So with the companion picture of Rawdon Crawley's farewell to Becky Sharp. who that reads it can resist sympathy, in spite of Rawdon's vices and shady shifts for a living, with his simple bravery and devotion to his wife? As for Becky, there is certainly not much to be said in her defence We know that she thought she would have found it easy to be good if she had been rich, and we know also what happened when Rawdon surprised her alone with Lord Steyne. How "she admired her husband, strong, brave and victorious." This admiration is the capital touch in a scene as powerful as any Thackeray ever wrote. The supreme art in the treatment of the character of the brilliant adventuress that Becky was, makes the reader feel her attractiveness, though he knows her evil qualities.

Vanity Fair was followed by *Pendennis*, *Esmond* and *The Newcomes*, which appeared respectively in 1850, 1852 and 1854. *Esmond* is perhaps Thackeray's capital work It is undoubtedly one of the greatest of English historical novels. The insolent beauty Beatrix reappears in the *Virginians* as the jaded, worldly, and not unkindly Baroness.

In 1851 Thackeray had written *The English Humourists of the Eighteenth Century*, delivered as a series of lectures at Willis's Rooms in the same year, and re-delivered in the United States in

1852 and 1853, as was afterwards the series called *The Four Georges*. In 1854 was published that delightful burlesque, *The Rose and the Ring* In 1857 Thackeray stood unsuccessfully as a parliamentary candidate for Oxford and in the same year appeared the first number of *The Virginians*, a sequel to *Esmond*. The last number came out in 1859, and in the same year Thackeray undertook the editorship of the *Cornhill Magazine* This was a task which, as readers of his *Roundabout Paper* "Thorns in the Cushion" will remember, the kindliness and sensitiveness of his disposition made irksome to him, and he resigned the editorship in April 1862, though he continued to write for the magazine until he died In the *Cornhill* appeared *Lovel the Widower*, previously written, with different names for some of the personages, in dramatic form; *The Adventures of Philip* (1861–62), the *Roundabout Papers*, some of his best essays; and (1860–63) the story, unhappily never finished, called *Denis Duval* Among the *Roundabout Papers* is one differing in form from the rest, called "The Notch on the Axe—a Story à la Mode," an almost perfect specimen of the author's genius for burlesque story-telling. *The Adventures of Philip* is in the nature of a sequel to *A Shabby Genteel Story*, contains scenes which rank with Thackeray's best work, there are fine sketches of journalistic, artistic and diplomatic life, but Philip himself is impossible; the character is not drawn at all *Denis Duval*, which reached only three numbers, promised to be a first-rate work in the *Esmond* manner. The author died while it was in progress, on Dec 24, 1863 He was buried in Kensal Green, and a bust by Marochetti was put up to his memory in Westminster Abbey.

The grace and the apparent spontaneity of Thackeray's verses are beyond question. Some of the more serious efforts, such as "The Chronicle of the Drum" (1841), are full of power and instinct with true poetic feeling Both the half-humorous, half-pathetic ballads and the wholly extravagant ones must be classed with the best work in that kind, and the translations from Béranger are as good as verse translations can be, for Thackeray had the true poetic instinct.

The books of reference that can be best commended are Merivale and Marzials' *Life of Thackeray* (1891); R. H 'Shepherd, *Bibliography of Thackeray* (1880); C P. Johnson, *The Early Writings of Thackeray* (1888); Charles Whibley's *Thackeray* (1903); the edition of Thackeray's works with biographical introductions (1897–1900), by his daughter, Lady Ritchie; the *Life of Thackeray* ("English Men of Letters Series," 1879) by Anthony Trollope, *W. M. Thackeray and E. Fitzgerald. Unpublished Letters and Verses*, with introduction by Lady Ritchie (1913); Rt Hon. Sir A C. Lyall, *Studies in Literature and History* (1915); E B Chancellor, *The London of Thackeray* (1923); Anne Thackeray Ritchie, *Letters, with 22 additional letters of W. M. Thackeray* (1924), ed. by her daughter, H. Ritchie; Malcolm Elwin, *Thackeray, A Personality* (1932); John W Dodds, *Thackeray· A Critical Portrait* (1941). *See* also the bibliography on Thackeray in *Cambridge Bibliography of English Literature* (1940), vol. iii, pp. 429–35.

THAILAND: *see* SIAM.

THAÏS, a Greek courtesan, who lived during the time of Alexander the Great. She accompanied him on his Asiatic campaign, and is chiefly known from the story which represents her as having persuaded the conqueror to set fire to the city of Persepolis. This anecdote forms the subject of Dryden's *Ode to Saint Cecilia's Day*. But its authenticity is doubtful, since it is based upon the authority of Cleitarchus, one of the least trustworthy of the historians of Alexander.

Thais subsequently became the wife of Ptolemy Lagus, king of Egypt.

See Diod. Sic xvii. 72; Plutarch, *Alexander*, 38; Athenaeus xiii. 576, 586; Quintus Curtius v. 7.

THALE, a town in the Prussian province of Saxony, Germany, at the northern foot of the Harz mountains, 8 mi. S.W. of Quedlinburg by rail, at the entrance to the gorge of the Bode. Pop. (1939) 13,567.

Thale is largely frequented as a summer resort and for its saline springs. It is a manufacturing centre, its chief products being tin wares and tiles, and it has iron foundries, sawmills and lignite mines.

THALER, a silver coin formerly circulating in North Germany. *See* MONEY, MEDIAEVAL

THALES OF MILETUS (640–546 B.C), Greek physical philosopher, son of Examyus and Cleobuline, is said to have been of Phoenician extraction, but was more probably a native Milesian of noble birth Thales was certainly a Greek and not a Phoenician. He was chief of the seven "wise men" of Greece; and in later times amongst the ancients his fame was remarkable This name (*σοφός*) was given on account of practical ability, and Thales had been occupied with civil affairs. The advice which he gave to his fellow-countrymen "before Ionia was ruined"—"that the Ionians should constitute one general council in Teos, as the most central of the twelve cities, and that the remaining cities should nevertheless be governed as independent states" (Herod. i. 170) —is noteworthy. The appellation "wise man" was conferred on him not only for his political sagacity, but also for his scientific eminence (Plut *Solon*, c 3).

He became famous by his prediction of the eclipse of the sun of May 28, 585 B.C. Herodotus's account of it (i. 74) contains two statements —(1) the fact that the eclipse did actually take place during a battle between the Medes and the Lydians, that it was a total eclipse, that it caused a cessation of hostilities and led to a lasting peace between the contending nations; (2) that Thales had foretold the eclipse to the Ionians, and fixed the year in which it actually did take place Various dates—ranging from 625 B.C to 583 B.C—have been assigned by different chronologists to this eclipse, but, since the investigations of Airy[1], Hind[2], and Zech[3], the date determined by them (May 28, 585 B.C) has been generally accepted (for later authorities *see* ECLIPSE and ASTRONOMY) This date agrees nearly with that given by Pliny

Thales's fame amongst the ancients must have been largely due to this achievement. Thales seems to have left no works (but *see* Diog Laer. i. 23) Many anecdotes are related of him, from some of which it would appear that he was engaged in trade (Plutarch, *Solon, c.* 2) Of the fact that Thales visited Egypt, and there became acquainted with geometry, there is abundant evidence. Hieronymus of Rhodes (ap. Diog Laër. i. 27) says, "he never had any teacher except during the time when he went to Egypt and associated with the priests."[4]

But the important feature of Thales's work was that he founded the geometry of lines, which was essentially abstract in its character The Egyptian priests only had the geometry of surfaces, a sketch of that of solids, *i e*, a geometry consisting of some simple quadratures and elementary cubatures, obtained empirically. Thales introduced *abstract* geometry, the object of which is to establish precise relations between the different parts of a figure, so that some of them may be definitely found by means of others. This was a phenomenon quite new in the world

The following discoveries in geometry are attributed to Thales: —(1) the circle is bisected by its diameter (Procl *op cit.* p 157); (2) the angles at the base of an isosceles triangle are equal (*Id.* p. 250); (3) when two straight lines intersect the vertically opposite angles are equal (*Id.* p 299); (4) the angle in a semicircle is a right angle[5], (5) the theorem Euclid i. 26 (Eudemus, Procl. *op. cit.* p. 352). Two applications to practical problems are also attributed to him:—(1) the determination of the distance of a ship at sea; (2) the determination of the height of a pyramid by means of the length of its shadow: the shadow was measured at the hour of the day when a man's shadow is the same length as himself[6]. According to Plutarch (*Sept. Sap. Conviv.* 2), Thales must have known Euclid vi 4, but without the restriction as to the hour of the day Further, we learn that he perfected the

[1]On the Eclipses of Agathocles, Thales and Xerxes," *Phil. Trans.* vol. cxliii, p. 179 *seq*, 1853

[2]*Athenaeum*, p. 919, 1852

[3]*Astronomische Untersuchungen der wichtigeren Finsternisse*, etc., p. 57, 1853.

[4]Cf. Pamphila and the spurious letter from Thales to Pherecydes, ap. Diog. Laer.; Proclus, *In primum Euclidis Elementorum Librum Commentarii*, ed Friedlein, p. 65; Pliny, *H. N.* xxxvi. 12; Iamblichus, *In Vit. Pythag.* 12; Plutarch, *Sept. Sap. Conviv* 2, *De Iside*, 10, and *Plac* i. 3, 1.

[5]This is unquestionably the meaning of the statement of Pamphila (temp. Nero), ap Diog. Laër i. 24, that he was the first person to describe a right-angled triangle in a circle.

[6]Hieronymus of Rhodes (Diog. Laer. i. 27) and Pliny (*N. H.* xxxvi 12).

theory of the scalene triangle and the theory of lines[1]. Proclus in his summary of the history of geometry before Euclid, says that Thales introduced geometry into Greece from Egypt, and communicated the beginnings of many propositions to his successors

From these indications it is difficult to determine what Thales brought from Egypt and what he himself discovered. This difficulty has, however, been lessened since the translation and publication of the papyrus Rhind by Eisenlohr[2]; and we can deduce certain facts from it. [1] Thales must have known the theorem that the sum of the three angles of a triangle are equal to two right angles. This inference is made from theorems (4) and (2). We know from Proclus, on the authority of Eudemus, that Euclid i. 32 was first proved in a general way by the Pythagoreans; but, on the other hand, we learn from Geminus that the ancient geometers discovered the equality to two right angles in each kind of triangle —equilateral isosceles, and scalene (Apoll *Conica*, ed Halleius, p 9); and the geometers older than the Pythagoreans can only have been Thales and his school. The theorem was probably arrived at by induction, and may have been suggested by the contemplation of floors or walls covered with regular triangular, square or hexagonal tiles. [2] We see also in the theorem (4) the first trace of the conception of geometrical loci, which we, therefore, attribute to Thales. It was in this manner that this remarkable property of the circle, with which, in fact, abstract geometry was inaugurated, presented itself to the imagination:—

> "O se del mezzo cerchio far si puote
> Triangol si, ch'un retto non avesse."—*Par.* c. xiii. 101.

[3] Thales discovered the theorem that the sides of equiangular triangles are proportional. This theorem was probably made use of also in his determination of the distance of a ship at sea.

Let us now consider the importance of the work of Thales I. In a scientific point of view: (*a*) by his two theorems he founded the geometry of lines, which has ever since remained the principal part of geometry; (*b*) he may be considered to have laid the foundation of algebra, for his first theorem establishes an equation in the true sense of the word, while the second institutes a proportion[3]. II. In a philosophic point of view; we see that in these two theorems of Thales the first type of a natural law, *i.e.*, the expression of a fixed dependence between different quantities, or, in another form, the disentanglement of constancy in the midst of variety—has decisively arisen[4]. III Lastly, in a practical point of view: Thales furnished the first example of an application of theoretical geometry to practice[5], and laid the foundation of the methods of measurement of heights and distances.

As to the astronomical knowledge of Thales we have the following notices.—(1) besides the prediction of the solar eclipse, Eudemus attributes to him the discovery that the circuit of the sun between the solstices is not always uniform[6]; (2) he called the last day of the month the thirtieth (Diog. Laër. i. 24); (3) he divided the year into 365 days (*Id.* i. 27); (4) he determined the diameter of the sun to be the 720th part of the zodiac[7]; (5) he remarked on the constellation of the Lesser Bear and instructed his countrymen to steer by it [as nearer the pole] instead of the Great Bear (Callimachus ap. Diog. Laër i. 23, *cf.* Aratus, *Phaenomena*, v. 36 *seq*). Other discoveries in astronomy are attributed to Thales but on doubtful authorities. He did not know, for example, that "the earth is spherical," as is erroneously stated by Plutarch (*Placita*, iii. 10); on the contrary, he conceived it to be a flat disk. The doctrine of the sphericity of the earth, for which the researches of Anaximander had prepared the way, was in fact one of the great discoveries of Pythagoras, was taught by Parmenides, who was connected with the Pythagoreans, and remained for a long time the exclusive property of the Italian schools. (*See* Schiaparelli, 1 Precursori de Copernico nell' Anticchità, 1873)

Philosophy.—Whilst in virtue of his political sagacity and intellectual eminence Thales held a place in the traditional list of the wise men, on the strength of the disinterested love of knowledge which appeared in his physical speculations he was accounted as a "philosopher" (φιλόσοφος). Thales's "philosophy" is usually summed up in the dogma "water is the principle, or the element, of things"; but, as the technical terms "principle" (ἀρχή) and "element" (στοιχεῖον) had not yet come into use, it may be conjectured that the phrase "all things are water" (πάντα ὕδωρ ἐστί) more exactly represents his teaching Writings bearing his name were extant in antiquity; but as Aristotle, when he speaks of Thales's doctrine, always depends upon tradition, the writings were probably forgeries.

From Aristotle we learn (1) that Thales found in water the origin of things; (2) that he conceived the earth to float upon a sea of the elemental fluid; (3) that he supposed all things to be full of gods; (4) that in virtue of the attraction exercised by the magnet he attributed to it a soul. Here our information ends. Aristotle's suggestion that Thales was led to his fundamental dogma by observation of the part which moisture plays in the production and the maintenance of life, and Simplicius's, that the impressibility and the binding power of water were perhaps also in his thoughts, are by admission purely conjectural. Simplicius's further suggestion that Thales conceived the element to be modified by thinning and thickening is plainly inconsistent with the statement of Theophrastus that the hypothesis in question was peculiar to Anaximenes The assertion preserved by Stobaeus that Thales recognized, together with the material element, "water," "mind," which penetrates it and sets it in motion, is refuted by the precise testimony of Aristotle, who declares that the early physicists did not distinguish the moving cause from the material cause, and that before Hermotimus and Anaxagoras no one postulated a creative intelligence

It would seem, then, that Thales sought amid the variety of things a single material cause; that he found such a cause in one of the forms of matter most familiar to him, namely, water, and accordingly regarded the world and all that it contains as water variously metamorphosed; and that he asked himself no questions about the manner of its transformation.

The doctrine of Thales was interpreted and developed by Anaximander, Anaximenes, and Heraclitus The Eleatic Parmenides (*q v.*), noted that, when Thales and his successors attributed to the supposed element changing qualities, they became pluralists; they therefore required that the superficial variety of nature should be strictly distinguished from its fundamental unity Hence, whereas Thales and his successors had confounded the One, the element, and the Many, its modifications, the One and the Not-One or Many became with Parmenides matters for separate investigation In this way two lines of inquiry originated On the one hand Empedocles and Anaxagoras, abandoning the pursuit of the One, gave themselves to the scientific study of the Many; on the other Zeno, abandoning the pursuit of the Many, gave himself to the dialectical study of the One. Both successions were doomed to failure; and the result was a scepticism from which the thought of Greece did not emerge until Plato, returning to Parmenides, declared the study of the One and the Many, jointly regarded, to be the true office of philosophy Thus, meagre and futile as the doctrine of Thales was, all the Greek schools, with the solitary exception of that of Pythagoras, took their origin from it. Not in name only, but also in fact, Thales, the first of the Ionian physicists, was the founder of the philosophy of Greece.

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[1] Diogenes Laërtius (i. 25).
[2] *Ein mathematisches Handbuch der alten Aegypter* (Leipzig, 1877).
[3] Auguste Comte, *Système de Politique Positive*, iii, pp. 297, 300.
[4] P. Lafitte, *Les Grands Types de l'Humanité*, vol. ii., p. 292.
[5] *Ibid.*, p. 294.
[6] Theonis Smyrnaei Platonici *Liber de Astronomia*, ed. Th. H. Martin, p 324 (Paris, 1849). *Cf.* Diog. Laër i. 24
[7] This is the received interpretation of the passage in Diogenes Laërtius, i. 24 (see Wolf, *Gesch. der Astron*, p. 160), where σεληνίου is probably a scribe's error for' ἡλίακου. *Cf.* Apulenus, *Floridа*, iv. 18, who attributes to Thales, then old, the discovery· "quotiens sol magnitudine sua circulum quem permeat metiatur."

of Greek philosophy mentioned *s.v.* PARMENIDES. A. B. Krische, *Forschungen*, pp 34-42 (Gottingen, 1840). (H. JN.; X)

THALLIUM, a metallic chemical element, discovered in 1861 by Sir William Crookes, who, during a spectroscopic examination of the flue-dust produced in the roasting of seleniferous pyrites occurring at Tilkerode in the Harz, observed a green line foreign to all then known spectra He concluded that the mineral contained a new element, to which he gave the name of thallium, from θαλλός, a green twig Crookes presumed that his thallium was something of the order of sulphur, selenium or tellurium; but Lamy, who anticipated him in isolating the new element, found it to be a metal. (Symbol Tl, atomic number 81, atomic weight 204.3.)

Chemical Character.—The chemical character of thallium presents striking peculiarities Dumas once called it the "*Ornithorhynchus paradoxus* of metals" As an elementary substance, it is very similar in its physical properties to lead, it resembles lead chemically inasmuch as it forms an almost insoluble chloride and an insoluble iodide But the hydroxide of thallium, in most of its properties, comes very close to the alkali metals; it is strongly basic, forms an insoluble chloroplatinate (platinichloride), and an alum strikingly similar to the corresponding potassium compounds Yet, unlike potassium or lead, it forms a feebly basic sesquioxide similar to manganic oxide, Mn_2O_3.

Traces of thallium exist in many kinds of pyrites, as used for vitriol-making The only known mineral of which it forms an essential component is the rare mineral crookesite of Skrikerum, Sweden, which, according to Nordenskiold, contains 33.3% of selenium, 45 8% of copper, 3·7% of silver, and 17 2% of thallium The best raw materials for the preparation of thallium are the flue-dusts produced industrially in the roasting of thalliferous pyrites and the "chamber muds" accumulating in vitriol-chambers worked with such pyrites; in both it is frequently associated with selenium. The flue-dusts may contain 0·5-3·5% of thallium, but usually do not exceed the lower value

For the extraction of the metal from chamber mud, the latter is boiled with water, which extracts thallium as sulphate From the filtered solution the thallium is precipitated as chloride by addition of hydrochloric acid, along with more or less of lead chloride The mixed chlorides are boiled down to dryness with sulphuric acid to convert them into sulphates, which are then separated by boiling water, which dissolves only the thallium salt From the filtered solution the thallium is recovered, as such, by pure metallic zinc, or by electrolysis. The (approximately pure) metallic sponge obtained is washed, made compact by compression, fused in a porcelain crucible in an atmosphere of hydrogen, and cast into sticks.

Metallic Thallium.—Metallic thallium is bluish white; it is extremely soft and almost devoid of tenacity and elasticity. Its specific gravity is 11·86 It fuses at 302° C; at about 1,300° It boils and can be distilled in hydrogen gas. Its vapour density corresponds to monatomic molecules. Its salts colour the Bunsen flame a bright green. When heated in air it is readily oxidized, with the formation of a reddish or violet vapour. When exposed to the air it becomes quickly covered with a film of oxide; the tarnished metal when plunged into water reassumes its metallic lustre, the oxide film being quickly dissolved When kept in contact with water and air it is gradually converted into hydroxide, TlOH. It decomposes water at a red heat, liberating hydrogen and being itself converted into the hydroxide. It is readily soluble in nitric and sulphuric acids, but less so in hydrochloric It does not combine with hydrogen, but unites directly with the halogens.

Salts.—Thallium forms two series of salts: thallous, in which the metal is univalent; and thallic, in which it is trivalent. The thallic salts are, however, much less stable than the thallous. In the thallous series many analogies with lead compounds are observed; in the thallic some resemblance to aluminium and gold

Thallous hydroxide, TlOH, is most conveniently prepared by decomposing the solution of the sulphate with baryta water. It crystallizes from its solution in long yellow needles, TlOH or $TlOH+H_2O$, which dissolve readily in water, forming an intensely alkaline solution, which acts as a caustic and greedily absorbs carbonic acid from the atmosphere. Unlike the alkalis, it readily loses its water at 100° C and even at the ordinary temperature, to form the oxide Tl_2O, which is black or black-violet. *Thallic oxide*, Tl_2O_3, is formed when the metal is heated in air or oxygen at 500-700°, by the action of hydrogen peroxide upon alkaline solutions of thallous salts, or by heating thallous nitrate. It decomposes into thallous oxide and oxygen above 800°. The corresponding hydroxide, $TlO{\cdot}OH$, is very unstable A thallothallic oxide, $Tl_2O{\cdot}Tl_2O_3$ or TlO_2 is also known

Thallous chloride, TlCl, is readily obtained from the solution of any thallous salt, by the addition of hydrochloric acid, as a white precipitate similar in appearance to silver chloride, like which it turns violet in the light and fuses below redness into a (yellow) liquid which freezes into a horn-like flexible mass It is also formed when the metal is burnt in chlorine. One part of the precipitated chloride dissolves at 0° C in 500 parts of water, and in 40 parts at 100° C It is less soluble in dilute hydrochloric acid. *Thallous iodide*, TlI, similarly obtained as a yellow precipitate, requires 16,000 parts of cold water for its solution. The yellow crystals melt at 190°, and when cooled assume a red colour, which changes to the original yellow on standing. *Thallous bromide*, TlBr, is a light yellow crystalline powder; it is formed analogously to the chloride. *Thallous perchlorate*, $TlClO_4$, and *periodate*, $TlIO_4$, are interesting inasmuch as they, together with several other thallous salts, are isomorphous with the corresponding potassium salts.

Thallous carbonate, Tl_2CO_3, more nearly resembles the lithium compound than any other ordinary carbonate It is produced by the exposure of thallous hydrate to carbon dioxide, and therefore is obtained when the moist metal is exposed to the air It forms resplendent monoclinic prisms, soluble in water The bicarbonate is not known

Thallous sulphate, Tl_2SO_4, forms rhombic prisms soluble in water, which melt at a red heat with decomposition, sulphur dioxide being evolved. It unites with aluminium, chromium and iron sulphates to form "alums" (*q.v.*) It also forms double salts of the type $Tl_2SO_4(Mg, Fe \text{ or } Zn)SO_4{\cdot}6H_2O$. *Thallous sulphide*, Tl_2S, is obtained as a black precipitate by passing sulphuretted hydrogen into a thallous solution. It is insoluble in water and in the alkalis, but readily dissolves in the mineral acids.

Thallous nitrate, $TlNO_3$, is obtained as white, rhombic prisms by crystallizing a solution of the metal, oxide, carbonate, etc, in nitric acid Various thallous phosphates are known, *e.g.*, $Tl_2HPO_4{\cdot}H_2O$, TlH_2PO_4, Tl_3PO_4, $Tl_4P_2O_7$, etc; they bear a close resemblance to the corresponding phosphates of the alkali metals.

Thallic chloride, $TlCl_3$, is obtained by heating the monochloride with chlorine under pressure, or by saturating a suspension of the monochloride in water with chlorine; when anhydrous it is a crystalline mass which melts at 24°. It forms several double salts, *e.g.*, with hydrochloric acid and the alkaline chlorides. The chlorine is not completely precipitated by silver nitrate in nitric acid solution, the ionization apparently not proceeding to all the chlorine atoms The mixed chlorides $TlCl{\cdot}TlCl_3$ and $3TlCl{\cdot}TlCl_3$ are also produced by the regulated action of chlorine on the monochloride. *Thallic iodide*, TlI_3, is interesting on account of its isomorphism with rubidium and caesium tri-iodides, a resemblance which suggests the formula $TI(I_2)$ for the salt, but T M. Lowry and A. J. Berry (1928) have shown that it does not give the reactions of a thallous salt, and, when dissolved in methyl alcohol, it behaves as a binary electrolyte, *i.e.*, as $(TlI_2)I$ or as $Tl[TlI_4]$. *Thallic sulphate*, $Tl_2(SO_4)_3{\cdot}7H_2O(?)$, and *thallic nitrate*, $Tl(NO_3)_3{\cdot}3H_2O$, are obtained as colourless crystals on the evaporation of a solution of the oxide in the corresponding acid The sulphate decomposes into sulphuric acid and the trioxide on warming with water, and differs from aluminium sulphate in not forming alums.

Thallium salts are used in the manufacture of certain optical glasses on account of the high refractive index conferred on the glass. They are all poisonous, having an action somewhat resembling that of lead salts, and are said to have a pronounced depilatory action, but this has also been denied.

Thallous acetylacetone, $C_5H_7O_2Tl$, prepared from an alcoholic solution of acetylacetone and the hydroxide, is of interest On the application of thallium compounds to organic syntheses, *see* R. C. Menzies, *J Chem. Soc.*, 1924, *et seq.*

Analysis.—All thallium compounds volatile or liable to dissociation at the temperature of the flame of a Bunsen lamp impart to such flame an intense green colour The spectrum contains a bright green of wave-length 5,351 From solutions containing it as thallous salt the metal is easily precipitated as chloride, iodide, or chloroplatinate by the corresponding reagents Sulphuretted hydrogen, in the presence of free mineral acid, gives no precipitate; sulphide of ammonium, from neutral solutions, precipitates Tl_2S as a dark brown or black precipitate, insoluble in excess of reagent Thallic salts are easily reduced to thallous by means of solution of sulphurous acid, and thus rendered amenable to the above reactions. Thallous chloride can be titrated by potassium iodate in moderately concentrated hydrochloric acid solution.

THALWEG, a land-form term adopted into general usage for the continuous line drawn through the lowest points of a river's valley from its source to its mouth. The concave curve thus drawn shows the natural direction of a watercourse.

THAMES, the chief river of England, rising in several small streams among the Cotswold Hills in Gloucestershire Its source is generally held to be at Thames Head, in the parish of Coates, 3 m. west of Cirencester, but claims have also been advanced on behalf of the Seven Springs, the head waters of the river Churn, 5 m south of Cheltenham. The length of the river from Thames Head Bridge to London Bridge is 161½ m. and from London Bridge to the Nore, 47½ m , a total of 209 m The width at Oxford is about 150 ft , at Teddington 250 ft , at London Bridge 750 ft., at Gravesend 2,100 ft , and between Sheerness and Shoeburyness, immediately above the Nore, 5½ m The height of Thames Head above sea-level is 356 ft , Seven Springs 700 ft , and Lechlade 237 ft. and the average fall below Lechlade is 20 in. per mile The Thames forms the boundary between the following counties along its course· Gloucestershire and Wiltshire, Gloucestershire and Berkshire, Oxfordshire and Berkshire, Buckinghamshire and Berkshire, Middlesex and Surrey, and finally, at its estuary, Essex and Kent In the succeeding paragraph the bracketed figures indicate the distance in miles above London Bridge.

The upper course lies through a broad valley The scenery is rural and pleasant; the course of the river winding Before reaching Oxford the stream swings north, east and south to encircle the wooded hills of Wytham and Cumnor, which overlook the city from the west. The Windrush joins from the north (left) at New Bridge (126¾), the Evenlode near Eynsham (119), and the Cherwell at Oxford (112). Between Lechlade and Oxford the main channel sends off many narrow branches; the waters of the Windrush are similarly distributed, and the branches in the neighbourhood of Oxford form the picturesque "backwaters." The river then passes the pleasant woods of Nuneham, and at Abingdon (103¾) receives the Ock from the Vale of White Horse, at Dorchester (95¼) the Thame (left), and it then passes Wallingford (90¾) and Goring (85) The river now bends eastward, and breaches the chalk hills, dividing the Chilterns from the downs of Berkshire From this point as far as Taplow the southern slopes of the Chilterns descend closely upon the river; they are finely wooded, and the scenery is peculiarly beautiful At Pangbourne (80¾) the Thames receives the Pang (right), and at Reading (74¾) the Kennet (right). After passing Reading it bends northward to Henley (65), eastwards past Great Marlow (57) to Bourne End (54), and southwards to Taplow and Maidenhead (49¾), receiving the Loddon (right) near Shiplake above Henley Winding in a south-easterly direction, it passes Eton and Windsor (43½), Datchet (41¼), Staines (36), Chertsey (32), Shepperton (30) and Sunbury (26½), receiving the Colne (left) at Staines, and the Wey (right) near Shepperton Flowing past Hampton Court, opposite to which it receives the Mole (right), and past Kingston (20¼), it reaches Teddington (18¾). Passing Richmond (16) and Kew the river flows through London and its suburbs for a distance of about 25 m , till it has passed Woolwich. Gravesend, the principal town below Woolwich, is 26½ m. from London Bridge The estuary may be taken to extend to the North Foreland of Kent. In the tideway the principal affluents of the Thames are the Brent at Brentford, the Wandle at Wandsworth, the Ravensbourne at Deptford, the Lea at Blackwall, the Darent just below Erith, and the Ingrebourne at Rainham, besides the Medway

The basin of the Thames is of a composite character Thus, the upper portion of the system, above the gap at Goring, is a basin in itself, defined on the west and south by the Cotswold and White Horse Hills and on the east and north by the Chilterns and the uplands of Northamptonshire But there are several points at which its division from other river basins is only marked by a very low parting Thus a well-marked depression in the Cotswolds brings the head of the (Gloucestershire) Coln, one of the head-streams of the Thames, very close to that of the Isborne, a tributary of the upper Avon, the parting between the head-streams of the Thames and the Bristol Avon sinks at one point, near Malmesbury, below 300 ft ; and head-streams of the Great Ouse rise little more than two miles from, and only some 300 ft. above, the middle valley of the Cherwell The White Horse Hills and the Chilterns strike right across the Thames basin, but almost their entire drainage from either flank lies within it, and similarly a great part of the low-lying Weald, though marked off from the rest of the basin by the North Downs, drains into it through these hills. Further, the Kennet continues upward the line of the main valley below the Goring gap, and the Cherwell that of the main valley above it The basin thus presents interesting problems The existence of wide valleys where the small upper waters of the Cherwell, Evenlode and Coln now flow, the occurrence of waterborne deposits in their beds from the north-west of England and from Wales, and the fact that the Thames, like its lower southern tributaries which pierce the North Downs, has been able to maintain a deep valley through the chalk elevation at Goring, are considered to point to the former existence of a much larger river, in the system of which were included the upper waters of the present Severn, Dee and other rivers of the west. The question, in fact, involves that of the development of a large part of the hydrography of England

Tamesis and Isis.—The Thames about Oxford is often called the Isis Caesar (*De Bell. Gall.* v 11) says that at the time of his invasion of Britain it was called Tamesis In the first statute passed for improving the navigation of the river near Oxford (21 Jac. I) it is called the river of Thames, and it was only in a statute of George II (1751) that the word Isis appears The flow of the Thames varies greatly, according to the season of the year. In very dry summers the flow at Teddington has been known to fall as low as 200,000,000 gal. per day and as high as 20,000,000,000 gal in a rainy season. Flooding of the surrounding country is not uncommon, and it becomes a serious menace to the low-lying parts of London, where the river is tidal, when flooding coincides with high spring tides. The importance of storage reservoirs is manifest under such conditions of flow, especially bearing in mind the ever increasing needs of the London district. The water-supply of London is considered under that heading; it may be noted here that the Thames forms its chief source of supply, but apart from this the corporation of Oxford and two companies in the Staines district have powers to draw water from the river.

Throughout the whole of the Thames watershed, and especially in the 3,800 sq m above the intakes of the water companies (at Hampton or in the vicinity), the Thames Conservancy has enforced the requirements of parliament that no sewage or other pollution shall be allowed to pass into the Thames, or any water communicating with it. The Thames is navigable for rowing-boats as far upwards as Cricklade and for barges as far as Lechlade. At Inglesham, three-quarters of a mile above Lechlade, the Thames and Severn canal has its junction with the Thames Barges drawing 3 ft 6 in. can now, even in the summer season, navigate from London to Inglesham.

Construction of Locks.—In 1771 an act of parliament was passed authorizing the construction of pound locks on the Thames above Maidenhead Bridge. In pursuance of the powers thus granted, the Thames Commissioners of that day caused locks

to be built at various points above Maidenhead, and between 1810 and 1815 the corporation of London carried out river works on the same lines as far down the river as Teddington. The works as subsequently maintained by the Thames Conservancy ensure an efficient head of water during the drier seasons of the year, and facilitate the escape of winter floods. The number of locks is 47, including four navigation weirs above Oxford. The uppermost lock is St John's, below Lechlade, the lowest is Richmond

The canals in use communicating with the Thames are the Thames and Severn canal, the Oxford canal, the Kennet and Avon canal from Reading to the Bristol Avon, the Grand Junction at Brentford, the Regent's canal at Limehouse, the Surrey canal at Rotherhithe, the Gravesend and Rochester canal. Navigation is also carried on by the Medway to Tonbridge, on the lower parts of the Darent, Cray and Wey. The Woking, Aldershot and Basingstoke canal joins the Wey, but is little used The vast trade on the estuary, which lies within the bounds of the port of London, as well as the bridges over the river in the London area, are considered under LONDON.

In 1857 the Thames Conservancy board was established Its powers were increased and its constitution varied in 1864, 1866 and 1894, but the creation of the Port of London authority (*see* LONDON) limited its jurisdiction. Fish are abundant, especially coarse fish such as pike, perch, roach, dace and barbel Of trout there are many fine specimens, especially at the weirs. The right of the public to take fish freely from the river has been frequently under dispute and fisheries came under the regulation of bylaws made by the Thames Conservancy

THANA, a town and district in India, in the northern division of Bombay The town is 21 mi from Bombay city, of which it is now practically a suburb Pop. (1941) 29,751.

The DISTRICT OF THANA has an area of 3,526 sq.mi It extends along the coast and is confined between the Western Ghats on the east and the sea on the west, while on the north it is bounded by the Portuguese territory of Damaun and by Surat district, and on the south by Bombay suburban district. The district is well watered and wooded, and, except in the northeast, is a low-lying rice tract broken by hills. Most of the hills were once fortified, but the forts built on them are now dilapidated and useless The only rivers of any importance are the Vaitarna and the Ulhas, the former being navigable for a distance of about 20 mi from its mouth There are no lakes, but the Vehar and the Tulsi, formed artificially, supply Bombay city with water. In 1941 the population was 932,733. The staple crop is rice Fishing supports many of the people, and the forests yield timber and other produce. Salt is manufactured by evaporation along the coast

The territory comprised in the district of Thana (apart from Salsette island, which was acquired in 1782) formed part of the dominions of the peshwa, and was annexed by the British in 1818 on the overthrow of Baji Rao

THANESAR, an ancient town of India, in Karnal district of the Punjab, on the river Saraswati. pop (1941) 6,574 As the centre of the tract called Kurukshetra in the Mahabharata, it is a holy place The bathing fair held here on the occasion of a solar eclipse is said to be attended by 500,000 pilgrims

THANET, ISLE OF, the extreme northeast corner of Kent, England, insulated by the two branches of the river Stour, and forming one of the 11 parliamentary divisions of the county Pop. of parliamentary division (1931) 95,394. Its name is said to be from Saxon *tene,* a beacon or fire (probably from the watchfires on this easily ravaged coast), and numerous remains of Saxon occupation have been found, as at Osengal near Ramsgate. Thanet is roughly oblong in form, its extreme measurements being about 8 mi. from E. to W., and 5 mi. from N to S. The branches of the Stour dividing near Sarre take the place of the former Wantsume, a sea passage which had diminished in breadth to half a mile in the time of Augustine. The Wantsume was guarded by the Roman strongholds of *Regulbium* (Reculver) in the north and *Rutupiae* (Richborough) in the south, and was crossed by ferries at Sarre and Wade. With the drying up of this channel and the closing of Sandwich harbour in the 16th century, the present marshlands or level to the south and west of the isle were left. The sea face of Thanet consists mainly of bold slopes or sheer cliffs, and the eastern extremity is the fine chalk headland of the North Foreland with a lighthouse Containing the popular seaside resorts of Ramsgate, Broadstairs, Margate and Westgate, Thanet is served by the Southern region railway, and Minster is a junction station of the lines to Ramsgate and Sandwich respectively.

THANKSGIVING DAY, a national holiday celebrated throughout the United States, is a day of religious observance, set apart to give thanks for the blessings of the past year, as well as an occasion for family reunions, bountiful dinners and festivities in the home. Originating with the thanksgiving festival held by Plymouth colony, Dec. 1621, in gratitude for the ending of a difficult year and for a successful harvest, it became a particularly popular holiday among the New England colonies. The native fruits and vegetables, wild turkeys and pumpkin pies which constituted the fare of that first thanksgiving feast became the traditional food for the day.

In succeeding years the various New England colonies celebrated thanksgiving days in recognition of such happy events as good harvests and victories over the Indians Pres George Washington in 1789 issued the first presidential thanksgiving proclamation in honour of the new constitution During the 19th century an increasing number of states observed the day annually, each appointing its own date. That Pres Abraham Lincoln, Oct. 3, 1863, by presidential proclamation appointed the last Thursday of November as Thanksgiving Day was due to the unremitting efforts of Mrs. Sarah J Hale, editor of *Godey's Lady's Book* Each succeeding president made similar proclamations, until Pres. Franklin D Roosevelt in 1939 appointed the third Thursday of November. In Dec. 1941, however, congress by joint resolution approved by the president set the fourth Thursday of November as Thanksgiving Day, a national public holiday. Though Thanksgiving Day in the United States is rooted in native tradition, the idea of a day set apart to celebrate the completion of the harvest and to render homage to the spirit who caused the fruits and crops to grow is ancient and universal. Similarly, the practice of designating a day of thanksgiving for specific spiritual or secular benefits has been followed in many countries.

In the United States Thanksgiving, despite its religious association, often had a distinctly secular flavour. The Yankee country Thanksgiving in the middle of the 19th century traditionally featured a raffle of fowls on Thanksgiving Eve and a shooting match in the morning In New York city the day was celebrated by companies of fantastically costumed persons who paraded noisily through the streets. Children dressed in the clothes of their elders went about their neighbourhoods begging for money or for contributions of fruits and vegetables

Canada has long celebrated a Thanksgiving Day, the date varying from year to year, but finally generally placed on the second Monday in October. Pan-American Thanksgiving Day, observed annually by representatives of the Latin American countries in the nation's capital, was first celebrated in 1909.

See F. B. Hough, *Proclamations for Thanksgiving* (1858); W. D Love, *The Fast and Thanksgiving Days of New England* (1895)

(J K So)

THANN, a town of France, capital of an arrondissement in the department of Haut-Rhin, on the Thur, 16 mi. by rail N.W. of Mulhouse. Pop. (1946) 6,017. In the course of World War I Thann was taken by the French in 1914, and was bombarded from time to time. The fine Gothic church of St. Theobald (1351) escaped serious injury; it has a tower (1459–1516) with a beautiful spire. Above the town are the ruins of the castle of Engelburg, destroyed by Turenne in 1675 Thann is the seat of a subprefect. It has a stone quarry, metal foundries and manufactories of chemical products, machinery and textiles.

THAPSACUS (Tiphsah, modern Kalat Dibse, also called for a short time Amphipolis), formerly an important crossing place on the Euphrates (*q.v.*), about 8 miles below Meskene in 36° N 38° E The city seems to have stood on the right bank and on the direct line to Syria. It was used as a centre from which to measure distances by Eratosthenes. The earlier crossing place

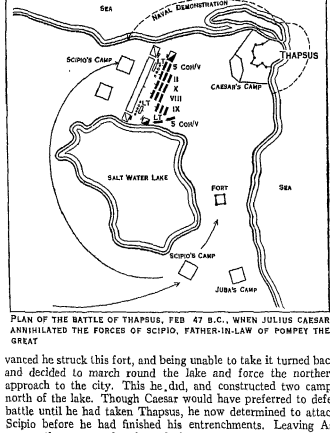
seems to have been higher up the river, but Xenophon, who reports that it was a large prosperous city, forded his army here, and by the time of Alexander there was a bridge of boats

THAPSUS, a low peninsula, now known as Magnisi, joined by a narrow isthmus to the mainland of Sicily, about 7 m N N W of Syracuse. The Athenians used it as a naval station in their attack on Syracuse early in 414 B C A number of tombs contained objects belonging to a transitional stage between the second and third Sicel period, attributable roughly to 1000–900 B C, with a proportion of Mycenean importations

See Orsi in *Monumenti dei Lincei* (1897), vi. 89–150.

THAPSUS, BATTLE OF (47 B.C.). After his victory at Pharsalus Julius Caesar followed Pompey to Egypt, where the Pompeians accumulated a large army and were joined by Juba, king of Numidia A battle was fought at Ruspina in which Caesar was almost overwhelmed, after which he moved to Vesta and besieged it, withdrew on account of lack of supplies, and, in order to compel Scipio to battle, marched on Thapsus, an ancient city of North Africa in the province of Byzacium (the modern province of Tunis), on the coast more than 100 m. north of Carthage Thapsus contained large military stores, was strongly garrisoned and blockaded by Caesar's fleet On Feb 4, 47 B C he arrived before the city, and immediately besieged it This drove Scipio into action, for he at once advanced on Thapsus and threw up two entrenched camps, one for his own men and the other for Juba's eight miles south of the city.

The manoeuvres which now followed were controlled by a salt water lake, the modern Sebka di Moknine, which lies to the south-west of Thapsus. Caesar had entirely surrounded the town, but Scipio considered that it was still possible to relieve it from the south Caesar had foreseen the likelihood of this move, and had built a strong fort in the centre of the strip of land which separates the eastern margin of the lake from the sea When Scipio advanced he struck this fort, and being unable to take it turned back and decided to march round the lake and force the northern approach to the city. This he did, and constructed two camps north of the lake. Though Caesar would have preferred to defer battle until he had taken Thapsus, he now determined to attack Scipio before he had finished his entrenchments. Leaving Asprenas, the pro-consul and two legions to carry on the siege, with the rest of his force he marched against Scipio One half of his fleet he left to continue the blockade, and the other he ordered to sail down the coast, and make a demonstration against Scipio's rear Placing his left on the coast, Scipio drew up his army in three lines with his elephants and light troops in front of his right and left wings, his Numidian cavalry on the left, and the rest of his cavalry and light troops on the right Advancing on him, Caesar also extended his army into three lines with the II and X legions on the right, the VIII and IX. on the left, and five legions in the centre His flanks he covered by five chosen cohorts supported by archers, slingers and cavalry



PLAN OF THE BATTLE OF THAPSUS, FEB 47 B.C., WHEN JULIUS CAESAR ANNIHILATED THE FORCES OF SCIPIO, FATHER-IN-LAW OF POMPEY THE GREAT

As Scipio's camp was but half dug, Caesar's men wished to advance at once Caesar, however, was not over anxious to precipitate the battle because he was largely outnumbered by the Numidian cavalry Whilst he hesitated, the X legion suddenly sounded the charge which was repeated all down the line. The archers and slingers soon overwhelmed Scipio's elephants with their arrows and stones, driving them back on their own line, where they not only demoralized the infantry but scattered the left wing horse The infantry lines then clinched, fighting each other until sunset, when Scipio's right wing became demoralized This affected the centre, and soon the entire line broke and sought refuge in the half-completed camp, which was speedily captured by a double envelopment of Caesar's wings Scipio's force was annihilated in an awful slaughter of which Mommsen writes "If the hydra with which they fought always put forth new energies, if the army was hurried from Italy to Spain, from Spain to Macedonia, from Macedonia to Africa, and if the repose ever more eagerly longed for never came, the soldier sought, and not wholly without cause, the reason of this state of things in the unseasonable clemency of Caesar" Fifty thousand corpses were strewn over the battlefield of Thapsus, and among them were several Caesarian officers known as opponents to the new monarchy

In this battle neither strategy nor tactics are remarkable, but what is so is the insubordination of the men, and their growing sense of mastership in the new order which Caesar was creating. He wished to found an Empire, and aimed at a complete victory, constantly taking tremendous risks and ignoring the units. The soldiers wanted peace, so that they could return to their homes and families At Thapsus a battle was begun between the will of Caesar and the desires of his men, it was slow and progressive, and did not end until Alaric had sacked Rome *See* Pharsalus, Battle of; *Bibliography.*

(J F C F)

THARAUD, JEROME (1874–1953), French man of letters, was born on March 18, 1874, at Saint-Junien, Haute Vienne, and educated at the collège Sainte-Barbe and the *Ecole normale supérieure.* He became a lecturer at the University of Budapest In collaboration with his brother Jean (1877–1952), he gained the Prix Goncourt in 1908, and the *grand prix de littérature* at the French academy in 1920. The brothers are joint authors (J J Tharaud) of all their works Jerome was elected to the French academy in 1938. He died Jan. 28, 1953

Their works include, *Dingley, l'illustre écrivain* (1902); *Bar-Cochebas* (1907); *La Maîtresse Servante* (1910), *La Bataille à Scutari d'Albanie* (6th ed., 1913), *La Tragédie de Ravaillac* (1913), *La Vie et la Mort de Déroulède* (1914), *L'Ombre de la Croix* (1917), *Un Royaume de Dieu* (1920); *Quand Israël est roi* (1921), *Rendezvous espagnols* (1925), *La Rose de Saron* (1927). *See* J. Bonnerot, *Jérôme et Jean Tharaud, leur oeuvre* (1927)

THARGELIA. A Greek festival bearing signs of very high antiquity, in historical times part of the cult of Apollo, but quite possibly, indeed probably, older than its arrival in Greece The name is derived from *θάργηλος,* which signifies an offering of some sort (exact nature and etymology quite uncertain) used at the festival. In Attica, it was held on the 6th and 7th of the month Thargelion, to which it gave its name; the latter date (toward the end of May) was supposed to be Apollo's birthday. On the 6th, certainly at Athens and probably elsewhere, two persons known as *pharmakoi* (magical people, "medicine men"), who had been chosen for their ugliness, were beaten with plants of a magically purifying value, including squills; being thus filled with good magic, they were led through the city, presents of food being made to them In classical times they seem to have been regarded chiefly as scapegoats, and some pretense was made of stoning or burning them to death; it is, however, fairly clear that this was not their only significance. In Attica they were called *σύβακχοι;* their

connection with Apollo is simply that he is the great god of purification They occur elsewhere in Ionian ritual.

On the 7th, sundry holy things, very likely *including an εἰρεσιώνη* (*see* PYANEPSIA), were carried in procession, and an important musical festival, with prizes for the best chorus, was held in honour of Apollo, this is the only rite which definitely can be said is Apolline, and not taken from some still earlier ceremony It is noteworthy that on the 6th an offering of a ram was made to *Demeter Chloe* The principal part of the festival was, therefore, agricultural, as already suggested, Apollo perhaps took it over because it was in part purificatory, it certainly had no intimate relation to his worship

BIBLIOGRAPHY.—A. Mommsen, *Feste der Stadt Athen*, p. 468 *et seq.* (1898), M P. Nilsson, *Griechische Feste*, p 105 (1906), L R Farnell, *Cults of the Greek States*, vol iv, p 267 *et seq.* (1907). For the pharmakoi *see* V Gebhard, *Die Pharmakoi in Ionien und der Sybakchoi in Athen* (Amberg, 1926; bibl)

THAR PARKAR, a district of India in the Sind province of Bombay Area, 13,649 sq mi. Pop. (1941) 581,004 The district is divided into two portions The western part, called the Pat, is watered by the Eastern Nara canals and the Jamras canal, which constitute the water systems of the district, and the presence of water has created a quantity of jungle and marsh, the other part, called the Thar, is a desert tract of rolling sand hills, running northeast and southwest, composed of a fine but slightly coherent sand To the southeast of Thar is Parkar, where there are ranges of rocky hills, rising to 350 ft. above the surrounding level, and open plains of stiff clay This portion contains the ruins of several old temples The principal crops are millets, rice, wheat, oilseeds and cotton. Mirpur Khas is the administrative headquarters of the district The town lies on the Jodhpur-Bikanes metre-gauge line, which connects it with Hyderabad and Rajputana. A feeder line runs north from Mirpur Khas to Khadro, and another south to Jhudo. (*See* also INDIAN DESERT)

THARRAWADDY, a town and district in the Pegu division of Burma The town has a station on the railway, 68 mi. N W of Rangoon. Pop. (1931), 7,131. The district has an area of 2,815 sq.mi. The Pegu Yoma range separates it from Toungoo district, and forms the water-parting between the rivers Irrawaddy and Sittang; there are also many small elevations. The Irrawaddy is the principal navigable river. Teak forests and fuel reserves cover more than a quarter of the whole area. Among the wild animals found in the mountains are elephant, bison and various kinds of feathered game. The rainfall ranges from about 60 to 90 in Pop (1941), 593,909, showing an increase of 15,880 in the decade. The railway runs through the centre of the district, with ten stations The chief towns are Letpadan (12,160); Gyobingauk (7,675); Zigôn (6,338), Thonzè (7,962); Nattalin (5,633) and Minhla (4,413) The staple crop is rice. The history of the district is identical with that of Henzada (*q v.*) Tharrawaddy was formed in 1878 out of that portion of Henzada lying east of the Irrawaddy

THARROS, an ancient town of Sardinia, situated on the west coast, on the narrow sandy isthmus of a peninsula at the north extremity of the Gulf of Orstano, now marked by the tower of S. Giovanni di Sinis It was 12 mi W. of Othoca (Oristano) by the coast road, which went on northward to Cornus and from there to Turris Libisonis. It was of Phoenician origin but continued to exist in Roman times. It was destroyed by the Saracens in the 11th century. In the necropolis to the south of Tharros many Phoenician tombs have been excavated, they are rectangular or square chambers cut in the rock, measuring from 6 to 9 ft each way. Some 3 mi. to the north is the church of S Salvatore, with underground rock-cut chambers below it with walls decorated with pre-Christian paintings

THASOS, Greek island in the north of the Aegean sea, off the coast of Thrace and the plain of the river Nèstos (Turk. *Kara-Su*). Herodotus (ii. 44; vi, 44–48) tells of an early Phoenician settlement, of gold mines, and of a temple of Heracles· Thasus, son of Phoenix, gave his name to the island. In 720 or 708 B.C. Thasos received a Greek colony from Paros. In a war between the Parian colonists and the Saians, a Thracian tribe, the poet Archilochus threw away his shield The Greeks owned gold mines also on the mainland From these sources the Thasians drew annual revenues of from 200 to 300 talents. The Athenians, after a siege of two years, compelled the Thasians in 463 to destroy their walls, surrender their ships, pay an indemnity and an annual contribution (in 449 this was 2½ talents, from 445 about 30 talents), and resign their mainland possessions After the battle of Aegospotami (405 B.C.), Thasos again fell into the hands of the Lacedaemonians under Lysander who formed a decarchy there. In the dispute between Philip V and the Romans, Thasos submitted to Philip, but received its freedom after Cynoscephalae (197 B.C.) After a period of Latin occupation in the 13th century it was captured by the Turks in 1462 After the close of the first Balkan War it was, by the terms of the Treaty of London, May 30, 1913, ceded by Turkey to Greece. The capital stood on the north coast, and had two harbours The highest mountain, Ipsario, is 3,947 ft high. Besides gold, it produces wine, nuts and marble. Germany occupied it in 1941.

The population, 8,000, is distributed in ten villages, mostly at some distance from the sea, for the island suffered from pirates The people are Greek Christians, and do not differ in appearance from the inhabitants of the other Greek islands.

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THATÔN, a town and district in the Tenasserim division of Burma. The town is situated below a hill range, 10 mi. from the sea It was formerly the capital of the Talaing kingdom and a seaport. Pop (1931), 16,851 The district has an area of 4,870 sq mi., pop (1941) 592,638.

THAXTER, CELIA LAIGHTON (1835–1894), U.S poet, was born at Portsmouth, N.H., on June 29, 1835. In 1841 her father, Thomas B Laighton, became keeper of the White Island lighthouse in the Isles of Shoals, a small barren group ten miles off Portsmouth Her girlhood was spent in marine surroundings which coloured the best of her verse. Her poems, mainly lyrical, deal with sympathetic fidelity with aspects of her island life—with the beacon-light, the sea storm, the glint of sails, the sand piper on the beach and the flowers among the rocks. Her works include *Poems* (1871), *Poems for Children* (1884) and *The Cruise of the Mystery and Other Poems* (1886). She wrote also *Among the Isles of Shoals* (1873), prose sketches of life and scenery, stories for children and *An Island Garden* (1894), a book on floriculture. She married in 1851 Levi L. Thaxter (d. 1884), a devoted student of Browning's poetry, and spent most of her life on Appledore, one of the Isles of Shoals, where she died on Aug. 26, 1894.

THAXTER, ROLAND (1858–1932), U.S. botanist, was born in Newton, Mass., on Aug 28, 1858. He graduated in 1882 from Harvard university, from which he received the degree of doctor of philosophy in 1888. He served as assistant in biology at Harvard from 1886 to 1888, and from 1888 to 1891 as mycologist at the Connecticut agricultural experiment station. He was assistant professor of cryptogamic botany at Harvard from 1891 to 1901 and professor from 1901 until 1919, when he became professor emeritus. In 1909 he served as president of the Botanical Society of America and in 1912 he was elected member of the National Academy of Sciences. He died April 22, 1932. *See* G P. Clinton, *Biographical Memoir of R Thaxter* (1936).

THAYER, ABBOTT HANDERSON (1849–1921), U.S. artist, was born at Boston, Mass., Aug 12, 1849. He was a pupil of J. L. Gérôme at the École des Beaux Arts, Paris, and became a member of the Society of American Artists (1879), of the National Academy of Design (1901) and of the Royal Academy of San Luca, Rome. As a painter of portraits, landscapes, animals and the ideal figure, he won high rank among American artists.

Thayer is also well known as a naturalist. He developed a theory of "protective coloration" in animals (*see* COLOURS OF ANIMALS), which has attracted considerable attention among naturalists According to this theory, "animals are painted by

nature darkest on those parts which tend to be most lighted by the sky's light, and vice versa," and the earth-brown of the upper parts, bathed in skylight, equals the skylight colour of the belly, bathed in earth-yellow and shadow. During the World War he worked in England on the development of camouflage. He died at Dublin (N H), May 29, 1921.

See his article, "The Law which underlies Protective Coloration," in the *Annual Report* of the Smithsonian Institution for 1897 (1898); and *Concealing Coloration in the Animal Kingdom* (1910), a summary of his discoveries, by his son, Gerald H Thayer.

THAYER, WILLIAM ROSCOE (1859–1923), American writer, was born in Boston (Mass.) on Jan. 16, 1859. After travel abroad with a private tutor, he graduated at Harvard in 1881. In 1918 he was elected president of the American Historical association and was awarded numerous other scholarly honours. He died at Cambridge (Mass.) on Sept. 7, 1923. Thayer was best known for his works on Italian history, especially *The Dawn of Italian Independence* (1893); *A Short History of Venice* (1905), and *The Life and Times of Cavour* (1911). His *Letters* (1926) were edited by C. D. Hazen.

THAYETMYO, a town and district in the Magwe division of Burma. The town is situated on the right bank of the Irrawaddy, opposite Allanmyo. Pop. (1931) 9,279. The cantonment is no longer used, and the population and importance of Thayetmyo have tended to decrease with the rise of Allanmyo (12,511 in 1931) on the opposite bank of the Irrawaddy. There is a special industry of silver work.

The district has an area of 4,642 sq mi.; pop. (1941) 297,434. The rainfall ranges between 30 and 50 inches. On the west is the Arakan Yoma range, and on the east the Pegu Yomas; and the face of the country, where it does not rise into mountains, is everywhere broken by low ranges of hills, many of which are somewhat barren. The chief river is the Irrawaddy, which traverses Thayetmyo from north to south

Products are rice, cotton, ground nuts, oilseeds and tobacco; cutch is also abundant, and the manufacture of the dyestuff is carried on extensively.

THEACEAE, an important family of dicotyledonous plants, all shrubs or trees, with 23 genera and more than 400 species, chiefly tropical and subtropical, in both hemispheres. Important genera are *Camellia*, wholly Asiatic, named in honour of G. J. Kamel, with 50 or more species, among them tea, *C. sinensis*, the cultivated camellia, *C. japonica*, and the Chinese tea oil plant, *C. drupifera*. *Stewartia* and *Franklinia* species are often cultivated for ornamental purposes. *Laplacea* has 26 species, chiefly in tropical America, the closely allied *Guidonia* having in excess of 30 species, mostly Asiatic. *Ternstroemia*, with 90 or more species and *Eurya*, with 100 or more species, occur in both hemispheres.

For a consideration of the genera *see* H. Melchior in Engler and Prantl, *Die Natürlichen Pflanzenfamilien*, ed. 2, vol. 21, pp. 109–154, fig. 59–67 (1925). (*See also* TEA.)

THEAL, GEORGE McCALL (1837–1919), British historiographer, was born in Canada in 1837, and became a schoolmaster in Cape Colony in 1858. He developed an interest in the natives and in the history of the country, and after settling a dispute with the Gaika Kafirs on behalf of the government (1877), joined the Cape civil service, in the native department. He was also appointed keeper of the archives, and in 1891 was made colonial historiographer, a position which he held until 1905. He died at Wynberg, Cape Province, on April 17, 1919.

He published a *History of South Africa* (*1486–1872*) (5 vols., 1888–93), official *Records of South East Africa* (9 vols., 1898 etc.); *Records of Cape Colony, 1793–1827* (36 vols., 1897 etc.); *The Beginning of South African History* (1902); and many other works, some in Dutch.

THEATRE, a building or place furnished with seats and provided with a stage upon which plays or dramatic spectacles are performed; a playhouse. In treating fully the various aspects of the theatre, the following sections are presented in this article: (A) *Architecture:* (1) *Development*, (2) *Modern Exteriors and Interiors*, (3) *General Planning*, (4) *Modern Theory of Design;* (B) *Production and Direction.* (1) *Modern Tendencies*, (2) *Direction and Acting*, (3) *The Actor*, (4) *Theory of Modern Production.* (X)

ARCHITECTURE

DEVELOPMENT

In considering the form of the modern theatre building, its physical aspect, and in tracing the origins and development of that form from the earliest known theatres of Europe, the investigator does well to keep constantly in mind the basic meaning of the word "theatre." From the Greek θεαθαι, it means roughly "a place for seeing." In a short survey of the subject it is not necessary to mention pre-Greek theatres, beyond saying that there is no known connection between those of earlier civilizations and the playhouse with which the history of drama in the Western world is generally supposed to start—the theatre of Dionysus at Athens.

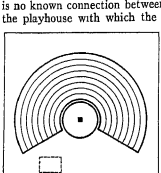


FIG 1—PLAN OF GREEK THEATRE OF EARLIEST TYPE

Greek Theatre.—The first Greek theatres, according to those who have studied the subject most thoroughly, were little more than marked-out dancing-circles, each around an altar, at the foot of hillsides on which spectators stood or sat From this natural form the first *built* theatres took their main outlines. a circle or *orchestra* (ὀρχήστρα) for the chorus and actor or actors, and rising tiers of wooden seats, built against a hillside for the spectators These seats extended usually around two-thirds or more of the orchestra, since at this time dancing or movement was more important than acting, and there was no stage for the spectators to face The type of the first built theatres is shown in fig 1 It should be kept in mind, however, that in no period were any two Greek theatres exactly alike, and exceptions to this general type were common.

Taking the theatre of Dionysus as an example, one notes that the temple of Dionysus Eleuthereus appeared in relation to the theatre approximately as indicated in the diagram (all within the precinct sacred to Dionysus on the south-eastern side of the Acropolis). One conjecture is that the architectural form of this 6th century temple helped to determine the shape of the stage building which was later to be added at the edge of the circle opposite the seats. But the more widely accepted theory is that out of necessity a hut or tent (σκηνή) was added at the edge of the orchestra as a retiring-room for the actors, for changes of costume, etc.; and that the stage building was in all later ages an elaboration of this rude shelter—dressed, in the Greek period, with those beautiful architectural forms with which the Athenians adorned all their important structures.

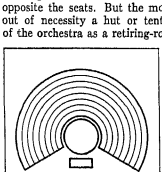


FIG. 2.—THE THREE-PART THEATRE ARRANGEMENT OF SEATS, ORCHESTRA AND SKENE

Just when this *skene* became truly a stage building, with definite and studied relationship to orchestra and auditorium, is a matter of conjecture As a step in the development of the larger theatre form, we may think of the three parts of the theatre as developing gradually into a set arrangement as shown in fig. 2.

Here one sees the accretion of the three features that characterized theatre building through many succeeding centuries: (1) θέατρον, or auditorium; (2) orchestra; and (3) scene, names which persist even to-day. But at this time players appeared only in the orchestra, the scene remaining an architectural background to the action and a practical retiring-house for the actors, structurally separated from the auditorium, by entrances or runways, called παραδοι (Lat. *parodi*).

Such was the theatre form when the 5th century B C dawned, and such it remained, with only slight changes, in all probability, during the period of Aeschylus, Sophocles and Euripides. The architectural features and the height of the *skene* are still only to be conjectured, though recently excavated foundations at Athens indicate clearly the plan and limits of an early stage building, wider than the dancing circle and with ends projecting forward toward the auditorium

Archaeologists have waged one of their bitterest battles over the question as to when the raised stage made its first appearance, but in the "high" period of Greek drama it is now almost unanimously agreed that there was no platform stage The theatre at Athens had taken this general form, with probably a portico at the front of the scene building, between the *paraskenia* (fig. 3).

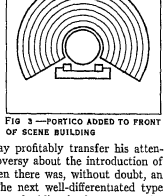


FIG 3 —PORTICO ADDED TO FRONT OF SCENE BUILDING

In Greece the theatres were regularly built in hillside hollows, thus avoiding any need to build supporting framework for the tiers of seats, except perhaps at the ends of the "rings" The auditorium was broken by up-and-down aisles with steps, into a number of wedge-shaped "segments" of seats, and sometimes by one or more lateral aisles.

The student of later forms may profitably transfer his attention to a point beyond the controversy about the introduction of the raised stage to that time when there was, without doubt, an auxiliary platform for acting. The next well-differentiated type of theatre is that in which the stage building is characterized by a high narrow platform on the audience side, called at times the *proskenion* (from which our "proscenium" is derived), and at others the *logeion* or "place for speaking" As acting has become more and more important, the *skene* has developed into a combined architectural background and platform for lifting the actor into clearer view (fig. 4). It is to be noted here that the typical Greek separation of auditorium and scene building still exists, although *acting* now is divided between the orchestra and a stage in our later sense. Through the late Greek and the so-called Greek-Roman periods, the narrow *logeion* doubtless went through a gradual widening process.

Roman Theatre.—The existing ruins of Roman theatres give absolute evidence regarding the arrangement of the Roman stage

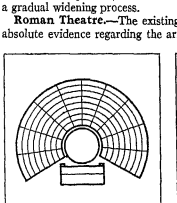


FIG. 4.—A PLATFORM ADDED AS PART OF THE SKENE

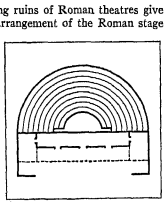


FIG 5 —PLAN OF TYPICAL ROMAN THEATRE AS A STRUCTURAL UNIT

and auditorium. The two heretofore separate buildings have now been pushed together to form one structure, which is not placed as in Greek times against a hillside hollow, but is erected as a free-standing building supported by arch construction; the orchestra has been contracted to a half-circle, and is now added to the seating space; and all the acting is done on a platform stage, behind which the greatly enlarged *skene* and *paraskenia* rise, with rich architectural ornamentation, to a considerable height. The type plan is shown in fig. 5. A special type of theatre with wooden platform stage, for comedies, as shown in many extant vase paintings, is disregarded here as having little or no influence on the traditional or persisting form of theatre.

In the Roman theatres there were no built-in facilities for scene changing, and it may be assumed that in general there was no painted scenery and no effort to indicate change of locality, though elaborate "stage machinery" for trick effects, apparitions, etc., is described by contemporary writers In general, the architecture of the stage wall was the "scene" This wall was regularly pierced by five doorways, three at the back and one in each of the *paraskenia*. The large centre door was the "palace entrance."

(S CHE)

The larger of the two theatres at Pompeii dates from the Hellenistic period but was thrice reconstructed and it is not clear to what date we are to assign the low stage of Roman pattern. Probably it belongs to the earliest period of the Roman colony at Pompeii founded by Sulla 80 B C. The theatre of Pompeii is said by Plutarch to have been copied from that of Mytilene which suggests that the Roman theatre was derived from a late Greek model and this is made probable by the existence of transitional forms

During the Republican period the erection of permanent theatres with seats for the spectators was thought to savour of Greek luxury and to be unworthy of the stern simplicity of Roman citizens Thus in 154 B.C. Scipio Nasica induced the senate to demolish the first stone theatre which had been begun by C. Cassius Longinus. Even in 55 B C when Pompey began the theatre of which remains still exist in Rome he thought it wise to place a shrine to Venus Victrix at the top of the cavea, as a sort of excuse for having stone seats below it—the seats in theory serving as steps to reach the temple This theatre which was completed in 52 B.C is spoken of by Vitruvius as "the stone theatre" *par excellence:* it is said by Pliny to have held 40,000 people, but Huelsen has shown that this statement was exaggerated and estimates the number of spectators at between 9,000 and 10,000 It was also used as an amphitheatre for the bloody shows in which the Romans took greater pleasure than in the intellectual enjoyments of the drama. At its inauguration 500 lions and 20 elephants were killed by gladiators. Near it two other theatres were erected, one begun by Julius Caesar and finished by Augustus in 13 B C. under the name of his nephew Marcellus and another built about the same date by Cornelius Balbus Little remains of the latter, but the ruins of the theatre of Marcellus are among the most imposing which now exist in ancient Rome.

A long account is given by Pliny of a most magnificent temporary theatre built by the aedile M Aemilius Scaurus in 58 B C. It is said to have held the incredible number of 80,000 people and was a work of most costly splendour. Still less credible is the account which Pliny gives (H. N. xxxvi. 116) of two wooden theatres built by C. Curio in 50 B.C. which were made to revolve on pivots so that the two together could form an amphitheatre in the afternoon after having been used as two separate theatres in the morning.

All Roman provincial towns of any importance possessed at least one theatre and many of these are partly preserved. Covered theatres were sometimes built, whether on account of climatic conditions (as at Aosta) or more commonly for musical performances. These latter were generally called *Odea* (a place for singing). The best preserved is the Odeum of Herodes Atticus, at the south-west angle of the Athenian Acropolis, which has a semicircular orchestra. It was built in the reign of Hadrian by Herodes Atticus. Its cavea which is excavated in the rock, held about 6,000 people; it was connected with the great Dionysiac theatre by a long and lofty porticus or stoa of which considerable remains still exist, probably a late restoration of the stoa built by Eumenes II. of Pergamum It was also a common practice to build a small covered theatre in the neighbourhood of an open one, where performances might take place in bad weather. We have an example of this in Pompeii The Romans used scenery and stage effects of more elaboration than did the Greeks. Vitruvius (iii. 7) mentions three sorts of movable scenery.—(1) for the tragic drama, facades with columns representing public buildings; (2) for comic plays, private houses with practicable windows and balconies such as are shown on Graeco-Roman vases of the latest type, with

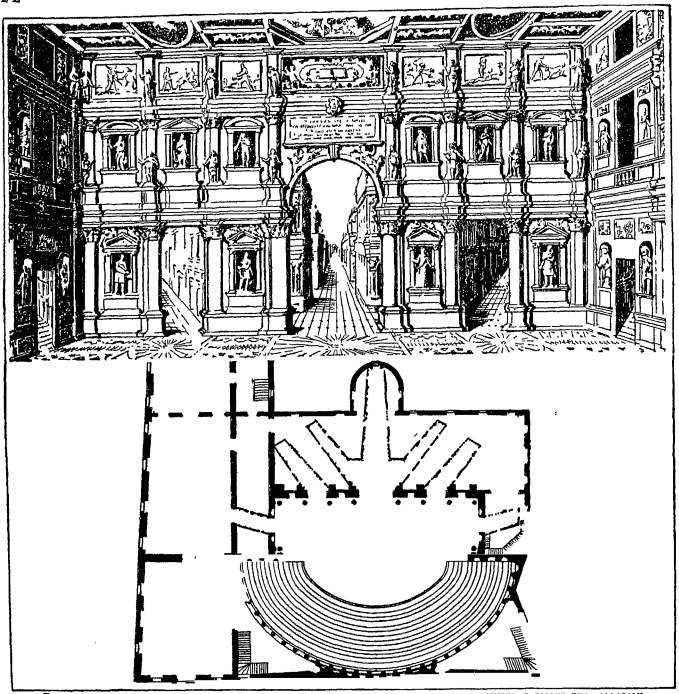


FIG. 6.—PLAN AND STAGE WALL OF THE THEATRE OF THE OLYMPIAN ACADEMY, VICENZA, ITALY, SOMETIMES CALLED THE PALLADIAN THEATRE AFTER ITS FAMOUS ARCHITECT, ANDREA PALLADIO (1518–1580). IT PRESERVES THE ROMAN FORM WITH THE FIVE CLASSIC DOORWAYS AND PROVIDES FOR INTRODUCING SCENERY (NOT AS YET CHANGEABLE)

paintings of burlesque parodies of mythological stories, and (3) for the satyric drama, rustic scenes, with mountains, caverns and trees. (X.)

Renaissance Theatre.—The classic theatres were disused after Roman civilization faded, but it was the classic theatre that determined the form of the playhouse built by the learned academies in the cities of Renaissance Italy, and they were the links between the ancient theatre and that of to-day. At Vicenza, the Renaissance theatre of the Olympian academy, sometimes called the Palladian theatre after its famous architect, still exists, with all its distinctive architectural features and ornament intact. It is, in effect, a small Roman theatre roofed over and made more compact, with typical Renaissance modification of Roman motifs in the decoration. The stage wall is heavily encrusted with architectural ornamentation and statuary, and the five classic doorways are in orthodox position. One addition, made by Scamozzi in 1585, links this classic stage with the theatres of later times In that year were constructed the vistas or "perspectives" behind the five doorways of the stage wall, forming the earliest "make-believe" scenes that have been preserved for posterity. (Already the mystery and miracle stages had in cases been characterized by a combination of half-formed architectural "stations" and realistic localized scenes like the famous "Hell-mouth"; and the court masques were being staged with picture scenes, including the "perspective" type.) The Roman-type building and the added vistas at Vicenza form a plan as shown in fig. 6.

The picture scenes were not yet designed as localized backgrounds for the action so much as an added spectacular attraction, in the Italian masques, and at first the "new style" settings had little effect on the form of the classic-revival playhouses; but the appeal of such pretty playthings could not be long denied, and the modern playhouse emerged where the two currents met. Thus

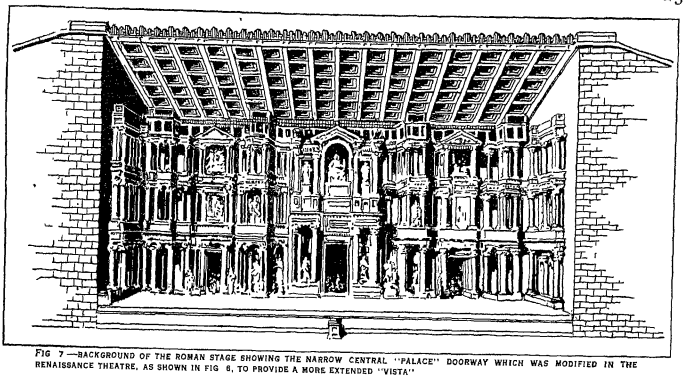


FIG 7.—BACKGROUND OF THE ROMAN STAGE SHOWING THE NARROW CENTRAL "PALACE" DOORWAY WHICH WAS MODIFIED IN THE RENAISSANCE THEATRE, AS SHOWN IN FIG 8, TO PROVIDE A MORE EXTENDED "VISTA"

the Palladian theatre at Vicenza takes on double importance as *historic evidence*: (1) as preserving the Roman playhouse form, including the rigid architectural stage; and (2) as providing for introduced "scenery" (not as yet changeable) The backgrounds of the Roman and Palladian Renaissance stages are shown in fig. 7 There are extant plans which indicate that certain artists of the time, trying to think through to a more practical combination of the classic stage with provision for pictorial backgrounds, saw a means in the widening of the central "palace" doorway to provide acting space within the "vista." Thus Inigo Jones made a plan and an elevation similar to those shown in fig 8 And the theatre at Sabbioneta (of which the scene unfortunately no longer exists) showed the whole stage as one narrowing vista (1588); *see* fig 10.

The next step is illustrated in the playhouse that is usually called "the first modern theatre," the Teatro Farnese at Parma (1618 or 1619), diagram of which *is shown in fig 9*. Here the entire stage may be said to have been pushed through the central doorway of the old stage wall, the ornamentation of the Roman *skene* remaining only as decoration of what is now the proscenium

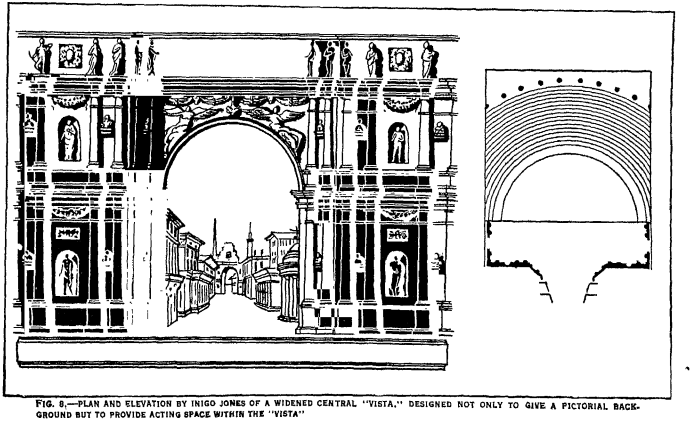


FIG. 8.—PLAN AND ELEVATION BY INIGO JONES OF A WIDENED CENTRAL "VISTA," DESIGNED NOT ONLY TO GIVE A PICTORIAL BACKGROUND BUT TO PROVIDE ACTING SPACE WITHIN THE "VISTA"

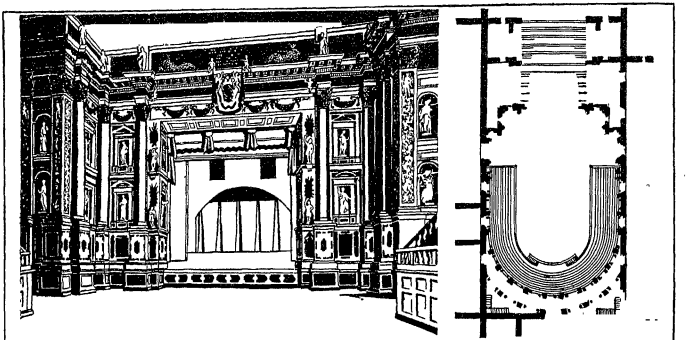


FIG. 9.—PLAN AND ELEVATION OF "THE FIRST MODERN THEATRE" (1618–19), THE TEATRO FARNESE AT PARMA, ITALY. (A) SHOWS THE STAGE CURTAINED OFF FROM THE AUDITORIUM, (B) THE U-SHAPED AUDITORIUM, A NEW INFLUENCE IN THEATRE DESIGNING

arch. The stage within is curtained off from the auditorium (fig. 9*A*) and is thus adapted to changing pictorial settings. From this time on the curtained stage and proscenium arch are unfailing features of the theatre. The plan of the Farnese theatre is particularly interesting, too, as showing the entry of another influence into the shaping of the auditorium: instead of a semi-circular bank of seats, as illustrated in the diagrams so far, the auditorium is U-shaped (fig. 9*B*). This influence entered because the masques and court plays had been produced largely in ballrooms or banquet-halls, where one end of the hall had been reconstructed for an auxiliary stage, the main floor left free for dancing, or as an "arena" for pageantry, etc., with the spectators ranged around the three sides away from the stage, perhaps in chairs on temporary platforms, perhaps in balconies Architects combining this U-shaped auditorium with the curtained proscenium-frame stage soon determined the theatre form that was the basic plan of the famous horseshoe auditorium (fig. 11).

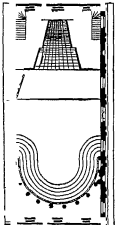


FIG. 10.—PLAN OF NARROWING VISTA. THEATRE (1588) AT SABBIONETA, ITALY, BUILT BY SCONOZZI

It was this Italian plan that became the standard of theatre building throughout the Western world, conquering successively the French courts, the courts of Austria, Bavaria and other countries to which the Italian Renaissance influence extended, then England (where the Elizabethan theatre form was cast aside —having only the slightest influence after the Restoration), and indirectly America. "Scenery" was soon standardized so that the wings and backdrop restricted the playing space to a wedge-shaped section of the stage floor; and the auditorium lines roughly followed the lines formed by the edges of the wings (fig. 12). This picture scene persisted through two and a half centuries, with ever greater elaboration, demanding larger and larger stages; and the auditorium half of the building kept its many galleried horseshoe plan. With variations toward rounder or narrower auditorium, the general form persisted until late in the 19th century, from smaller court playhouses to immense opera houses.

At first the arena portion of the auditorium was merely a flat floor, and consequently the best seats were not there but at the front of the first balcony; and almost throughout the period of the horseshoe theatre, the main floor sloped but slightly, thus allowing three, four or five superimposed balconies or galleries.

Modern Theatre.—The main changes in the construction of the 20th century theatre have been the exclusion of all but one balcony, and the steeper tilting of the main floor, thus throwing the best seats into the orchestra. Even to-day, however, in France and Italy, where the 17th–18th century theatre form stubbornly persists, the orchestra is contracted, and the more expensive seats are in the slightly raised ring of loges and the first balcony above.

During the 19th century there were efforts to reform the "picture" scene, and with it the horseshoe auditorium, which almost invariably had possessed the disadvantage of providing a considerable number of seats, at the gallery ends, which had a poor view of the stage. The first attempts of importance to design a more democratic type of theatre, and one in which "sight-lines" would more logically determine the form occurred in Germany. The Festival theatre at Bayreuth is the most noteworthy example, greatly antedating the present general movement toward the fan-shaped auditorium. Its main outlines are shown in fig. 13.

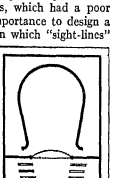


FIG. 11.—PLAN OF A HORSESHOE-SHAPED AUDITORIUM

The impulse was taken up by Max Littmann, the most notable theatre architect of the century-end; his Prince Regent theatre and Künstlertheatre in Munich, and his Schiller theatre in Charlottenburg, Berlin, all with simplified banks of seats, had great influence in both Europe and America. Littmann experimented also with the proscenium frame in an effort to adapt the theatre to the demands of modern stage lighting. More recently architectural practice, particularly in Germany and the United States, has come to the fairly standardized form that is shown in fig. 14. Here the architects restrict the horseshoe bowing-out, since the scene is no longer wedge-shaped but more usually box-like, and the auditorium is narrower in relation to the width of the proscenium opening. (In large cities where ground-value is such an important consideration, the commercial theatres are commonly built with wider proscenium openings and wider auditoriums, but

on the fan principle Standard fire laws impose the necessity for a certain number of aisles and adjacent doorways, and have caused minor differences from the type as it developed in Germany.) In general it may be said that the modern auditorium presents a single bank of seats, on a floor uniformly sloping or slightly saucer-shaped, more tilted than during the horseshoe period, and restricted at the sides along lines determined by the

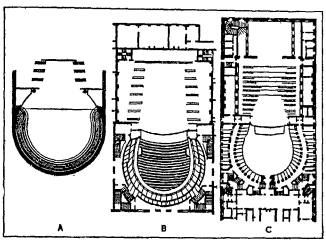


FIG. 12.—PLANS SHOWING TYPES OF THEATRE DESIGN USED FROM MIDDLE 17TH TO LATE 19TH CENTURY: (A) DRURY LANE, LONDON, (B) THEATRE-FRANÇAIS, PARIS (1790), (C) LA SCALA (1778), MILAN

edges of the proscenium opening There is usually a single balcony, with a steeply sloped floor, at the rear. There are seldom boxes (unless at the back of the orchestra); and modern engineering and steel construction make it possible to dispense with pillars and posts. The outline plan is not unlike the plan of the arena or pit portion of the many-galleried opera houses, with the surrounding galleries sliced off. Along with this simplification of plan there has been a general simplification in decoration.

Two examples of 20th century theatre building may be considered typical of progressive practice (fig. 15). The more radical experimenters have already called for the scrapping of the entire proscenium-frame house, and a return to the principles which determined the theatre form before "picture" scenes were introduced—with reference, however, to modern lighting advances. It may be assumed that some such change will come shortly, and that the return to an architectural stage will demand radical changes in auditorium construction. But as yet the several theatres built with formal stages, without proscenium arch, are too different, and their advantages too tentative or too special, to warrant any generalization beyond the proscenium-frame house illustrated above. (S. CHE.)

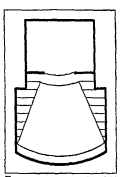


FIG 13.—MAIN OUTLINES OF FESTIVAL THEATRE AT BAYREUTH, AN ADVANCE IN "SIGHT-LINES"

BIBLIOGRAPHY.—The only historical work in English dealing at all fully with this subject is *The Development of the Theatre*, by Allardyce Nicoll (London and New York, 1927). It is profusely illustrated, particularly as regards the Greek, Roman and English theatres As a complementary volume, with many illustrations of the Continental court theatres of the 17th–18th century, the reader should consult *Der Moderne Theaterbau*, by Martin Hammitzsch (Berlin, 1906) Another useful reference work in German is Manfred Semper's *Theater*, in the *Handbuch der Architektur* series (Stuttgart, 1904). In English a useful brief treatment from the 20th century viewpoint is to be found in *Modern Theatres*, by Irving Pichel (New York, 1925). The "standard" work on theatre architecture in English is *Modern Opera Houses and Theatres*, by Edwin O. Sachs (London, 1896–98), a monumental work in three volumes, with extraordinarily fine plates; but it can be recommended only with the reservation that the conception of stage art has been so revolutionized in the last quarter-century that it is wholly out-of-date in its viewpoint. For an earlier period one may profitably consult G M Dumont's *Parallèle des plus belles salles de spectacle d'Italie et de France* (Paris, 1763). To trace the material about the theatres of individual countries or periods, the reader may best consult the descriptive bibliographies in Professor Nicoll's book

MODERN EXTERIORS AND INTERIORS

The theatre, with its special uses and special restrictions, naturally calls for special architectural treatment. The peculiarly public nature of dramatic art stamped one primary requirement on theatre architecture long before the advertising mania of the present age appeared to reinforce it: it must attract attention and its function must show in outer aspect

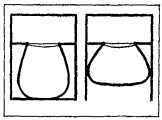


FIG. 14.—TO SHOW STANDARDIZED FORMS OF MODERN THEATRE

The essential architectural beauty of the exterior of a theatre must come not from decoration but rather from the massing of those portions of the walls which reveal the three essential inner parts of the playhouse—the stage, the auditorium and the foyers.

Importance of Site.—The art of theatre building has reached its height in Europe where every period developed and perfected its own rich style of architectural expression, and where the conditions of life in the larger cities permitted the theatre to attract attention to itself and its structure through appearance of three or four façades. In Europe a theatre was usually built on a wide street or square—the Paris Opera House (Ch Garnier, arch.); the Schauspielhaus in Berlin (Carl Friedrich Schinkel, arch.); the Champs Élysées, Paris (A. and G Perret, archs), Staatsoper, Vienna (Van der Null and von Siccardsburg, archs.); Dresden Opernhaus (Gottfried and Manfred Semper, archs.); or the Prinz Regenten theatre in Munich (Max Littmann, arch.)—or even in a park, as in the case of the twin State theatres of Stuttgart (Littmann, arch.), and many others Everywhere we find that it is growing more and more difficult to find such ample and predominant sites in the larger cities on account of the high value of land,

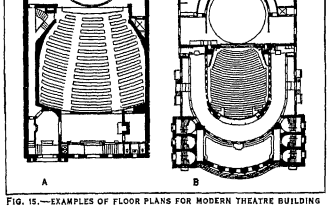


FIG. 15.—EXAMPLES OF FLOOR PLANS FOR MODERN THEATRE BUILDING (A) THE LITTLE THEATRE, NEW YORK: HARRY C INGALLS AND F. B HOFFMAN, JR., ARCH'TS. (B) VOLKSBÜHNE (PEOPLE'S THEATRE), BERLIN. OSKAR KAUFMAN, ARCH'T

the lengths of blocks, and the type of buildings dominating the view. Difficult conditions reach their acme in New York. The Metropolitan Opera House (Cady, Berg and See, archs.) alone occupies an entire block. The Radio City Music Hall, which is reputed to be the largest theatre in the world, with a seating capacity of approximately 6,200, is situated in a relatively inconspicuous place in the group of buildings which constitute Rockefeller Centre. In London among many examples showing one façade only there are the new Carlton theatre (F. Verity, arch.), and the Fortune theatre. The theatre architect in all countries has

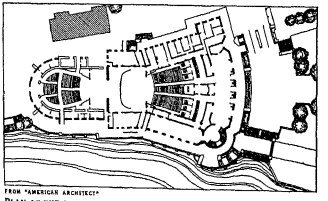
now usually only one façade available to tell the story which two, three or even four told in the past

Modern Conditions and Restrictions.—The architect limited to one façade facing a narrow street, has found it hardest to show in the outer form of his building the anatomy that lives within Yet even under these conditions the Guild theatre (C Howard Crane and Kenneth Frazenheim, archs) manages to mark off handsomely the stage-house like an Italian brick tower above the stucco front of the lower auditorium

Congestion and fire regulations play particular havoc with theatre architecture, yet several more or less successful attempts have been made to combine necessity with beauty In the bold Martin Beck theatre (G. Albert Lansburgh, arch) and in the charming Music Box (Crane and Frazenheim, archs) the inevitable fire-escapes required by law find a pleasant hiding place within porticoes. The Henry Miller theatre (Paul R. Allen and Harry Creighton Ingalls, archs) conceals unsightly alleyways—again required by law—within its Georgian walls. The law does not require the builder of a theatre to protect his patrons from the rain while they wait for taxis and motor-cars, yet the marquee becomes inevitably one of the most important items of the façade, unless an arcade or portico has been designed to protect the waiting crowds.

Electric Signs.—The worst problems of the architect who builds theatres in a great city come from the primary requirements of such a building—that it must be seen and tell its story at the greatest possible distance The set-back laws, new treatments of L-shaped, U-shaped, or H-shaped courts in front of tall buildings, and the enormous height of the skyscrapers make period fronts on three or four-storied theatres an insufficient and even ridiculous attraction against the gigantic, varied and vital proportions of the neighbouring buildings To compete for visual notice under these conditions, the theatre owner turns to enormous electric signs, and blankets the façade behind flashing bulbs and painted tin London examples of good exterior lighting arrangements are the Plaza theatre (F. Verity, arch), and the Astoria cinema (E A. Stone, arch.).

The modern architect has to consider as the main requirements in the exterior design of theatres three things which the architect has never before had to deal with. These are electric advertising signs, fire escapes and marquees. Not until we have made these necessities a part of our architecture, not until these necessary evils have been fused into a thing of beauty and have formed



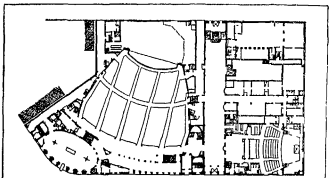
FROM "AMERICAN ARCHITECT"

PLAN OF THE SHAKESPEARE MEMORIAL THEATRE, PRIZE WINNING DESIGN IN THE PROCESS OF CONSTRUCTION IN STRATFORD-ON-AVON, ENGLAND

their own architectonic style and expression, can we hope for a new, adequate and handsome theatre façade.

Type of Entertainment Determines Type of Auditorium.—Each type of dramatic entertainment—including the motion picture—demands its own type of auditorium. In the ancient world the Greek theatre developed along lines suited to drama and comedy that employed large choruses, while in Rome something nearer the modern stage came into being as the chorus disappeared. Unfortunately the theatre architect of to-day is much too uncertain of the type of entertainment which will ultimately make use of his creation He may intend the building for popular melodrama, but financial misfortunes may turn it over to motion pictures or to musical revues It is only in the smaller communities that a theatre should be built for general usage, and some compromise arrived at which will suit both stage and auditorium to almost any kind of entertainment

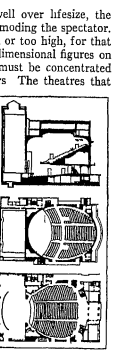
The Motion Picture House.—In a motion picture theatre, where the attention of the audience is concentrated on a silver



FROM BRETON AND BETTS, "AMERICAN THEATRES OF TO DAY" (ARCHITECTURAL BOOK PUBLISHING CO.)

PLAN OF THE EASTMAN THEATRE, ROCHESTER, N.Y., DESIGNED BY GORDON AND KAELBER, ARCHITECTS, AND MCKIM, MEAD AND WHITE, ASSOCIATE ARCHITECTS

screen and on figures of actors that are well over lifesize, the auditorium may be very deep without incommoding the spectator. On the other hand, it must not be too broad or too high, for that would distort the appearance of these two-dimensional figures on the flat screen. The mass of the audience must be concentrated in the centre and placed on two main floors The theatres that carry this out most notably are the Marmorhaus, Berlin (Hugo Pal, arch), the U-T Theater, Berlin (Fritz Wilms and Max Bischoff, archs.), the Capitol theatre, New York (Thos. W. Lamb, arch), the Roxy theatre, New York, the Plaza theatre, London, the Empire theatre, London, the Piccadilly theatre, London.

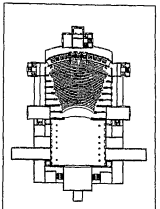


LONGITUDINAL SECTION OF THE ZIEGFELD THEATRE (TOP), PLAN OF BALCONY (CENTRE), AND OF THE ORCHESTRA (BOTTOM), DESIGNED BY JOSEPH URBAN AND THOMAS W LAMB, ASSOCIATE ARCHITECTS

The Revue Theatre.—The theatre intended for the use of the big musical revue is rather closely related to the moving picture house, though it, too, has its peculiar requirements. Here the main interest lies in the stage picture, the beauty of costumes and scenery, and so a large auditorium is possible. Care must be taken, however, to avoid too great a depth, for comedy scenes and solo singing demand more intimacy and a closer view of the performer than in the case of the motion picture. Here it is of great importance that the height of the seats in relation to the stage floor shall permit everyone in the house to see the feet of the dancers For the revue house—as well as for any theatre, that is not used on the one hand, for the motion picture, or on the other for the strictly realistic, peep-show type of drama—the architect must take great care to avoid anything in the proportions of stage and auditorium that may indicate a separation between the actors and the spectators. He must strive to use every means for uniting both groups in close spiritual contact.

The realistic play of the type which presupposes the presence of a fourth-wall between the actor and the audience has set special problems for the modern architect. Hitherto he has solved these as perfectly as possible—and, of course, by the very nature of the case he has not achieved anything exhilarating, notable or truly theatric. In the main he has had to restrict himself to a

small auditorium and if he sought larger capacity, a single balcony hung far out over the orchestra floor He has done away with boxes as obtrusions between the audience and the picture frame And this picture frame has become a definite and complete separation between the audience and the actors. In decoration he has been forced to subdue the colour of his auditorium so as to leave the audience in peep-show darkness while the play goes on. Two of Ingalls's playhouses in New York, the Little theatre and the Henry Miller, meet these stultifying conditions as well as they can be met

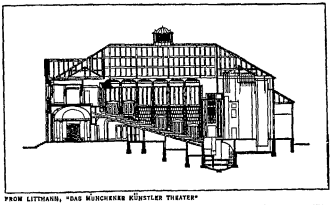


PLAN OF THE BAYREUTH FESTSPIELHAUS, MANFRED SEMPER, ARCH'T: THE FAN WITH STRAIGHT SIDES AND A WIDE SPLAY WAS USED

Problems of Site and Seating Capacity.—Within the limits of the particular piece of land on which he has to build, the architect must work out as large a seating capacity, and as roomy and convenient an arrangement of stage, dressing rooms, and foyers as possible Where the site is rectangular the problem is comparatively simple, but where the site is irregular it is often difficult to accommodate the auditorium and stage.

The architect has generally to secure the largest seating capacity possible on a given site. Usually this has meant widening the stage and still further widening the fan-like auditorium until only revues can be properly presented. The architect plans one very large, overhanging balcony because the higher prices that can be charged in a balcony, compared with a second balcony or gallery, more than make up in financial capacity for the greater number of seats that a double-decker arrangement provides.

Occasionally the architect tries some new method of getting a large but intimate auditorium on a piece of property of restricted size A popular method is to place the stage in one corner of the site instead of along the back, and then to throw the auditorium diagonally across the lot. Though this arrangement is better suited to the almost stageless motion picture theatre, it has been used in a "legitimate" theatre, The Ambassador, New York (Herbert J. Krapp, arch) Among large motion picture houses with



FROM LITTMANN, "DAS MÜNCHENER KÜNSTLER THEATER"

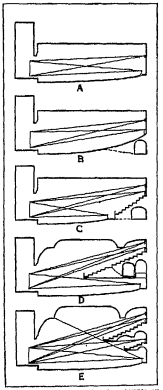
SECTION OF MUNICH ARTISTS' THEATRE, SHOWING THE STEEPLY SLANTING FLOOR

well-equipped stages which have also utilized this seating plan are the Paramount theatre, Palm Beach, Fla (Joseph Urban, arch.), the Bondi theatre, Sydney, N.S.W. (C. Bohringer, arch.), "the Majestic," Leeds (Messrs. Skinlet and Maxwell, archs) and the Roxy, New York.

Auditorium Shapes.—The shape of the auditorium itself, which used to be invariably a horseshoe, is now most apt to take the form of a fan with convex sides curved in towards the front and rear. An elliptical form has been tried with good decorative effect in the theatre of the Carnegie Institute of Technology, Pittsburgh, Pa. (Alden and Harlow, archs) and in the Ziegfeld theatre, New York (Urban and Lamb, archs). The New Cinema, Portsmouth (A E. Lutte, arch.) is also a good example of this type. The fan with straight sides and a wide splay was used in the Beyreuth Festspielhaus (Manfred Semper, Arch) where the boxes are located in a straight row across the back of the theatre and the "diamond horseshoe" of boxes eliminated.

Acoustics.—Any divergence in shape from auditoriums tried and tested by time involves the risk, of course, of producing bad acoustics. But the danger is far from absent in any theatre for the problem of acoustics is the most difficult that an architect has to meet. In 1895 Prof. Wallace C Sabine of Harvard, beginning by means of formulae and of photographs of sound waves in models of auditoriums, was able to determine in advance with a certain degree of accuracy the acoustic properties of a given design of theatre. Later research has devised methods of correcting bad acoustics by means of felts, wires, sounding boards, etc., but the fact remains that the best material for the interior of an auditorium, wood, generally cannot be used on account of the restrictions of the fire laws.

Visibility.—A problem of theatre construction which has not had as complete a study and formulation as it deserves is the line of slant in auditorium floor and balconies in relation to the height of the stage. The essential aimed at is the most perfect visibility from every seat in the house. One of Germany's theatre reformers, Littmann, in a desire to give the last row as clear a view as the first, prescribed a very steeply slanting floor, but made the grave mistake of making it merely a straight inclined plane. The result was that the front rows had more range of vision than they needed, while the last rows suffered from the feeling of looking down a narrow tunnel. The better method, which is generally followed today, is to begin with little or no inclination at the front, and then to increase this radically towards the rear. The slant of the auditorium and, of course, of the balconies, too, is controlled in most cities by the requirements of the building regulations. The height of the stage above the auditorium floor is not so restricted, and can be worked out freely to give the whole auditorium a complete and comfortable view of the actors upon the stage. It is often very badly handled.



FROM GEYER AND BETTS, "AMERICAN THEATRES OF TO-DAY" (ARCHITECTURAL BOOK PUBLISHING CO.)

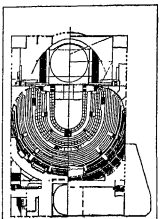
LONGITUDINAL SECTIONS OF VARIOUS TYPES OF THEATRES

A. One floor type, B. Bleacher type, C. Stadium type, D. Single balcony type, E. Balcony-mezzanine type

The slant of the floor and the arrangement of the balconies bring out many interesting possibilities. Krapp combined the "bleacher," "stadium," and "single balcony" types in a so-called "arena" arrangement used experimentally in Chanin's Forty-Sixth Street theatre, New York, and better worked out in another Chanin playhouse, the Majestic, New York. The purpose is to get a very deep orchestra floor by running the entrance foyers under its steeply slanting rear. The Guild theatre, New York, (on a suggestion by Norman-Bel Geddes) managed to place its roomy lobbies under the auditorium without raising the latter so far above the street as to bring it into conflict with the fire regulations

German Seating Arrangements.—In most countries fire laws have prevented the wider use of an arrangement of the

seats themselves which has found general popularity in Germany This arrangement abolishes the aisles dividing the floor into sections, and the seating of the audience in one unbroken mass of solid, continuous rows from wall to wall. Adequate entrance and exit are obtained by spacing the rows a little wider apart than in the ordinary arrangement, and making the walls of both sides of the auditorium a succession of doors emptying into the lobbies. The effect of this arrangement is that the spectators are seated in one solid mass. An equally important consideration — which should argue a change in fire regulations—is that a house seated on the German model can be cleared in half the time it takes an audience to press into and up the ordinary narrow aisles. This German seating arrangement has been used with success in the Kenneth Sawyer Goodman Memorial theatre, Chicago (Howard Shaw, arch.), which happens to be located outside the jurisdiction of the Chicago fire commissioners.



FROM ZUCKER, "THEATER & LICHTSPIEL-HAUSER (WASMUTH)

FLOOR PLAN OF SECOND AND THIRD BALCONY OF THE GROSSES SCHAUSPIELHAUS, BERLIN, DESIGNED BY HANS POELZIG, ARCHITECT

Stage Lighting from the Auditorium.—The stage arrangements, except as to adequate dressing rooms, property rooms, and scene stacking space, are matters for the theatre technician—scene designer, electrician, etc.—not the theatre architect, although the architect should see that there is ample space allowed Something should be said, however, on one point connected with lighting arrangements; this is the necessity of providing room in the auditorium for the placing of lights for the illumination of the stage and the actors. In 1914 Granville Barker introduced at Wallack's theatre in New York a row of powerful incandescent lamps around the balcony rail to replace the footlights. David Belasco took the next step forward by installing such lights in a recess in the balcony rail closed by doors automatically controlled from the stage switchboard Some such provision, or perhaps a light bridge concealed in the ceiling beams, as in the Yale university theatre, New Haven, Conn. (C. H. Blackall, arch.), or the Guild theatre, New York, ought to be a part of every architect's plan of a new house

Decoration.—The decorative problem within the auditorium has found many solutions, depending on the kind of dramatic entertainment to be presented. The modern decorative movement towards larger, smoother and less ornamented surfaces has its peculiar applicability to the playhouse, where the eye should not be distracted from the players by too ornate detail. Yet there is something undeniably exciting and truly theatrical in the rococo interior of the Residenz theatre in Munich (Cuvilliés, arch.), and Oskar H. Kaufmann, beginning with a rigid simplicity in the Volksbuehne and other houses in Berlin, has had delightfully amusing recourse to the Chinese baroque for the Theater am Kurfuerstendamm and the Komoedie also in Berlin. The limitations and the values of decoration depend, after all, on the interpretive genius of the architect.

The new attempts to break away alike from the old horseshoe opera house and the realistic peep-show theatre all look back for their justification to the history of the development of playhouse architecture, and borrow heavily from the past.

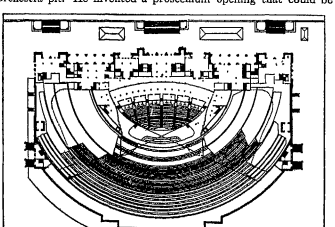
Development of the Opera House.—Following the Fall of Rome and the decline of classic culture the classic theatre disappeared save for a renewal of some of its form and spirit during a few brief decades of the Renaissance. The theatre, and especially the early opera, supposed ironically enough to be founded on classical tragedy, became a mere excuse for brilliant court festivity. As a result of the desire on the part of the audience to be observed by one another good visibility for the stage suffered. The style of the popular Italian opera predominated. The singers delivered their important arias as close to the prompter's box as possible while the chorus stood practically inanimate. Contact between the stage and auditorium disappeared and with it the spiritual union of performers and audience. Good acoustics and a brilliant social display were the demands made upon the Baroque theatre. The decorative type of auditorium with its heritage of the richness of the Renaissance and the charm of the rococo had originally been a thing of gorgeous, festive yet graceful beauty.

In the course of years it added to the pernicious Italian shape new horrors of decoration and became that horrid overladen gold-and-plush spectre of its former self of which unfortunately we still see examples.

Toward the latter part of the nineteenth century, however, came evidence of change and reform. Splendid acting was increasingly in demand and rich settings and appropriate historical costumes were considered essential to enhance the beauty of operatic music. The problem of displaying these adjuncts began to make even the architects of the opera houses see that their art had reached a standstill and that some attempt had to be made to recapture the spirit and some of the form of the classic stage. Their efforts were partly compromises in the shape of the auditorium, partly a simplification of the baroque theatre following the more serious and less social tendencies of the legitimate theatre

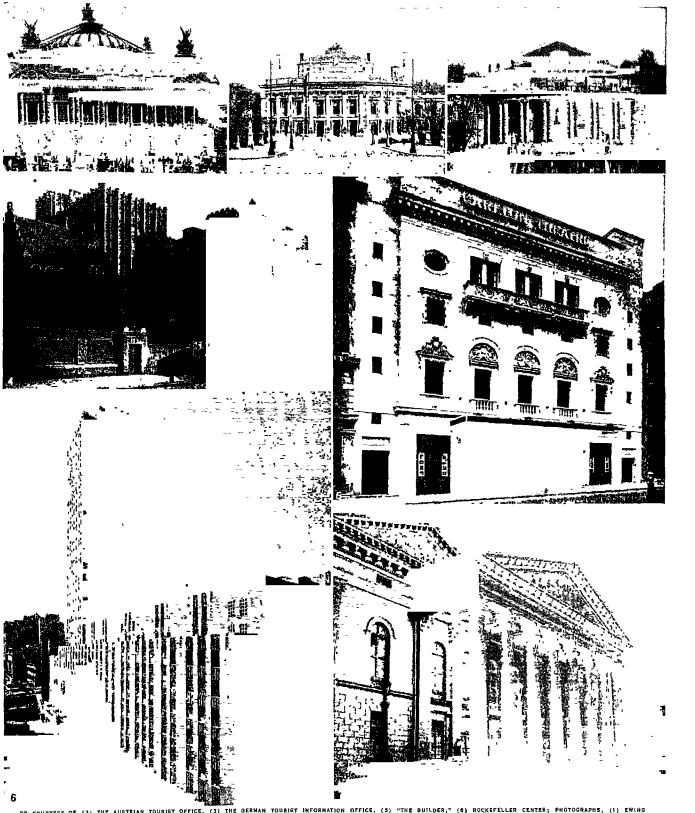
The reform dates from the work of the Sempers in mid-Victorian days and is punctuated with March's Festbühne for Worms in 1887. The attempts at a new type of auditorium seldom aim at a direct return to the classic but only to one of its descendants, the Shakespearian stage Already the results in projects and even a few completed playhouses have been notable

The Circus Theatre.—Steele MacKaye, actor, playwright, artist, director and inventor, was the first to produce a notable plan for a circus-theatre In 1892 he had almost completed in Chicago as part of the World's Fair a remarkable structure called the Spectatorium. Like so many efforts at the "theatre of the 10,000," it strove to gather together the huge audiences of Greek days and to bring them into close contact with all the possibilities of the stage. MacKaye devised a means of bringing his actors and choruses up from under the audience through steps in the orchestra pit. He invented a proscenium opening that could be made wide or narrow, thin or deep. He provided a crescent-shaped stage with scenery sliding on tracks. This stage could be flooded with water. He closed in the back of his semi-circular stage with a linoleum cyclorama. He invented cloud machines for projecting moving clouds on the sky. There were few reforms of modern stage technique that this remarkable man did not foreshadow in this project, which the American financial panic of 1893 arrested when only half built.



PLAN OF STEELE MACKAYE'S SPECTATORIUM-THEATRE DESIGNED TO SEAT TEN THOUSAND PEOPLE AND TO INTRODUCE SLIDING STAGES, A LINOLEUM CYCLORAMA AND MANY OTHER MODERN STAGE REFORMS

It was along the lines of this MacKaye theatre that Max Reinhardt built when he developed his performances of Greek tragedies



6

BY COURTESY OF (2) THE AUSTRIAN TOURIST OFFICE, (3) THE GERMAN TOURIST INFORMATION OFFICE, (5) "THE BUILDER," (6) ROCKEFELLER CENTER; PHOTOGRAPHS, (1) EWING GALLOWAY, (4) GENERAL PHOTOGRAPHIC AGENCY, (7) SCHALL-PIX

EXTERIORS OF 19TH AND 20TH CENTURY THEATRE BUILDINGS

1. The Opera House, Paris, erected 1861–75, in the court style of the period of Louis Napoleon. Architect, Charles Garnier. 2. The Burgtheater, Vienna, an elaborate structure of classic 19th century type. Architects, Semper and Hasenauer. 3. View of the State theatre, Stuttgart, showing the façade of the larger of the two auditoriums contained in the single unit building which fronts the lake in the park. Architect, Max Littmann. 4. Back view of the Schauspielhaus, Düsseldorf, Germany, erected 1904–05. Architect, B. Sehring. 5. The Carlton theatre, London, an exterior designed in a prevailing British mode, and crowded between neighbouring houses, as are most American and British commercial theatres. 6. View of Radio City Music Hall, New York city, showing the artists' many windowed dressing rooms. The Music Hall's broadcasting studio is on top of the theatre building. 7. The National theatre at Munich, Germany, built by Karl Fischer from 1811 to 1818 and rebuilt from the original plans after the fire of 1823.

THEATRE

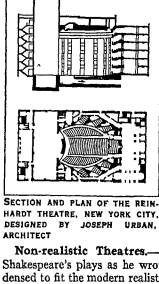


BY [illegible] (1) MC TIG GUEST PHOTOGRAPHS, (2) 4) ZINKHAM STUDIO, (3) INTERNATIONAL AND VANDAMM STUDIO, (5) CULVER SERVICE, (6) ANGUS McBEAN

SCENES FROM MODERN THEATRICAL PRODUCTIONS

1. Scene from "The Miracle," produced by Max Reinhardt, in which worshippers surround the Lame One, who was healed at the shrine of the wonder-working Madonna
2. Act 6 of Eugene O'Neill's 9-act play, "Strange Interlude." The four principal characters have come together for the first time in four years
3. The well-known shaving scene from Laurence Housman's "Victoria Regina," with Helen Hayes as Queen Victoria and Werner Batemen as her prince consort
4. Scene from the comedy, "Life with Father," dramatized by Howard Lindsey and Russel Crouse from a book by Clarence Day
5. Scene from Erskine Caldwell's "Tobacco Road," which set a record for consecutive performances in New York city
6. Pamela Brown and John Gielgud in "The Lady's Not for Burning" by Christopher Fry

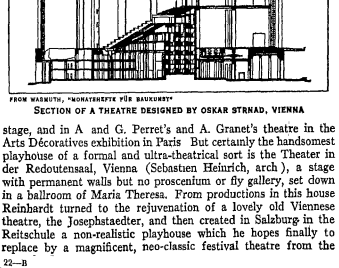
in circus buildings into the finally realized Grosses Schauspielhaus in Berlin (Hans Poelzig, arch) Here he came close to the true conditions of the classic stage, with the actors appearing on a semi-circular orchestra floor almost in the midst of the spectators, and then retreating up steps to a completely equipped stage with sky-dome, revolving stage, and all the modern appurtenances. The son of Steele MacKaye, Percy MacKaye, realized many of the values his father had planned in his open air performances of "masques" at St. Louis, New York and Cambridge, Mass., between 1912 and 1927.



SECTION AND PLAN OF THE REINHARDT THEATRE, NEW YORK CITY, DESIGNED BY JOSEPH URBAN, ARCHITECT

Copeau's Theatre.—At the opposite extreme in size, Jacques Copeau created in the Théâtre du Vieux Colombier, Paris, a playhouse which united the actors on a naked architectural stage with an audience seated within auditorium walls that continued back unbroken by any proscenium to make the walls of the stage itself. The Théâtre du Marais, Brussels (Louis Jouvet, arch), and other projects were offshoots from this pattern.

Non-realistic Theatres.—The stimulus of trying to give Shakespeare's plays as he wrote them and not garbled and condensed to fit the modern realistic theatre has resulted in a number of attempts to revive the conditions of the Shakespearean stage on the stage of an ordinary theatre. This has brought back canvas make-believe, the portals of proscenium doors which all English theatres rejoiced in a century ago. First merely represented as part of the scenery, these means of linking the actor and the auditorium have now been built into the actual proscениums of many new houses, especially in the "little theatres" built here and there about the United States Some such theatricalizing of the stage is present in the Werkbund Theater, Cologne (Van de Velde, arch), with its tripartite division of the

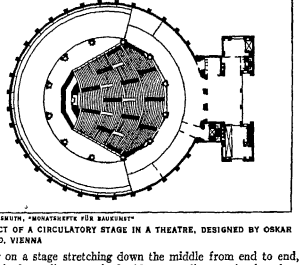


FROM WASMUTH, "MONATSHEFTE FÜR BAUKUNST"

SECTION OF A THEATRE DESIGNED BY OSKAR STRNAD, VIENNA

stage, and in A and G. Perret's and A. Granet's theatre in the Arts Décoratives exhibition in Paris But certainly the handsomest playhouse of a formal and ultra-theatrical sort is the Theater in der Redoutensaal, Vienna (Sebastien Heinrich, arch), a stage with permanent walls but no proscenium or fly gallery, set down in a ballroom of Maria Theresa. From productions in this house Reinhardt turned to the rejuvenation of a lovely old Viennese theatre, the Josephstaedter, and then created in Salzburg in the Reitschule a non-realistic playhouse which he hopes finally to replace by a magnificent, neo-classic festival theatre from the plans of Poelzig.

Radical Projects.—Radical designs, which are as yet largely projects, include those of the distinguished American pioneer architect, Frank Lloyd Wright. Norman-Bel Geddes has devised a remarkable theatre with the stage in one corner, the whole auditorium and playing floor surrounded by a single dome of light. He has also devised a long rectangular playhouse with the action



FROM WASMUTH, "MONATSHEFTE FÜR BAUKUNST"

PROJECT OF A CIRCULATORY STAGE IN A THEATRE, DESIGNED BY OSKAR STRNAD, VIENNA

passing on a stage stretching down the middle from end to end, and with the audience on both sides, as well as a circular playhouse with the stage in the centre, a scheme suggested by Robert Edmond Jones's project for Shelley's *The Cenci* in a prize ring. Variants on the usual relations of stage and audience are many, including a scheme by Friederich Kiesler for two opposing auditoriums sharing the same stage. One of the most remarkable is Oskar Strnad's circular theatre with the audience seated in the centre and the big ring of the revolving stage coming into view a segment at a time.

Out of all these attempts and projects, a really healthful new theatre is slowly but surely developing. It will not reach its full maturity until actors can enter naturally and easily from the auditorium as well as from the stage and step down from their own level to the level of the spectators. When every division between the world of the actors and the world of the spectators is eliminated, and when those who give and those who receive are —in the spirit of the classic theatre—once more surrounded by the walls of the same room, then and only then will it be possible to meet completely all the demands not alone for proper acoustics and proper visibility, but for purely spiritual pleasure achieved without hampering physical effort

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GENERAL PLANNING

Real development in modern theatre architecture started in the latter part of the 19th century and each year has brought added progress in planning and designing. Theatres 10 years old are out of date, while some 20 years old are practically obsolete. From the point of view of construction, new methods due to the advent of modern steel framing, progress made in the science of lighting (*see* STAGE DESIGN) and the necessary adherence to present day building codes have been a few of the potent factors in this advancement. Changing social and economic conditions continue to affect the theatre and its planning radically. The old style theatre with posts and horse-shoe balconies is gone. The theatres of only a few years ago containing a balcony and gallery

are now "old fashioned."

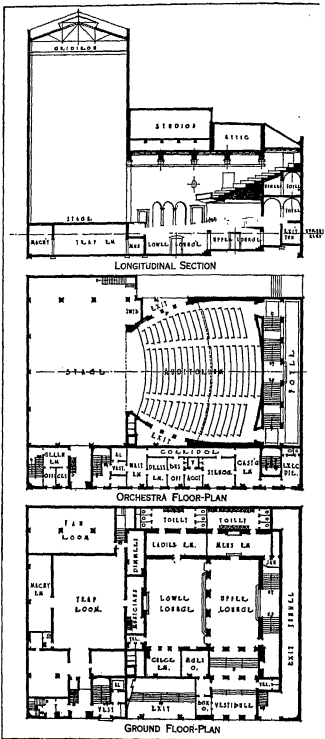
The modern theatre consists of a lower floor, or orchestra level, and one large sloping balcony. Sometimes a small mezzanine or loggia is placed between the lower floor and balcony. Every seat must be so situated as to have an unobstructed view of the stage. The auditorium floor and balconies must have the proper curve or incline, to ensure proper "sight lines." The acoustic problem must be worked out so that each patron will hear distinctly; to accomplish which methods that eliminate as much as possible all reverberations must be employed. The stairways, foyers, lobbies, box offices, lounges and retiring rooms should be so laid out as to avoid confusion. The architect should strive for perfect circulation of the patrons. The box office should be situated at the right hand side on entering a theatre. The entrance doors and the main stairs to the balcony should also be placed at the right hand side. The exit doors and a stairway from the balcony to be used when leaving the theatre should be on the left hand side of the main lobby. This arrangement allows the incoming and outgoing audiences to pass without mixing.

On account of the high land value, it has often been necessary for the architect to get a maximum building on comparatively small property, with the result that after space has been utilized for an adequate stage and maximum seating capacity, there remains in most cases comparatively small areas for public spaces such as foyers and general lounges. The traffic problem in most of the larger cities makes it impossible for the entire audience to be in their seats at the rise of the curtain. Late arrivals coming into the small vestibule and foyer spaces of the usual dramatic theatre spoil the opening of many performances. A constructive development to alleviate this condition is represented by the device used in the new Theatre Guild theatre in New York, where the audience enters the theatre by a lower level than the street. On this level are situated the lounges and retiring rooms. A large stairway leads to the promenade and the rear of the auditorium from which the patron enters without confusion Although in this scheme the main floor is above the street level, the necessary slope of the floor brings the lower part of the main auditorium to street level elevation, where the main exits are situated.

The motion picture industry has had more to do with the building and development of theatres than any other agency. The so-called "movie" is usually a theatre with a fairly large seating capacity, spacious provisions for orchestra and organ, but no stage. A small platform usually suffices for the performance given in addition to the pictures. These auditoriums in most cases are treated architecturally and decorativelv as one room. As this type of theatre is usually longer than it is wide, the auditorium treatment is as elaborate in the rear as at the front, giving the patron sitting in the rear seat the feeling of closeness to the stage.

Problems.—Architecturally, each type of theatre has distinct problems. Dramatic houses and opera houses have to care for audiences during intermissions; these audiences usually leave en masse; therefore, lounges, foyers and promenade spaces must be provided to allow the free movement of the people and to avoid congestion. Most moving picture theatres are run continuously and the patrons for the most part come and go at no specific time; in them perfect circulation is most necessary. The exterior treatment of all types should be somewhat festive and characteristic of their function. More restraint and dignity should be expressed on the exterior of dramatic than vaudeville or picture houses. Since the moving picture theatre depends a great deal on the passer-by for its patrons, its exterior should be designed to attract attention and should have a very inviting and unusual façade; electric illumination is utilized to a great extent to enliven and add glamour to it.

Every theatre should have a marquee at the entrance. This marquee or ornamental canopy is used for a double purpose: (1) to protect the public on entering or leaving the theatre during inclement weather; (2) to afford an excellent means of advertising. The marquee of a modern theatre is in reality a very ornamental electrical sign attached to the three sides. It should be carefully designed so as to add to the appearance of the façade.



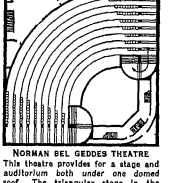
PLAN OF THE THEATRE GUILD THEATRE, NEW YORK CITY, DESIGNED BY C. HOWARD CRANE, FRANZHEIM AND BETTIS, ARCHITECTS

Rarely does one of these signs enhance the architecture of the building and in most cases hideous results are obtained because it is designed by inexperienced draughtsmen without regard for the architectural treatment of the exterior. However, much more extensive consideration is now being devoted to the problem of the marquee not only by architects but by sign makers also. In consequence of this changed attitude more harmonious and artistic results are being attained.

The old method of treating the interior of theatres was first to design an elaborate proscenium arch or frame, then to treat the proscenium boxes very ornamentally but less elaborately than the proscenium. From these boxes back to a point near the centre of the balcony, a very simple treatment was generally used, and

from this point to the extreme rear a very plain one. In this type the audience was really sitting in so many different rooms, varying with the distance from the stage. There was no continuity of design. The modern method is to unify the auditorium or to treat the theatre as one room, making no distinction in elaborateness of detail because of location. Psychologically, a higher audience *moral* is effected as this scheme of decoration, eliminating segregation by sections, establishes a feeling of equality between patrons.

Increase in Size.—The latest development in the design of the theatre is brought about by the building of the present-day "super cinema palace." Here the architect has been allowed to use to the fullest his imagination and ability. The acoustics and sight lines must be perfect. Unusual lighting effects must be devised and provisions made for the latest modern development such as talking pictures, public address or amplifying systems, and mechanically operated stage and organ lifts These theatres schedule and are often attended by as many as 30,000 persons in one day. Expert planning is necessary adequately to house and control these large audiences Some noteworthy examples have been completed recently; they are rich in ornament and gorgeous in colouring and lighting effects, and they are usually extremely elaborate in furnishings. Due to their extreme widths and to the essential absence of posts, these large modern theatres present great structural problems. Fresh, cooled air in summer and pure, warmed air in winter must be constantly and evenly distributed to every part.



NORMAN BEL GEDDES THEATRE
This theatre provides for a stage and auditorium both under one domed roof. The triangular stage in the lower right corner sinks into the basement for changes of setting

Equipment.—Theatres seating between 5,000–6,000 persons, with large comfortable chairs liberally spaced, are now being built in nearly all the large cities of almost every country. Theatres of this size would ordinarily produce serious problems in acoustics By means of public address systems or a series of cleverly concealed amplifiers, evenly distributed over the theatre, an operator, by simply turning dials similar to those on a radio set, can increase or diminish the stage performer's voice at will. Proper precautions must be taken to overcome reverberations. This is usually done by careful and scientific use of absorbent materials, of either specially prepared plaster or felt. Disappearing organ and orchestra lifts, enabling large orchestras to enter and leave the pit without confusion to the audience, are necessary. They also permit the orchestra to be raised in full view for the overtures and special numbers, and to be concealed when playing incidental music accompanying the pictures. These lifts or elevating platforms are controlled by push buttons fixed by the leader's desk. The operating rooms or projection booths are becoming the most important part of the entire ensemble. With the introduction of talking pictures, coloured photography and amplifying systems, projection booths have to be very carefully planned They are strictly fire-proof and contain all the modern fire prevention equipment possible. Automatic shutters cover all openings. Metal furniture is used throughout, and a decorative note is often afforded by fine tiles. Dressing and rest rooms, including showers and toilets, are provided for the operators, and there is usually a separate room for rewinding film.

The stage equipment is also of the latest and finest description. The switchboard, controlling the many coloured effects both on the stage and in the main auditorium, is a complicated work. With its many-coloured pilot lights, pre-set switch handles, and numerous other controls it almost resembles a complete organ manual and is almost as difficult to operate. The old-fashioned fly gallery and pin rail, with sand bags for counterweights, is gone. The modern method of handling scenery is by the latest improved counterweight systems. The operation of a small lever will bring a drop into position quickly and without effort The controls are usually placed on the stage level Wire cables have replaced the old-style ropes, and gas pipes the wooden battens, to which the scenery was formerly attached. All stages are equipped with sprinkler systems, automatic ventilators and fire curtains. Modern safety laws require fire-proof scenery, with the result that the fire hazard, in the present-day theatre, is reduced to a minimum One of the most important pieces of stage equipment to-day is the cyclorama. This is a large elliptical-shaped piece of scenery reaching from the stage floor nearly to the gridiron. It is absolutely plain and usually painted a neutral tone so that all kinds of lighting will be effective on it It is used as the sky or back piece of the settings. The cyclorama is unequalled as an agency in obtaining beautiful stage effects. The usual cyclorama is constructed of plaster or heavy sheet boarding and in many instances also acts as a sounding board

The following represents a list of some of the rooms required in the operation of a large modern theatre: assembly room or green room; dressing rooms, chorus and ballet rooms, for both men and women, all equipped in a modern manner with bath and toilet facilities, stage manager's and assistant stage manager's office; wardrobe rooms; commissary department; carpenter and electrical shops; large and small property rooms; private offices for the conductor, assistant conductor and organist, a music library and a fire-proof vault for sheet music storage; a lounge room with necessary toilets and locker rooms adjoining, for the musicians; an instrument storage room; soundproof motor rooms for the organ blowers and mechanical lifts; rehearsal room with picture screen and operating booth, locker and toilet rooms for the men and women ushers; building superintendent's office; lockers and wash rooms for the scrub women; numerous small rooms for electric lamp storage and other supplies. One of the greatest developments is in the lounges and retiring rooms provided for patrons.

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(C. H. Ch.)

MODERN THEORY OF DESIGN

To the Greeks, the theatre was their most vital creative expression, and they succeeded in achieving results that for "pure theatre" have never been surpassed. They built them to look like theatres and to dignify what transpired within them. The Greeks lived in an age of imagination. Their knowledge of the material world was much more restricted than ours. It was as uncharted to them as the universe is to us, and life had a greater interest for them because of this mystery. In this mood, they created their drama. Their tragedy penetrated the mysteries of nature beyond the humdrum of ordinary life Their comedy was carried to an extreme that, to our gradually neutralizing mind, appears exaggerated and vulgar. Civilization has by degrees impoverished its audiences from an enthusiastic appreciation of extremes toward a glorification of the commonplace mean.

We live in an industrial age. We should have theatres that belong to our time, drama that voices this time. Instead, our theatre is a secondary expression We exercise our emotions by reading daily papers, riding in automobiles, listening in on the radio, playing bridge and seeing mediocre motion pictures. The theatre is in a state of sham. The plays, the actors, the scenery all try to make audiences forget they are in a theatre. The buildings themselves are made to look like office buildings, tavern

museums, Renaissance palaces, Spanish missions or casinos To plan a practical theatre, the designer, architect, or engineer should possess a knowledge of theatres, past and present, and of the latest experiments toward the future, with an experience in the theatre that would class him with such specialists as are called upon to build our sky-scrapers, suspension bridges and subway tubes. In exterior design, the most conspicuous elements, such obviously dominating features as the electric signs, the *porte cochère*, the huge cubical mass of the flying space above the stage, offer problems of unusual contrast specifically in theatre design.

Primarily, the theatre in this modern world, from every standpoint, lacks style Inside and out, it should be distinguished It should look and be "theatre," in its architecture, plays, acting or staging. Theatres naturally vary in size, requirements and class of entertainment. The point of view of the artists engaged in the theatre should likewise vary. The working parts of a theatre must possess the utmost flexibility, must be alterable, in simple practical terms, from one person's use of it to another's, hampering experiment as little as possible Until the theatre, architecturally, becomes more flexible, the dramatist, producer, designer, will continue to have difficulties in exploring new forms For any radical or improved or experimental idea, in dramatization or staging, beyond what has been developed in the last 15 years, the present stage is inadequate. It suffices for only a few types of plays, and is completely impractical for any style out of this groove It is probably the most restricting theatre man has ever conceived New basic ideas of architecture will materially stir the imagination of everyone connected with it. Instigate a type of stage of a three dimensional order and see what happens in the actual creative work in the theatre.

To any student of the subject, the development of the theatre since the Greeks shows gradual deterioration. The single item that has most influenced these changes is the proscenium arch There was no arch in the Greek theatre, but by successive stages from that time to the present, the arch idea has developed. Its two dimensional aspect imposes an effect which is deadening, as compared with the exhilaration of an audience surrounding the actors, such as we get in the circus. There is no more reason or logic in asking an audience to look at a play through a proscenium arch than there would be in asking them to watch a prize fight through one. At a prize fight, although each individual looks into the ring from one point of view, a more intensified atmosphere is gained by the sight of the audience seated on all sides of the ring. In an art gallery, looking at a piece of sculpture, you instinctively walk slowly around the object to view it from different directions, rather than merely standing and looking at it as you would a painting. The exaggerated importance of the picture-frame stage of the past generation is undoubtedly due to lack of imagination of the minds working in the theatre. After all, the proscenium in its present maximum form has only existed over one-fifteenth of the time that has lapsed since the theatre of Dionysus.

In thinking of the theatre, we naturally begin with the stage. The auditorium is built around the stage and a relationship must be maintained between these two major elements. In nearly all modern examples, the stages are too small in proportion to the auditoriums. Half of the audience is in a poor position to see and hear The inadequacy of the stage is accepted as a matter of course, since the actors have sufficient space to move in during a performance. Actually, the part of the stage that the actor utilizes during the playing of a scene is only about a tenth of the total cube required for stage purposes The off stage space (to both sides and rear of the acting area) should equal three times the floor space of the acting area in order to handle adequately the changes of settings. In most modern theatres, it is not even equal to it. The entrances and exits for actors, the facilities for handling scenery, properties and electrical apparatus are neglected correspondingly The flying space (above the stage) should be four times the height of the maximum scene, but seldom is. The present-day stage does nothing for the dramatist but cause him to worry as to how this or that idea will be visualized in two dimensional terms, and it has gradually reduced the actor to an immobile loud speaker. The last few years have brought out various mechanical features, such as the application of the hydraulic, revolving, sliding and turning-over principles for changing part or all of the stage with its scenery; and a permanent plaster cyclorama to replace the drop cloth painted to represent a sky, upon which light of any colour can be thrown But although all of these are important, they fail to get at the root of the difficulty, which is the adjustment of the style and proportions of the theatre to its uses and needs while the building is being planned

The auditorium should be designed so that everyone may enter easily, reach his seat without annoying other people, sit comfortably, see and hear everything on the stage. The best angle of vision between the stage and the seats, because we are most accustomed to it in everyday life, is shoulder height, yet in our theatres to-day, the best seats, judging from the scale of prices, place the spectator's eye on a level with the actors' feet Each successive row of seats should be at an angle in relation to the stage, so that the spectator does not have to peer between the heads of those in front of him

The audience is the governing factor of drama There can be no drama without it. All the dramatist, director, designer and actor do is to project elements which will create a certain effect in the audience's imagination A dramatic production has no significance until it is performed in conjunction with its audience. This is why each type of play sifts out its particular audience. The theatre takes its place among the arts when the audience not merely witnesses a reproduction of life as it is outside the theatre, but takes part in an experience that does not exist anywhere outside the theatre.

Suffering from the limitation that it is not a single-vision medium as that of painters, sculptors, poets, musicians and architects, the usage of the theatre is contradictory to what is accepted as the ordinary working procedure of an artist The dramatist works in a composite medium, which is stage, actor and audience. The designer takes the play and develops it for production in all its visual phases, working out its rhythm, movement, manner of staging, setting, costuming, lighting. Finally the director, whose position is synonymous to that of the orchestra conductor but who uses actors instead of musicians, rehearses all of these elements into an unified performance The dramatist reaches his audience indirectly through the director, designer and actors His work may be limited by these people, or his stimulation may inspire them to develop his ideas further than he could have done alone The result, good or bad, is the very element that gives the theatre its unique qualities, its advantages and disadvantages, over other forms of expression

The end we seem to be going toward has a more plastic three dimensional stage structure, formal, dignified and neutral, as a basis, its various acting platforms inviting a variety of movement, and provided with adequate space for lighting instead of the cramped condition of the present. Such a structure is designed for the playing of a sequence of scenes of diverse mood, locale and character, not imitative in geographical terms, but creative in dramatic terms, with emphasis on the intensity of dramatic action and its projection to an audience. It will give the impression of being solid and enduring, and will be composed of a variety of levels, ramps, platforms, aprons projecting into the audience, high stages towering to the rear, the whole achieving pictorial qualities by the composition of actors on various levels and their movements in conjunction with lighting. Portions of these settings may or may not be changed to vary as a play goes on. Any adequate technique for staging plays should permit of a play being run off in any combination or series of rhythms and not destroyed by such crude makeshifts as darkening the stage or lowering of the curtain to make changes in the setting.

Theatres for motion pictures and television are bound to be distinct from theatres for plastic drama, and in the same way that screen drama is of necessity going to emphasize two dimensional vision, the stage drama, as it develops away from the picture medium in a mental sense, will likewise grow away from it in a physical sense and become decidedly more three dimensional.

(N. B. G.)

PRODUCTION AND DIRECTION
MODERN TENDENCIES

At one time or another the theatre has used some part of every method of production that we so fervently hail—or condemn—as the last word in modernism to-day, for in 25 centuries it has been all things to all men. It has been religious and blasphemous. It has been as noble as its god-heroes and as petty as its bourgeoisie—whether of Rome or London It has been fantastic and formal in the temples of the living masks where men meet the gods throughout the East. It has been minutely realistic Back in Greece, when someone painted wave-lines on the *periaktoi*, and thus let the audience know that it stood by the shore of the sea, the theatre was expressionistic A performance of *The Tempest* on Shakespeare's open stage, with the sailors swarming up the ropes into the canopy overhead, would have satisfied the constructivism of Meyerhold. And when Reinhardt put *Oedipus Rex* into a circus or gave Calderon's *The Great World Theatre* in a cathedral he was merely imitating with conscious art the naive habit that the ancient theatre had of playing cuckoo and laying its eggs of art in amphitheatres, chancels, inn yards, bear-pits, tennis courts, market places, and court ballrooms

Enter the Régisseur or Director.—Yet, in a narrow sense, there are modern tendencies in the theatre—two major tendencies, both founded on a new attitude towards the complex business of getting actors to speak lines in an effective *ensemble* The new attitude is seen in the commanding presence of a director. Some one has always insisted that the actors learn their lines, speak them with a certain skill, and walk where they will not trip over one another's heels or become entangled with the properties But the commanding director—or *régisseur*—is the notable contribution of the theatre of the past half century From Duke George II. of the little German State of Saxe-Meiningen—who fused supers into mobs, put ceilings on box sets, and created the first modern *ensemble* acting in the middle '70s—through Otto Brahm, first master of naturalism at the beginning of the 20th century, Max Reinhardt, Brahm's disciple to begin with, then pioneer in every form of theatre from cabaret to cathedral and little theatre to circus, Meyerhold the Russian, who preached and performed the "theatre theatrical"—from these masters on to the director of the tiniest of community theatres in some Californian town, the *régisseur* has taken his place as the centre of the modern theatre. His business has been to dominate, synthesize, and unify each production, and thus to bring forth a single work of theatrical art instead of a histrionic accident.

Realism Versus the Theatric.—Without the *régisseur* neither of the two great schools of modern production could have developed A single mind was needed to shape the performance, set its character, give it its pace, provide its atmosphere in scenery and lights. It did not matter whether the result was to be a realistic production or a production in which the true theatricalism of the stage was to be liberated—one creative spirit had to dominate.

In the terms of the past century, realism is a much older thing than the theatric, although the theatric goes far deeper into the historic past. Realism is likely to dominate the stage as long as machine civilization dominates life It is already come to a fine perfection, and we are more familiar with it than with the theatric. We have seen realism at its height in Stanislavsky of the Moscow Art theatre, and occasionally in David Belasco or Basil Dean. We have not seen much theatric acting outside Russia and Germany. In America and England the theatric and imaginative movement has expressed itself largely in things of the eye—in the scenery of the new stage-craft. The battle of realism and the theatric—first with a common enemy, then with each other—can in many ways be seen best through the activities of the *régisseurs* of scenery, the stage designers who have given it outward physical form Nothing but the theatre could—currently and importantly—harbour artistic tendencies so diverse. But, though one is photographic and one is imaginative, both began in fierce opposition to the theatre of Victorian days. The thing that both hated in this theatre was typified in its scenery, ugly, unillusive, accidental

Thus two very different types of artists were leagued as allies One was the realist, like Belasco, who wanted solid, plausible rooms on the stage. The other was the man of imagination, like Gordon Craig, who wanted beauty or something full of expressive artifice. There was a little of each in the first great *régisseur* of the 20th century, Max Reinhardt Together, the realist and the artist of the imagination banished the mechanism of the older stage. They banned false perspective and shallow pretence, muddy colour on flapping backdrops.

Realism triumphed first. It had the great dramatists of the day behind it, and the mood of 20th century audiences. Maeterlinck and von Hofmannstahl and d'Annunzio put up an anaemic front to Ibsen, Hauptmann, Sudermann, Brieux, Pinero, Jones, and Shaw The *régisseur* developed actors who could convey emotion by the quiver of an eyelash, and he found ways to surround them with the solid world of reality.

Mechanical Progress.—But how were the solid columns, weighty staircases, well-braced walls to be moved? How were scenes to be shifted quickly and economically? The problem was not alone a problem for the realistic producer, for when the *régisseur* put on Shakespeare the new settings were solid, plastic, three-dimensional, and he had dozens of these scenes and no long intermissions in which to change them. The answer—the typical answer—was modern machinery. America led—for just a moment or two in 1888—when Steele MacKaye, *régisseur*, actor, playwright, painter and mechanist, installed his double elevator stage in the Madison Square Theatre, New York, to shift scenery, actors and all. The great bulk of mechanical reform, however, has come from Germany, and dates from 1896 when Lautenschlaeger of Munich borrowed the revolving stage from Japan. Other scene-shifting machines from Germany include the sliding stage, which carries whole settings on great wagons, and sinking stages, which bring up the scenery from the basement Arthur Hopkins, the first American *régisseur* of imagination to follow MacKaye, introduced, about 1914, stages that swung on pivots, and Lee Simonson, the American designer, has made most ingenious use of small revolving units in Theatre Guild productions such as *Peer Gynt*. (*See* STAGE DESIGN.)

Progress in Lighting.—Even more energy and resourcefulness has gone into the improvement of lighting equipment since the days of gas, and this has served both the realist and the producer of imagination. The first notable attempt was made in Germany by the Venetian, Fortuny His aim was to provide diffused and softened light, more like the reflected sunlight of a shaded spot He threw all the light rays of an arc upon screens of coloured silk which reflected them upon the stage. His sky-dome or *Kuppelhorizont* further diffused the light while producing an illusive sky of almost infinite depth From the mechanism of Fortuny and the ideas of Gordon Craig's great rival, Adolphe Appia—who first called for the shadowed, sculpturesque lighting that comes from large sources of illumination, instead of the blank glare of the footlights—electrical invention has gone on to a surprising degree of perfection in Germany and America. Through Max Hasait and Adolph Linnebach, both working at Dresden in hot rivalry, devices were at last perfected for projecting scenery by means of light on to backdrops or cycloramas Simonson made fine use of the Linnebach process in *Back to Methuselah* and *Peer Gynt*.

There is, after all, a considerable difference between a decoration thrown on a backdrop by electric light and interiors so solid and heavy that they must be shifted by machinery. And yet both extremes fall easily within the limits of the revolt which realist and theatricalist began in the name of the new stagecraft. Even the old-fashioned backdrops of the opera house, painted in false perspective, have their place in the modern movement of the imagination if only they are painted with the boldness, the dramatic vigour, and the expressive colour of a Russian like Bakst or Roerich or Golovin. If the artist can create an effect upon the stage just as characteristic of the play and its emotion as anything the actors may do, then he has done the work expected of him. The medium and the method do not matter.

Pioneers of the New Stage-craft.—This was not quite so clear when Gordon Craig and Adolph Appia began their campaign of scenic enlightenment about the beginning of the 20th century

All about them the stage was filled with flat and shallow artificiality. There was neither beauty nor truth to life in the jaundiced meadows and mildewed mountains and splayed rooms which the hack scene painters spread over backdrops and wings in very, very false perspective. The realist and the imaginative artist had to hate them equally. Craig and Appia might have accepted the stage conventions of the old theatre—the simple flats and backdrops, and awakened them to new life as the Russians did. Instead they fought them, and fought them on the one legitimate issue on which they can be fought. Paintings in two dimensions do not and cannot harmonize with three dimensional actors So away with false perspective and its painted shadows. Make room for solid plastics, for rocks and walls against which the actor may lean

Gordon Craig did a great deal more than argue against backdrops and wings In his articles and books he showed that the theatre is a composite art made up of the contributions of playwright and actor and painter and musician. He demanded unity upon the stage and he declared that the ideal artist of the theatre must be the man who can write the play, direct the actors, design the scenery and lights, and provide any other element such as the music or the dance that may be needed. Only in this fashion can the theatre have the creative unity which is at its heart And in all his writing and through all his brilliant designs, Craig sought to interpret in as dramatic a fashion as possible the emotion of the play.

Appia, a Swiss doctor, who began theorizing and sketching in the early '90s, stood likewise against false perspective and in favour of the plastic stage. Like Craig, he was truly a *régisseur*. His great contribution was a sense for the value of light. In his book describing and picturing the production of Wagner's music-dramas, Appia provided many appropriate and striking sketches, dictating the movements of actors as well as lights. He showed how spotlights, used instead of footlights, produce shadows; how light and shadow give a sculpturesque quality to everything on the stage, and how changes in the light can indicate the passage of time and the development of the drama To demonstrate this, he drew a series of sketches of scenes from Wagner's music-dramas following the light changes throughout each act.

When the theories of Craig and Appia annihilated the old stage setting, they opened the way for something they were not the least interested in—realism. Fortunately they also provided the corrective for it. When realism is most complete it is at its worst. It then furnishes an absolute photograph of life. A room becomes a junk shop. It is solid, real and wooden, and utterly confused. There are so many knick-knacks about that you can hardly find the actors. The eye is tempted to wander off and count the bowls of flowers and admire the woodwork and discover curios all over the place. Belasco and all the realists soon learned better than this. So far as America is concerned, Arthur Hopkins and the artists of the new stage-craft taught them how to make a room seem real and plausible and yet never distracting, and how to make it express something of the drama that goes on within.

Making Scenery Abstract.—The modern theatre has been quick to recognize that the mood created by a background is the important thing, and that, generally speaking, the less the material world is involved, the more the actor can summon up an ideal world of the theatrical imagination. Directors and designers tended, therefore, towards experiments with more and more abstract settings. Craig began with curtains, using them for walls. In a scene for a modern play, Robert Edmond Jones painted his curtains brown and green and hung them in folds that, under proper lighting, suggested a forest Other artists—Norman Wilkinson, for example, working in England under its one modern *régisseur* before 1920, Granville Barker—went a step further and treated curtains frankly as curtains, painting them with a landscape or a formal arrangement of stars, and then—so there could not be the least mistake about it—draped the curtains in folds, and banished even the quasi-illusion of the old backdrop.

Screens can be used even more abstractly. About 1912, Craig worked out a scheme for equipping a theatre with a set of folding screens of all sizes which could be rearranged in an endless variety of ways. When Stanislavsky tried to use this system of screens for *Hamlet* at the Moscow Art theatre, he found grave difficulties in the way of its practical employment. These difficulties were largely removed in a scheme devised by a pupil of Craig's, Sam Hume, which he used at the Detroit Arts and Crafts theatre.

In all this talk of scenery, you must note implication after implication of how the *régisseur* will direct the company towards an art far, far removed from the realism of the Moscow Art theatre. When the theatre goes still further into the abstract or the fantastic in stage setting, it must carry the actor along with it, or it is nothing. Already designers have thrust upon the stage the expressionistic methods of modern painters like Picasso —himself a designer for the Russian ballet of Diaghileff. In America, and in most of the Continent outside Russia, the *régisseurs* have done little to match these backgrounds with acting. The outstanding exceptions—Meyerhold, Yevreynoff, Komisarshefsky, Tairoff and Zemach, all of Russia—have laboured to infuse into the actor and the *ensemble* a stylized vitality which distinguishes their performances from anything in the Western world.

Expressionism and Constructivism.—Expressionism, whether of acting or scenery, postulates that the expression of inner emotion—which ought to be the emotion of the playwright and his play—comes before any resemblance to the outer aspect of life Expressionistic productions use distortion to arrest and excite the attention. Doorways assume strange forms, as in that notable attempt in *Macbeth* which Robert Edmond Jones and Arthur Hopkins made in New York some years ago without acting to back them up. Walls topple. The floor shoots up at weird angles. Lights flare in with no relation to reality, and shift in colour almost word by word. The make-up of the actors is startlingly obvious in its distorted lines, and the clothes of even modern characters are painted with high lights and shadows.

One can almost go back to Appia for the beginnings of constructivism, for Appia was the first to stress the necessity of varied levels on the stage. They have become increasingly important in the work of the more radical *régisseurs*. Leopold Jessner, Germany's outstanding director since Reinhardt, added these levels to the formal stage of the more conservative expressionists. By using steps and parapets, he was able to move his people in three dimensions, and make their physical relationships more vivid and significant. In each of his Shakespeare productions he stuck to a single arrangement of steps, upon which he arranged a few of Emil Pirchan's simply sketched indications of *locale*, all within the neutral wall of the often unlighted cyclorama.

From Jessner one leaped to Russia to find Meyerhold, a theatrical pioneer, developing in constructivism an art which seemed to steal its settings from the American skyscraper. High platforms, skeletonized structures, inclined planes, all manner of bare, unsentimentalized construction provided the footing as well as the background for the actors, and three or four *locales* were shown at one time—a trick of the Renaissance Tairoff mingled canvas expressionism with this when he mounted Eugene O'Neill's *The Hairy Ape* or *Desire under the Elms* In the musical studio of the Moscow Art theatre Dantchenko refined and humanized constructivism in performances of *Lyistrata* and *Carmen*.

New Theatres for Old.—Certain attempts at formalizing the existing stage carry us clear out of this phase and into new types of playhouses. Robert Edmond Jones's *Hamlet*, for instance, turned a Romanesque hall into a permanent setting for the whole drama. Such a scheme makes no pretence at the illusion of turrets, woods or any place except the theatre, tinged with the colour and mood of the drama. This recognition of the playhouse as a place of frank make-believe has carried many modern directors into experiments in theatre architecture that recall the stages of Greece and Elizabethan England. Reinhardt, after producing Greek tragedy in the one-ring circus buildings of Germany, reconstructed one of these houses into the Grosses Schauspielhaus. Here the actors could appear on the orchestra floor in the midst of the audience or retreat to a fully equipped modern stage with

sky-dome and revolving floor.

Half a dozen artists have designed theatres of even more revolutionary character. One of these, not yet built, however, is Norman-Bel Geddes's project for a stage in the corner of a sky-dome completely arching in the auditorium as well. The stage itself sinks into the basement for changes of scene to be made by means of rolling platforms already set. MacKaye's Spectatorium, conceived and partially built for the World's Fair in Chicago, was to seat 10,000 people. The stage itself was to introduce a number of reforms now adopted abroad—the sky-dome, the adaptable proscenium opening and fore stage, the cloud machine, and a sliding stage on wheels. The whole stage could be submerged in water for the discovery of America by Columbus.

Europe created two theatres of outstanding novelty in the Vieux Colombier of Copeau and the Theater in dem Redoutensaal opened in Vienna by Adolf Vetter, then head of the State theatres. The Vieux Colombier was a tiny playhouse without a proscenium opening in which the audience and stage were contained in a single room. The stage itself was provided with a permanent architectural setting of steps and balcony which could be converted, for example, from a classic exterior into a scene for *Twelfth Night* by altering parts of the decoration.

The Theater in dem Redoutensaal was also a theatre with no proscenium and, therefore, no fourth wall and no peep-show. At one end of this great and glorious ballroom of Maria Theresa, Vetter and Oberbaurat Sebastien Heinrich placed an acting platform without proscenium or "flies."

Upon this platform was a curving wall perhaps 15 ft. high, carrying out the decorative motifs of the hall and making a permanent background for the stage. In the middle, double stairways curved up to a balcony above. Upon the balcony were great doors leading to other rooms.

The shell of cream and gold wall was pierced by openings for doors and windows. Screens or simple set-pieces served to vary this setting, and to indicate mood and place. *The Marriage of Figaro* was there presented by the forces of the State opera, and Max Reinhardt staged many classic comedies in the Redoutensaal.

The bulk of this effort to match the realistic theatre with a theatre of imagination went forward unsupported by proper plays The classics served best. Some modern dramas were badly distorted to fit them to the Procrustean bed of expressionism. In Germany a certain number of playwrights, led by Georg Kaiser and Walter Hasenclever, made valiant and none too successful efforts to provide free and vivid plays of today cast in a nervous, fast-moving, subjective form. The success of the Russians in matching plays to constructivist production was not so notable as to pass far over the frontiers.

The only distinctly promising efforts towards new dramatic form came from America and largely from the pen of one writer, Eugene O'Neill Elmer Rice's *The Adding Machine* and George S. Kaufman and Marc Connelly's *Beggar on Horseback*, adapted from a German original, succeeded in enkindling a public response, but the pioneer work of John Howard Lawson, Francis E. Faragoh, John Dos Passos, and Em Jo Bassche failed to meet the requirements of the audiences of today. O'Neill's expressionistic drama *The Hairy Ape*, his constructivist experiment *Desire Under the Elms*, his drama of masks *The Great God Brown*, his nine-act exposition of spoken thoughts *Strange Interlude*, and his printed play *Lazarus Laughed*, seem the only completely mastered attempts of a playwright to strike out along the paths that modern pioneers in direction, scenery and acting have marked out.

(*See* STAGE DESIGN: *Development of Stage Lighting Equipment;* COSTUME DESIGN, THEATRICAL; ACTING.)

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DIRECTION AND ACTING

Theatrical art has always been collective, arising only where poetical-dramatic talent was actively combined with the actor's. The basis of a play is always a dramatic conception; a general artistic sense is imparted to the theatrical action by the unifying, creative genius of the actor. Thus the actor's dramatic activity begins at the foundation of the play In the first place, each actor, either independently or through the theatre manager, must probe for the fundamental motive in the finished play—the creative idea that is characteristic of the author and that reveals itself as the germ from which his work grows organically. The motive of the play always holds the character developing before the spectator; each personality in the work takes a part conforming to his own character; the work, then developing in the appointed direction, flows on to the final point conceived by the author. The first stage in the work of the actor and theatre manager is to probe for the germ of the play, investigating the fundamental line of action that traverses all of its episodes and is therefore called by the writer its transparent effect or action. In contrast to some theatrical directors, who consider every play only as material for theatrical repetition, the writer believes that in the production of every important drama the director and actor must go straight for the most exact and profound conception of the mind and ideal of the dramatist, and must not change that ideal for their own. The interpretation of the play and the character of its artistic incarnation inevitably appear in a certain measure subjective, and bear the mark of the individual peculiarities of the manager and actors; but only by profound attention to the artistic individuality of the author and to his ideal and mentality, which have been disclosed as the creative germ of the play, can the theatre realize all its artistic depth and transmit, as in a poetical production, completeness and harmony of composition. Every part of the future spectacle is then unified in it by its own artistic work; each part, in the measure of its own genius, will flow on to the artistic realization aimed at by the dramatist.

The actor's task, then, begins with the search for the play's artistic seed All artistic action—organic action, as in every constructive operation of nature—starts from this seed at the moment when it is conveyed to the mind. On reaching the actor's mind, the seed must wander around, germinate, put out roots, drinking in the juices of the soil in which it is planted, grow and eventually bring forth a lively flowering plant. Artistic process must in all cases flow very rapidly, but usually, in order that it may preserve the character of the true organic action and may lead to the creation of life, of a clear truly artistic theatrical image, and not of a trade substitute, it demands much more time than is allotted to it in the best European theatres. That is why in the writer's theatre every dramatization passes through eight to ten revisions, as is also done in Germany by the famous theatre manager and theorist, K. Hagemann. Sometimes even more than ten revisions are needed, occasionally extending over several months. But even under these conditions, the creative genius of the actor does not appear so freely as does, for instance, the creative genius of the dramatist. Bound by the strict obligations of his *collectif*, the actor must not postpone his work to the moment when his physical and psychic condition appears propitious for creative genius. Meanwhile, his exacting and capricious artistic nature is prompted by aspirations of his artistic intuition, and in the absence of creative genius is not reached by any effort of his will. He is not aided in that respect by outward technique—his skill in making use of his body, his vocal equipment and his powers of speech.

The Artistic Condition.—But is it really impossible? Are there no means, no processes that sensibly would help us, and spontaneously lead to that artistic condition which is born of

genius without any effort on its part? If that capacity is unattainable all at once, by some process or other, it may, perhaps, be acquired in parts, and through progressive stages may perfect those elements out of which the artistic condition is composed, and which are subject to our will. Of course the general run of acting does not come into being from this genius, but cannot such acting, in some measure, be brought by it near to what is evidence of genius? These are the problems which presented themselves to the writer about 20 years ago, when reflecting on the external obstacles that hamper actors' artistic genius, and partly compel substitution of the crude outward marks of the actor's profession for its results They drove him to the rediscovery of processes of external technique, *i.e.*, methods proceeding from consciousness to sub-consciousness, in which domain flow nine-tenths of all real artistic processes. Observations both upon himself and other actors with whom he happened to rehearse, but chiefly upon growing theatrical skill in Russia and abroad, allowed him to do some generalizing, which thereupon he verified in practice.

The first is that, in an artistic condition, full freedom of body plays a principal rôle; *i e*, the freedom from that muscular strain which, without our knowing it, fetters us not only on the stage but also in ordinary life, hindering us from being obedient conductors of our psychic action. This muscular strain, reaching its maximum at those times when the actor is called upon to perform something especially difficult in his theatrical work, swallows up the bulk of this external energy, diverting him from activity of the higher centres This teaches us the possibilty of availing ourselves of the muscular energy of our limbs only as necessity demands, and in exact conformity with our creative efforts.

The second observation is that the flow of the actor's artistic force is considerably retarded by the visual auditorium and the public, whose presence may hamper his outward freedom of movement, and powerfully hinder his concentration on his own artistic taste. It is almost unnecessary to remark that the artistic achievement of great actors is always bound by the concentration of attention to the action of their own performance, and that when in that condition, *i.e.*, just when the actor's attention is taken away from the spectator, he gains a particular power over the audience, grips it, and compels it to take an active share in his artistic existence. This does not mean, of course, that the actor must altogether cease to feel the public; but the public is concerned only in so far as it neither exerts pressure on him nor diverts him unnecessarily from the artistic demands of the moment, which last might happen to him even while knowing how to regulate his attention The actor suitably disciplined must automatically restrict the sphere of his attention, concentrating on what comes within this sphere, and only half consciously seizing on what comes within its aura. If need be, he must restrict that sphere to such an extent that it reaches a condition that may be called *public solitude*. But as a rule this sphere of attention is elastic, it expands or contracts for the actor, with regard to the course of his theatrical actions. Within the boundary of this sphere, as one of the actual aspects of the play, there is also the actor's immediate central *object of attention*, the object on which, somehow or other, his will is concentrated at the moment with which, in the course of the play, he is in inward communication This theatrical sympathy with the object can only be complete when the actor has trained himself by long practice to surrender himself in his own impressions, and also in his reactions to those impressions, with maximum intensity: only so does theatrical action attain the necessary force, only so is created between the actual aspects of the play, *i.e.*, between the actors, that link, that living bond, which is essential for the carrying through of the play to its goal, with the general maintenance of the rhythm and time of each performance.

Concentration.—But whatever may be the sphere of the actor's attention, whether it confines him at some moments to public solitude, or whether it grips the faces of all those before the stage, dramatic artistic genius, as in the preparation of the part so in its repeated performance, requires a full concentration of all the mental and physical talents of the actor, and the participation of the whole of his physical and psychic capacity. It takes hold of his sight and hearing, all his external senses; it draws out not only the periphery but also the essential depth of his existence, and it evokes to activity his memory, imagination, emotions, intelligence and will. The whole mental and physical being of the actor must be directed to that which is derived from his facial expression. At the moment of inspiration, of the involuntary use of all the actor's qualities, at that moment he actually exists. On the other hand, in the absence of this employment of his qualities, the actor is gradually led astray along the road leading to time-honoured theatrical traditions; he begins to "produce" wherever he sees them, or, glancing at his own image, imitates the inward manifestations of his emotions, or tries to draw from himself the emotions of the perfected part, to "inspire" them within himself. But when forcing such an image by his own psychic equipment, with its unchanging organic laws, he by no means attains that desired result of artistic genius; he must present only the rough counterfeit of emotion, because emotions do not come to order. By no effort of conscious will can one awake them in oneself at a moment, nor can they ever be of use for creative genius striving to bring this about by searching the depths of its mind. A fundamental axiom, therefore, for the actor who wishes to be a real artist on the stage, may be stated thus: he must not play to produce emotions, and he must not involuntarily evoke them in himself.

Activity of Imagination.—Considerations on the nature of artistically gifted people, however, inevitably open up the road to the possession of the emotion of the part. This road traverses activity of imagination, which in most of its stages is subject to the action of consciousness. One must not suddenly begin to operate on emotion; one must put oneself in motion in the direction of artistic imagination, but imagination—as is also shown by observations of scientific psychology—disturbs our aberrant memory, and, luring from the hidden recesses beyond the boundaries of its sense of harmony whatever elements there may be of proved emotions, organizes them afresh in sympathy with those that have arisen in our imagery. So surrounded within our figures of imagination, without effort on our part, the answer to our aberrant memory is found and the sounds of sympathetic emotion are called out from us. This is why the creative imagination presents itself afresh, the indispensable gift of the actor. Without a well developed, mobile imagination, creative faculty is by no means possible, not by instinct nor intuition nor the aid of external technique. In the acquiring of it, that which has lain dormant in the mind of the artist is, when immersed in his sphere of unconscious imagery and emotion, completely harmonized within him.

This practical method for the artistic education of the actor, directed by means of his imagination to the storing up of effective memory, is sufficiently enlarged upon; his individual emotional experience, by its limits, actually leads to the restriction of the sphere of his creative genius, and does not allow him to play parts dissimilar to those of his psychic harmony. This opinion is fundamental for the clearing away of misunderstandings of those elements of reality from which are produced fictitious creations of imagination; these are also derived from organic experience, but a wealth and variety of these creations are only obtained by combinations drawn from a trial of elements. The musical scale has only its basic notes, the solar spectrum its radical colours, but the combination of sounds in music and of colours in painting are infinite. One can in the same way speak of radical emotions preserved in imaginative memory, just as the reception in imagination of outward harmony remains in the intellectual memory; the sum of these radical emotions in the inner experience of each person is limited, but the shades and combinations are as infinite as the combinations that create activity of imagination out of the elements of inward experience.

Certainly, but the actor's outward experience—*i.e*, his sphere of vital sensations and reflections—must always be elastic, for only in that condition can the actor enlarge the sphere of his creative faculty. On the other hand, he must judiciously develop his imagination, harnessing it again and again to new propositions.

But, in order that that imaginary union which is the actor's very foundation, produced by the creative genius of the dramatist, should take hold of him emotionally and lead him on to theatrical action, it is necessary that the actor should "swing toward" that union, as toward something as real as the union of reality surrounding him

The Emotion of Truth.—This does not mean that the actor must surrender himself on the stage to some such hallucination as that when playing he should lose the sense of reality around him, to take scenery for real trees, etc. On the contrary, some part of his senses must remain free from the grip of the play to control everything that he attempts and achieves as the performer of his part. He does not forget that surrounding him on the stage are decorations, scenery, etc, but they have no meaning for him. He says to himself, as it were: "I know that all around me on the stage is a rough counterfeit of reality. It is false. But if all should be real, see how I might be carried away to some such scene; then I would act." And at that instant, when there arises in his mind that artistic "suppose," encircling his real life, he loses interest in it, and is transported to another plane, created for him, of imaginary life. Restored to real life again, the actor must perforce modify the truth, as in the actual construction of his invention, so also in the survivals connected to it. His invention can be shown to be illogical, wide of the truth—and then he ceases to believe it. Emotion rises in him with invention; *i.e.*, his outward regard for imagined circumstances may be shown as "determined" without relation to the individual nature of a given emotion. Finally, in the expression of the outward life of his part, the actor, as a living complex emotion, never making use of sufficient perfection of all his bodily equipment, may give an untrue intonation, may not keep the artistic mean in gesticulation and may through the temptation of cheap effect drift into mannerism or awkwardness.

Only by a strongly developed sense of the truth may he achieve that, in order that every one of his poses, and every gesture may be outwardly realistic; *i e*, he may express the condition representing the character, and may not serve, like the conventional theatrical gestures and poses of every race, a single inward beauty.

Internal Technique.—The combination of all the above-named procedure and habits also composes the actor's external technique. Parallel with its development must go also the development of internal technique—the perfecting of that bodily equipment which serves for the incarnation of the theatrical image created by the actor, and the exact, clear expression of his external consciousness. With this aim in view the actor must work out within himself not only the ordinary flexibility and mobility of action, but also the particular consciousness that directs all his groups of muscles, and the ability to feel the energy transfused within him, which, arising from his highest creative centres, forms in a definite manner his mimicry and gestures, and, radiating from him, brings into the circle of its influence his partners on the stage and in the auditorium. The same growth of consciousness and fineness of internal feelings must be worked out by the actor in relation to his vocal equipment. Ordinary speech—as in life, so on the stage—is prosaic and monotonous; in it words sound disjointed, without any harmonious stringing together in a vocal melody as continuous as that of a violin, which by the hand of a master violinist can become fuller, deeper, finer and more transparent, and can without difficulty run from the higher to the lower notes and vice versa, and can alternate from pianissimo to forte. To counteract the wearisome monotony of reading, actors often elaborate, especially when declaiming poetry, with those artificial vocal *fioritures*, cadences and sudden raising and lowering of the voice, which are so characteristic of the conventional, pompous declamation, and which are not influenced by the corresponding emotion of the part, and therefore impress the more sensitive auditors with a feeling of unreality.

But there exists another natural musical sonorousness of speech, which we may see in great actors at the moment of their own true artistic elation, and which is closely knit to the internal sonorousness of their rôle. The actor must develop within himself this natural musical speech by practising his voice with due regard to his sense of reality, almost as much as a singer. At the same time he must perfect his elocution. It is possible to have a strong, flexible, impressive voice, and still distort speech, on the one hand by incorrect pronunciation, on the other by neglect of those almost imperceptible pauses and emphases through which are attained the exact transmission of the sense of the sentence, and also its particular emotional colouring In the perfect production of the dramatist, every word, every letter, every punctuation mark has its part in transmitting his inward reality; the actor in his interpretation of the play, according to his intelligence, introduces into each sentence his individual nuances, which must be transmitted not only by the motions of his body, but also by artistically developed speech. He must bear this in mind, that every sound which goes to make a word appears as a separate note, which has its part in the harmonious sound of the word, and which is the expression of one or other particle of the soul drawn out through the word. The perfecting, therefore, of the phonetics of speech cannot be limited to mechanical exercise of the vocal equipment, but must also be directed in such a way that the actor learns to feel each separate sound in a word as an instrument of artistic expression. But in regard to the musical tone of the voice, freedom, elasticity, rhythm of movement and generally all external technique of dramatic art, to say nothing of internal technique, the present day actor is still on a low rung of the ladder of artistic culture, still far behind in this respect, from many causes, the masters of music, poetry and painting, with an almost infinite road of development to travel.

Production.—It is evident that under these conditions, the staging of a play, which will satisfy highly artistic demands, cannot be achieved at the speed that economic factors unfortunately make necessary in most theatres. This creative process, which every actor must go through, from his conception of the part to its artistic incarnation, is essentially very complicated, and is hampered by lack of perfection of outward and inward technique It is also much hindered by the necessity of fitting in the actors one with another—the adjustment of their artistic individualities into an artistic whole.

Responsibility for bringing about this accord, and the artistic integrity and expression of the performance rests with the theatre manager. During the period when the manager exercised a despotic rule in the theatre, a period starting with the Meiningen players and still in force even in many of the foremost theatres, the manager worked out in advance all the plans for staging a play, and, while certainly having regard to the existing cast, indicated to the actors the general outlines of the scenic effects, and the *mise-en-scène*. The writer also adhered to this system, but now he has come to the conclusion that the creative work of the manager must be done in collaboration with the actor's work, neither ignoring nor confirming it. To encourage the actor's creative genius, to control and adjust it, ensuring that this creative genius grows out of the unique artistic germ of the drama, as much as the external building up of the performance—that in the opinion of the writer is the problem of the theatre director to-day.

The joint work of the director and actor begins with the analysis of the drama and the discovery of its artistic germ, and with the investigation of its *transparent effect*. The next step is the discovery of the transparent effect of individual parts—of that fundamental will direction of each individual actor, which, organically derived from his character, determines his place in the general action of the play. If the actor cannot at once secure this transparent effect, then it must be traced bit by bit with the manager's aid—by dividing the part into sections corresponding to the separate stages of the life of the particular actor—from the separate problems developing before him in his struggle for the attainment of his goal. Each such section of a part or each problem, can, if necessary, be subjected to further psychological analysis, and sub-divided into problems even more detailed, corresponding to those separate mind actions of the performer out of which stage life is summed up. The actor must catch the *mind axes* of the emotions and temperaments, but not the emotions and temperaments that give colour to these sections of the part. In other words, when studying each portion of his part, he must

ask himself what he wants, what he requires as a performer of the play and which definite partial problem he is putting before himself at a given moment. The answer to this question should not be in the form of a noun, but rather of a verb: "I wish to obtain possession of the heart of this lady"—"I wish to enter her house"—"I wish to push aside the servants who are protecting her," etc. Formulated in this manner, the mind problem, of which the object and setting, thanks to the working of his creative imagination, are forming a brighter and clearer picture for the actor, begins to grip him and to excite him, extracting from the recesses of his working memory the combinations of emotions necessary to the part, of emotions that have an active character and mould themselves into dramatic action. In this way the different sections of the actor's part grow more lively and richer by degrees, owing to the involuntary play of the complicated organic survivals. By joining together and grafting these sections, the *score of the part* is formed; the scores of the separate parts, after the continual joint work of the actors during rehearsals and by the necessary adjustment of them one with another, are summed up in a single *score of the performance*.

The Score Condensed.—Nevertheless, the work of the actors and manager is still unfinished. The actor is studying and living in the part and the play deeper and deeper still, finding their deeper artistic motives; so he lives in the score of his part still more profoundly. But the score of the part itself and of the play are actually subject by degrees during the work to further alterations. As in a perfect poetical production there are no superfluous words but only those necessary to the poet's artistic scheme, so in a score of the part there must not be a single superfluous emotion but only emotions necessary for the *transparent effect*. The score of each part must be condensed, as also the form of its transmitting, and bright, simple and compelling forms of its incarnation must be found. Only then, when in each actor every part not only organically ripens and comes to life but also all emotions are stripped of the superfluous, when they all crystallize and sum up into a live contact, when they harmonize amongst themselves in the general tune, rhythm and time of the performance, then the play may be presented to the public.

During repeated presentations the theatrical score of the play and each part remains in general unaltered. But that does not mean that from the moment the performance is shown to the public the actor's creative process is to be considered ended, and that there remains for him only the mechanical repetition of his achievement at the first presentation. On the contrary, every performance imposes on him creative conditions; all his psychical forces must take part in it, because only in these conditions can they creatively adapt the score of the part to those capricious changes which may develop in them from hour to hour, as in all living nervous creatures influencing one another by their emotions, and only then can they transmit to the spectator that invisible something, inexpressible in words, which forms the spiritual content of the plays. And that is the whole origin of the substance of dramatic art.

As regards the outward arrangements of the play—scenery, theatrical properties, etc.—all are of value in so far as they correspond to the expression of dramatic action, *i.e.*, to the actors' talents; in no case may they claim to have an independent artistic importance in the theatre, although up to now they have been so considered by many great scene painters. The art of scene painting, as well as the music included in the play, is on the stage only an auxiliary art, and the manager's duty is to get from each what is necessary for the illumination of the play performed before an audience, while subordinating each to the problems of the actors. (*See* ACTING; MOTION PICTURES: *Acting* and *Production*.)

(C. ST.)

THE ACTOR

It is to the actor and to no one else that the theatre belongs. This does not mean, of course, the professional actor alone, but the actor as poet, as director, stage-manager, musician, scene-designer, painter, and, certainly not least of all, the actor as spectator, for the contribution of the spectators is almost as important as that of the cast. The audience must take its part in the play if we are ever to see arise a true art of the theatre—the oldest, most powerful, and most immediate of the arts, combining the many in one.

We all bear within us the potentiality for every kind of passion, every fate, every way of life. Nothing human is alien to us. If this were not so, we could not understand other people, either in life or in art. But inheritance and upbringing foster individual experiences and develop only a few of our thousands of possibilities. The others gradually sicken and die.

Bourgeois life to-day is narrowly circumscribed, and poor in feeling. Out of its poverty it has made merely virtues through which it pushes its way, severe and upright. The normal man generally feels once in his life the whole blessedness of love, and once the joy of freedom. Once in his life he hates bitterly. Once with deep grief he buries a loved one, and once, finally, he dies himself. That gives all too little scope for our innate capacity to love, hate, enjoy, and suffer. We exercise daily to strengthen our muscles and sinews that they may not grow feeble, but our spiritual organs, which were made to act for an entire lifetime, remain unused, undeveloped, and so, with the passing years, they lose their vitality. Yet our spiritual like our bodily health depends upon the regular functioning of these organs. Unconsciously we feel how a hearty laugh liberates us, how a good cry or an outbreak of anger relieves us We have an absolute need of emotion and its expression.

Against this our upbringing constantly works. Its first commandment is: "Hide what goes on within you. Never let it be seen that you are stirred up, that you are hungry or thirsty; every grief, every joy, every rage, all that is fundamental and craves utterance, must be repressed." Hence the well-known sublimations, the hysterical tendencies of the time, and finally that empty play-acting of which modern life is full. Passion, bursts of feeling and fancy, are ruled outside the bounds. In their place we have set up in a row common stereotyped forms of expression that are part of our social armour. This armour is so rigid and constricted that there is hardly any room for natural action. We cultivate a few useful expressions of interest, of pleasure, of dignity, and a set grimace of politeness. We ask people how they feel without waiting for an answer or, in any case, without paying attention to it. With a fixed intonation, which could be written down and reproduced wholesale, we say that we are happy to see them, though the encounter may be a matter of complete indifference to us when it is not actually fatal. At weddings, christenings, burials, festivities we make out of hand-shaking and bowing, out of frowns and grins, a ghostly play, in which the absence of feeling is shocking.

The modern social code has crippled the actor, whose business it is to body forth feeling. When generations have been brought up to repress the emotions, nothing in the end remains either to inhibit or to show. How can the actor, rooted deep in the bourgeois existence of every-day, suddenly in the evening leap into the life of the mad king, whose unrestrained passion sweeps like a storm across the moors? How shall he make it credible that he is killing himself through love, or that he has killed another through jealousy? It is significant that our modern theatre can hardly boast a true lover. When the actor on the stage says "I love you," it is the custom in many theatres to resort to musical accompaniment of the wood instruments, in order to evoke a poetical atmosphere. The soul is set vibrating by a *vibrato* of the violins—otherwise one could scarcely distinguish an "I-love-you" from a "How-do-you-do." Generally, the women are more impulsive because they still live closer to nature than men.

In former times, when actors were excluded from bourgeois society and wandered about like gypsies, they undoubtedly developed stronger, rarer personalities. They were more unbridled in their passions; their outbursts were more powerful, the spirits that possessed them, more masterful. They had no outside interests. They were actors, body and soul. To-day the body is willing, but the spirit is weak, and their interests are divided.

Of course, all these observations and all rules fail before the wonder of genius. But there is little genius, and there are many theatres. Now, to every person nature gives a face of his own.

There is as small chance of finding two men who exactly resemble each other as of finding two leaves on a tree which are precisely alike. Yet in the narrow course of bourgeois life, driven hither and thither by the current of every-day, they are in time worn down until they become like round pebbles One individual looks like another. This grinding process also has its effect upon their psychological make-up. But the highest boon of mankind is personality. In the arts, personality is the decisive factor; it is the living kernel which we seek in every artistic work

Bourgeois standards should not be applied to artists, for what is it that distinguishes the artist? It is that he reacts to whatever he encounters deeply and powerfully; that things hardly visible, hardly audible, stir and move him; that he is driven by an irresistible impulsion to give all that he experiences back again, realized in some form of expression It would be a gross injustice to wish to profit by these gifts in the arts, and yet in life outside to condemn them.

The art of acting originated in the earliest childhood of the race Man, allotted a brief existence, in a close-pressing crowd of various kinds of individuals, who were so near him and yet so elusively far, had an irresistible desire to throw himself into a fantastic play of changing one form into another, one fate into another, one effect into another. These were the first attempts to fly above his narrow material existence The possibilities inherent in him but not brought to full growth by his life thus unfolded their shadowy wings and carried him far over his knowledge and away into the heart of a strange experience. He discovered all the delights of transformation, all the ecstasy of passion, all the illusive life of dreams.

Made as we are in God's image, we have in us something of the godlike creative will Therefore we create the whole world over again in the arts, with all the elements, and on the first day of creation, as the crown of our work, we make men in *our* image

Shakespeare is the greatest, the one truly incomparable boon that the theatre has had. He was poet, actor, and producer in one. He painted landscapes and fashioned architectural scenes with his words. In his plays everything is bathed in music and flows into the dance. He stands nearest to the Creator. It is a wonderful full-rounded world that he made—the earth with all its flowers, the sea with all its storms, the light of the sun, the moon, the stars; fire with all its terrors and the air with all its spirits—and in between, human beings with all their passions, their humour and tragedy, beings of elemental grandeur and, at the same time, utter truth His omnipotence is infinite. He was Hamlet, King Claudius, Ophelia, and Polonius in one person. Othello and Iago, Brutus and Cassius, Romeo and Juliet, Falstaff and Prince Henry, Shylock and Antonio, Bottom and Titania, and the whole line of merry and sorrowful fools lived within him. He engendered them and brought them to birth; they were part of his inscrutable being Over them he hovers like a godhead, invisible and intangible. Nothing of him is there but this great world. Yet in it he is ever present and mighty. He lives eternally.

Only that art is living, in whose inmost chamber the human heart beats.

For the moment the theatre is, we realize, threatened; it is in a decline to-day because in the noise and rush of the great cities, though material means of existence are given it, its peculiar festal beauty, the enchanted sense of play, has been taken from it. It has not yet been organically co-ordinated with the sudden growth of the modern metropolis.

The arts, especially the theatre, forsaken by the good spirits, can be the sorriest business, the poorest prostitution—there is its pale first cousin, the film, which was born in the city and has undoubtedly flourished better there. But the passion to act in the theatre, to go to the theatre, is an elemental desire in mankind. It will always draw actors and spectators together to the play, and out of that dionysian union in which they rise above the earth, it will produce the highest art that alone brings felicity.

The theatre is deathless. It is the happiest loophole of escape for those who have secretly put their childhood in their pockets and have gone off with it to play to the end of their days. The art of the stage affords also liberation from the conventional drama of life, for it is not dissimulation that is the business of the play but revelation. Only the actor who cannot lie, who is himself undisguised, and who profoundly unlocks his heart deserves the laurel. The supreme goal of the theatre is truth, not the the outward, naturalistic truth of every-day, but the ultimate truth of the soul.

We can telegraph and telephone and wire pictures across the ocean, we can fly over it. But the way to the human being next us is still as far as to the stars. The actor takes us on this way. With the light of the poet he climbs the unexplored peaks of the human soul, his own soul, in order to transform it secretly there and to return with his hands, eyes, and voice full of wonders.

He is at once sculptor and sculpture; he is man at the farthest borderline between reality and dream, and he stands with both feet in both realms The actor's power of self-suggestion is so great that he can bring about in his body not only inner and psychological but even outer and physical changes. And when one ponders on the miracle of Konnersreuth, whereby a simple peasant girl experiences every Friday the Passion of Christ, with so strong an imaginative power that her hands and feet show wounds and she actually weeps tears of blood, one may judge to what wonders and to what a mysterious world the art of acting may lead; for it is assuredly by the same process that the player, in Shakespeare's words, changes utterly his accustomed visage, his aspect and carriage, his whole being, and can weep for Hecuba and make others weep Every night the actor bears the stigmata, which his imagination inflicts upon him, and bleeds from a thousand wounds. (M. Re)

THEORY OF MODERN PRODUCTION

The theatre at any period in history has always provided an immediate reflection of the life of that period, and accordingly, we find in the theatre of to-day splendour, speed, luxury and an eager reaching out in every direction for new ways in which to seize and to communicate every phase of modern life. A brief glance at the illustrations, shown herewith, which are chosen from the designs of artists whose work is characteristic of the theatre of our time, will confirm this statement. Life is moving and changing and the theatre is moving and changing very swiftly with it. We are living in a period of high nervous vitality, of discontent, of restless experimentation, of feverish search for new ideals and new standards.

In the midst of this incessant activity it is difficult to indicate any one precise direction in which the theatre is moving at the present time or to prophesy the forms it may assume even in the near future. A decade hence the theatre of 1930 may come to be regarded as incredibly crude, naïve and amorphous. But it is suggested that at this moment we have at our disposal a new and hitherto undeveloped medium of dramatic expression which during the next few years may profoundly change modern theatrical production. This medium is the talking picture.

Modern psychology has made us all familiar with the idea of the subconscious. We have learned that just beneath the surface of our everyday normal conscious existence there lies a vast region of dreams, a hinterland of energy which has a form of its own and laws of its own, laws that motivate our inmost thoughts and actions. This conception has profoundly influenced the intellectual life of our day. It has already become a commonplace of our thinking, and it is beginning to find expression in our art. Writers like James Joyce and Gertrude Stein, painters like Matisse and Picasso, musicians like Debussy and Stravinsky, ventured into the realm of the subjective and recorded the results of their explorations in new and arresting forms. Our playwrights, too, have begun to explore this land of dreams. In two dramas produced in New York, Eugene O'Neill's *Strange Interlude* and Sophie Treadwell's *Machinal*, an attempt has been made to express directly to the audience the unspoken thoughts of the characters, to show us not only their conscious behaviour but the actual pattern of their subconscious lives. These adventures into the subjective indicate a trend in dramatic writing which is bound to become more general as the laws of the subconscious become more and more clearly understood. It seems strange, strik-

ing, that just at this moment in the world's history there has come into existence the talking picture, a perfect instrument for expressing the subconscious in theatrical productions *In the simultaneous use of the living actor and the talking picture in the theatre there lies a wholly new theatrical art, an art whose possibilities are as infinite as those of speech itself.*

The dramatists of to-day are casting about for ways in which to express the workings of the subconscious, to express thought before it becomes articulate They have not seen that the moving and talking picture is itself a direct expression of thought before thought becomes articulate They are trying to give us in the theatre not only the outward actuality of our lives, but the inward reality of our thoughts They are seeking to go beyond the everyday life we normally know into the never-ending stream of images which has its source in the depths of the self, in the unknown springs of our being. But in their search for ways in which to express their new awareness of hfe, they have not observed that the moving picture is thought made visible.

This statement is in itself a revolutionary one, but it is true The moving picture runs in a stream of images, just as our thoughts do, and the speed of the moving picture, with its "flash-backs" and abrupt transitions from subject to subject, is very close to the speed of our thoughts. Here lies the potential dramatic importance of this new invention. The dramatist has it in his power to enhance and elaborate the characters of his drama to an infinite extent by means of these moving and speaking images. Some new playwright will presently set a motion picture screen on the stage above and behind his living actors and will reveal the two worlds that together make up the world we live in— the outer world and the inner world, the world of actuality and the world of dream. *Strange Interlude*, *Machinal* and the "talkies" have shown us the way toward this new drama. Within the next decade a new dimension may be added to our theatre

(R. E J.)

CHINESE THEATRE

The Chinese drama, as it had existed from ancient times up to the time of the Revolution in 1911, was a continuous development from simple primitive forms to a very complex and elaborate one. (*See* DRAMA: *Chinese Drama.*) Such evidence as can be found in the Chinese classics makes it certain that the origins were in ancestor worship and religious dancing, and in the acrobats and clowns who entertained the courts, presenting an obvious analogy to the drama of the middle ages Added to this, we have the evidence of the engraved reliefs of the Wu tombs and of such stelae as that in the Boston museum (dated AD 529) Also the numerous grave figurines which present a variety of actors and dancers, giving visual proof of the type of dancing engaged in in the Six Dynasties and the T'ang dynasty Traditionally, the acting of stories is attributed to the Han dynasty. References are made to stories accompanied by song and dance in the North Ch'i dynasty. The use of animal and demon masks was probably primitive and early, but legend ascribes the origin of the terrifying warrior masks to the prince of Lan Ling who had a face so beautiful that he had to invent a "false face" of carved wood in order to frighten the enemy. Whatever the truth of the matter, the Chinese have developed painted faces which are the equivalent of the Japanese NÔ masks. (*See* MASKS.)

In the T'ang dynasty the Emperor Ming Huang was famous as a patron of the arts of drama and dancing. He established the "Pear Garden," a court institute of music, dancing and acting, and established a similar institute for the training of females, a reference which seems to indicate that the 19th century tradition of the segregation of sexes in dramatic companies was an old and persistent one.

Development.—The Chinese speak of three epochs in the development of the drama: (1) from the reign of Ming Huang (AD. 720) to the fall of the T'ang dynasty; (2) from the beginning of the Sung dynasty up to the close of the reign of Hui T'sung, a great patron of all the arts; (3) from and including the reign of the Golden Tatars of North China and the whole Yüan (Mongol) dynasty. This classification seems to be purely arbitrary and the real puzzle to the historian of Chinese drama lies in the question of the Mongol drama. All the proper pre-Yüan dramatic literature is lost; the theory is that Chinese littérateurs under a barbarian rule turned their genius to an art which they considered inferior This they did partly as a matter of politics, partly for diversion and partly out of contempt

From this period the names of plays and dramatists are preserved. (Among the dramatists were Wang Shih-fu, 王實甫 Shih Chun-mei, 施君美, Kuan Han-shêng, 關漢聲, Ma Chih-yüan, 馬致遠, and Ch'iao Li-fu, 喬立符.) Sure as it seems that the drama as serious literature was at its height during this period, the question of how much of the theatre of that period was an innovation and how much was the elaboration of straight tradition is a completely open one. The opinion of the author is that the tradition, however tricked out, was not changed. Dancers of the 20th century move from posture to posture which are identical with those of the T'ang dynasty grave figurines and there are many analogies to the NÔ drama of Japan which have never been properly looked into, notably similar conventions, and, in the male characters, a similar use of intoned chanting (*See* NÔ DRAMA.)

The drama continued to flourish under the Ming dynasty and apparently did not give way to a new form until the middle of the Ch'ing period when an easier and more popular style became the mode. The classical drama, or *k'un ch'u*, 崑曲 has persisted to the present day but is largely kept up by scholarly amateur societies. There are a few great professional singers of the classical drama, and the great popular actors usually include a few classical rôles in their repertoires, but for the most part dramatic performances are in the popular (*êrh huang*) 二黃 mode developed under the Manchus. In the third decade of the 20th century the modernists were attacking the stage tradition with everything else that has been great in China and have fallen into weak imitation of the western dramatic forms, so far with very little effect on the old theatre except that the fashionable actors are deserting the traditional type of stage and are taking to western stages, painted scenery and spotlights.

Forms of Entertainment.—The Chinese employ a form of entertainment for which we have no single word It is a combination of spoken dialogue, operatic singing and ballet dancing. Both the theatre and the performance present immediate analogies to the Elizabethan drama. The theatre, except for refinement of decoration, is almost identical in arrangement, but the Chinese theatre always has a roof except in the case of temple theatres which consist only of the actual stage itself. Like the Elizabethan theatre, the Chinese use only the scantiest stage properties: an embroidered curtain at the rear with entrances left and right, furniture carried in and out during the performance, landscapes indicated by symbolic plaques. The Imperial theatres went further and had contraptions which resemble those described in writings of the Italian Renaissance, including balconies, pits in the floors and holes in the ceilings through which actors could be lowered. Further analogies with the Elizabethan theatre appear in the long monologues which the actor addresses to an audience in a fully lighted house, and monologues so presented become logical and exciting confidences and not at all the dull and abstract versions which westerners present in Elizabethan revivals Furthermore, the actors are all of one sex, usually males, and the perfection of female representation teaches the westerner what such representation must have been in England Another analogy is in the comic interludes of exaggerated clowning, as yet happily unexpurgated.

But the Chinese have developed a whole set of conventions which are apparently incomprehensible to Western nations. Not only are the gestures and movements of the different sexes and ages represented bound by conventions, but the very voices themselves must conform to similar conventions. The typical classification of parts is as follows. The *tan* (旦, Mongol colloquialism for "woman"), or young female, moves in a set, rhythmical sway and speaks and sings in a high falsetto. The clothes for these parts are designed and built in long flowing lines to increase the impression of flower-like grace; the make-up is elaborated red and white. The *lao tan* (老旦, *lao*, old; *tan*, see above), or old lady, walks in four-four time with a slight palsied shake; she bends a little but does not sway, wears no make-up and usually wears a

bright orange bandeau to increase the effect of pallor. She speaks and sings in a falsetto. The *hsiao shêng* (小生, young man) moves in a measured and animated stride His make-up is slight, confined to pink-and-white cheeks and exaggerated eyebrows. He speaks and sings in falsetto and may, in speaking, change his range from falsetto to a natural tenor. The cut of his costume is simple and sculpturesque, a long loose robe in which he moves easily. The *lao shêng* (老生, old man) uses movements and gestures the same as the young man's but with less buoyancy. He usually speaks and sings in falsetto but may talk in a sustained tenor. His clothes are of the same cut as the young man's but differ in details of head-dress and are less gay in colour. The *hua lien* (花臉, painted face) represents the warrior. With the exception of very young warriors, who wear neither painted faces nor beards, all actors represen.ing warriors are made up with elaborately painted faces in bright colours and striking designs appropriate to the contours of the human face. These painted faces are the equivalents of masks. The warrior moves in an exaggerated strut and speaks in a deep throaty roar. He sings variously, according to part and actor, ordinarily in a forced bass but occasionally in a piercing tenor. His clothes are built to give the impression of force and strength and include elaborate underpads for the torso and shoulders, heavily embroidered epaulettes and stomachers and long scalloped panniers which flare as he moves. He wears enormous head-dresses, often with 6 ft. pheasant feathers and sometimes four pennants attached to his back. The *ch'ou* (丑 *ch'ou*, is the second of the 12 zodiac signs but has come to be applied to the comedian or clown, probably because it is homonymous with *ch'ou*, 醜, meaning homely), or comedian, is allowed more liberty of voice and action, the result being close to our exaggerated clown parts. He is almost always distinguished by white circles around the eyes.

These are the main distinctions. The conventions are carried much further into the special representation of definite characters in which not only the exact make-up for that particular character is prescribed but even the colours used carry symbolic meanings. The costumes themselves are far more subtle and complicated than those of the Nō drama of Japan, the obvious beauty of which is apparent to the dullest eye The Chinese costumes, like the Japanese Nō costumes, are in a style which might well be described as architectonic. The actor is considered a kind of puppet on which the designer builds up a character of whatever sex and of whatever physique he chooses. The outlines of the figures are always clearly defined but the surface of a given mask is often covered with intricate patterns, which makes an ensemble of Chinese actors a more complicated picture than an ensemble of the Nō actors. The subject matter of the plays is almost always traditional. It includes stories from famous novels, anecdotes and legends about historic personages, stories of the "Three Kingdoms," in content suggestive of the Morte d'Arthur legend, and satiric burlesques of the church and of historic villains.

Kinds of Drama in China.—The classical drama or *k'un ch'ü* (崑曲) takes its name from the K'un Shan district in the present province of Kiangsu. It is a highly refined and perfected form in which every gesture is in prescribed concordance with words and music, but the gestures and, to a certain degree, the emphasis of the singing is not written down but is handed down from teacher to teacher. The music itself includes an infinite number of tunes, each composed for a particular drama. The instruments include wind instruments (a kind of flute and oboe, and the *shêng*, 笙, a mouth organ made of 17 small bamboo pipes), trumpets, drums, bells and plucked string instruments. Stringed instruments played with a bow are never used in the *k'un ch'ü*.

The popular drama which has several different names, most of which bear a geographical significance, is best referred to as *erh huang* (二黃) and *p'i huang* (皮黃), because it originated at Huang Kang and Huang P'i, two districts in the province of Hupei. It is sometimes known as *han tiao* (漢調) from the river Han which flows through the region. It is also called *ching tiao* (京調), a southern name given to it after it had become the popular form in Peking, the capital. It is a much more flexible and careless form than the classical form. Tunes are less varied and are often used for a number of different plays, and the tunes have far less quality than those of the classical drama. The accompaniment includes largely stringed instruments played with a bow, wind instruments (exclusive of the *shêng* which is not used), drums, gongs and cymbals. The action is far less highly developed. A third kind of theatrical entertainment is known as the *shansi pang tzü* (山西梆子) or *pang tzü ch'iang* (梆子腔), a rustic form of drama introduced from the province of Shansi, the outstanding characteristic of which is the persistent use of the trumpet and a kind of rattle known as *pang tzü* (梆子).

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(A. R. Ps.)

THEATRES, LAW RELATING TO. Playhouses grew up in England after the Renaissance, when the religious drama began to give place to the secular drama. Apparently, licences for temporary theatres were first granted in the reign of Henry VIII, but as the number of regular playhouses increased, letters patent to perform stage plays were granted to Burbage, Shakespeare and others by Elizabeth and James I. By an Order in Council passed in 1600, the number of playhouses in London was limited to two, one in Middlesex and one in Surrey; but this restriction was not strictly enforced.

The theatres continued to function independently of legal control until 1647, when an Ordinance of the Roundhead Government closed all playhouses and even inflicted penalties on any spectator at stage plays.

With the Restoration, the theatres were re-established, and royal patents granted to Killigrew and Davenant, in 1662, for their theatres in Drury lane and Covent garden, the one enjoying the official patronage of Charles II, the other the patronage of the duke of York.

The Theatres Act of 1737 (10 Geo. II. *c.* 28) instituted statutory control over playhouses, plays and players which continued for more than a century. The act provided (*inter alia*) that no person should be authorized either by letters patent or by licence to perform stage plays anywhere in Great Britain except within the City of Westminster or the liberties thereof or in places of royal residence during the period of such residence. This limitation was subsequently modified by an act passed in 1788 (28 Geo III. *c.* 30). The acting of plays at the universities (which had been privileged places originally) was forbidden by 10 Geo. II. *c.* 19.

Walpole's act of 1737 consolidated the position of the patent theatres; and in spite of a long and bitter struggle between the patent theatres and the non-patent theatres, the former maintained a virtual monopoly down to 1843, when the recommendations of the parliamentary committee of 1832 were put into effect by the passing of the Theatres Act, 1843 (6 and 7 Vict. *c.* 68), which freed the London stage, and established legal control over playhouses as it exists to-day.

All theatres, music-halls, etc., must now be licensed for the purposes for which they are intended to be used:

Theatre Licences.—A theatre licence is not required if the performances are not public (see *Harms* v. *Martans Club*, 1926, 1 Ch.'870); or if the plays presented are not stage plays within the meaning of the act (for meaning of stage plays, *see* below); or if the premises are not of a permanent character (*e.g.*, a portable booth); or if the theatre is licensed by letters patent; or if the performance is given in any booth or show at a fair or other customary feast.

Theatre licences are granted by the lord chamberlain for all theatres within the parliamentary boundaries of the cities of London and Westminster, and of the boroughs of Finsbury and Marylebone, etc. For theatres situate elsewhere, the county councils are the proper licensing authority; but they may delegate

their powers to committees or to justices of the peace. Licences can only be granted to the responsible manager for the time being of the theatre in question, who must enter into a bond for a sum not exceeding £100. The fee for a licence is 10s. per calendar month in the case of the lord chamberlain's licence, and 5s. per calendar month for a licence granted by any other authority. All licensing authorities are empowered by the Theatres Act to make rules and regulations for maintaining order and decency in theatres licensed by them and for ordering the closing of any theatre and suspending its licence where any riot or misbehaviour takes place (ss. 8 and 9).

Music and Dancing Licences.—Music-halls and similar places of entertainment were first brought under legal control by the Disorderly Houses Act, 1751, which is still in force. A licence is required for any house, room, garden or other place kept for public dancing, music, or other such public entertainment.

The conditions under which music and dancing licences are granted vary according to the area in which the premises to be licensed are situate. The London County Council deals with all licensing within the administrative county of London. Premises situate within the administrative county of Middlesex are governed by the Music and Dancing Licences (Middlesex) Act, 1894; and certain portions of the home counties (Buckinghamshire, Essex, Hertford, Kent, etc), are now governed by the Home Counties (Music and Dancing) Licensing Act, 1926. Outside these areas, either part IV. of the Public Health Act, 1890, applies, or the licensing of music and dancing is provided for by local acts. In London, Middlesex and the home counties, licences are granted by the county councils, and elsewhere by the licensing justices, to such persons as they think fit, for any specified period up to one year. Except in the case of licences granted by the London County Council, it is made a condition of every licence that an inscription must be affixed to licensed premises stating that they are licensed pursuant to the act of parliament, and that such premises may only be kept open during specified hours. A licence which is granted only for music does not authorize public dancing and vice versa (*Brown* v. *Nugent*, 1872, L.R. 7, Q.B. 588).

Neither a theatre licence nor a music and dancing licence is required in the case of an army or navy recreation room which is managed or conducted under the authority of a secretary of State or the Admiralty. A theatre licence does not dispense with the necessity of holding a licence for music or dancing, and vice versa. Licensing authorities have a discretion to refuse a theatre or music and dancing licence or to grant it only subject to such conditions as they think fit to impose; but they must act reasonably (*Reg.* v. *West Riding County Council*, 1896, 2 Q.B. 386).

Censorship and Legal Control of Stage Plays.—An Ordinance was published by James I. forbidding the representation of any living Christian king upon the stage. This was occasioned by the appearance of players in the character of the king of Spain and Gondomar; and it foreshadows part of the present policy of the censorship. The control of stage plays was originally vested in and exercised by the master of the revels, whose office has been traced back to the year 1545. The supervision of stage plays was also carried out by the Privy Council, the Star Chamber and the lord chamberlain; but records show that about the year 1624 the lord chamberlain became the principal authority over these matters. The lord chamberlain continued to control stage plays, deriving his authority from the royal prerogative until Walpole's act in 1737 gave statutory recognition to his censorship by enacting (ss. 3 and 4) that all new plays must be submitted to the lord chamberlain for approval. He, in turn, named an examiner of plays to assist him. The stage censorship, thus constituted, was continued by the Theatres Act, 1843.

Stage plays produced anywhere in Great Britain are now under the absolute control of the lord chamberlain of His Majesty's household. Under the Theatres Act, 1843, the lord chamberlain is empowered:—(*a*) to license every new stage play or any new addition to an old stage play or to an old prologue or epilogue which is intended to be produced and acted for hire in any theatre in Great Britain (s. 12); (*b*) to control all stage plays, whether new or old, by forbidding them to be acted or presented if he is of opinion that it is fitting for the preservation of good manners, decorum, or of the public peace to do so (s. 14).

The lord chamberlain's "Regulations for the Submission of Stage Plays" set out the procedure to be observed in applying for a licence to perform a stage play, and the fees to be paid for the licences required. (*See* also Theatres Act, s. 13.) A licence is only required if the performance is to be given "for hire" in a theatre; and a performance is only deemed to be given "for hire" if any money or other consideration is taken, directly or indirectly, for admission to the performance, or if it takes place in any house, room, etc., in which distilled or fermented excisable liquor is sold (s. 16). The lord chamberlain's regulations lay down some of the grounds on which the lord chamberlain may intervene to prohibit the performance or refuse a licence. As to penalties, *see* Theatres Act, s. 15, as amended by the Criminal Justice Act, 1925 (s. 43).

Days and Times of Performances.—The Sunday Observance Act, 1781, prohibits the opening on Sundays of any premises for public entertainment or amusement, to which the public are admitted by the payment of money or by tickets sold for money. The Act does not apply to religious meetings, or to any entertainment to which persons are admitted without payment. Licences frequently contain a condition that performances shall not take place on certain specified days, and sec. 8 of the Theatres Act, 1843, empowers the lord chamberlain to order any patent theatre or theatres licensed by him to be closed on such public occasions.

Theatres under the jurisdiction of the lord chamberlain are not under any restrictions as to the hours for performances; but other licensing authorities may make rules regulating the times during which the theatres within their jurisdiction may be opened (s. 9 of Theatres Act, 1843). Premises licensed for music and dancing, etc., may only be opened for those purposes between noon and midnight; but the Licensing Statutes provide for these hours being extended on special occasions if permission is first obtained from the licensing authority.

There are a number of statutory provisions relating to the construction and safety of theatres and other buildings used for public entertainments, the chief of which are to be found in the Metropolis Management Act, 1878, the Public Health Act, 1875, sec. 158, the Children Act, 1908, sec. 121, etc.

The Common Law Affecting Theatres, etc.—At common law the admission of the public to theatrical, etc., performances is in the discretion of the management, but once the right of admission is granted, it cannot be withdrawn except under certain circumstances. The legal position of the ordinary ticket-holder is that he has the irrevocable right to be admitted to see an entertainment until its close, provided that he behaves properly (*Hurst* v. *Picture Theatres Ltd.*, 1915, 1 K.B. 1), and that he has not obtained admission by fraud or by the concealment of identity (*Said* v. *Butt*, 1920, 3 K.B. 497). The purchase of a ticket for a performance carries an implied warranty by the management that the premises shall be reasonably safe; but this warranty does not extend to any unseen and unknown defects which could not be discovered by ordinary inspection (*Francis* v. *Cockrell*, 1870, L.R. 5, Q.B. 184, 501; *see* also NEGLIGENCE).

The management is also responsible for the safety of the performance itself; and they will be liable for injury caused to the audience by the negligence of any actor or other performer who is their servant or agent. If, however, the actor is not the servant of the management but of another person *e.g.*, a touring manager who is presenting the play or entertainment under a contract with the management of the theatre, the latter will only be liable if the performance is intrinsically dangerous, or if they fail to take reasonable steps to ensure that any dangerous incidents are performed without risk to the playgoer (*Cox* v. *Coulson*, 1916, 2 K.B. 177; *see* also NUISANCE).

Theatrical Performers and the Law.—The legal position of theatrical performers is now governed by (*a*) the common law of contract; (*b*) theatrical custom; and (*c*) special legislation.

(*a*) At common law an actor or other theatrical performer is regarded as being in a different position from that of the ordinary servant or employee. Thus he is entitled to be given the oppor-

tunity of performing and of gaining the publicity which is an essential part of the consideration of the contract of performance (*Clayton & Waller Ltd.* v. *Oliver*, 1930 A.C. 209) He may refuse a part which is unsuitable for him (*Clayton-Greene* v. *De Courville*, 1920, 36 T.L.R. 790); and may decline to play a part at unreasonably short notice (*Graddon* v *Price*, 1827, 2 C. and P. 610). The tendency of recent years has been to standardize theatrical contracts. The standard form of contract for engagements of variety artists is the "Award" contract, evolved as the result of the arbitrations held in 1913 and 1919 to settle disputes between members of the variety profession and their employers. The "Valentine" form of contract is largely (but not universally) used for London (West End) engagements of actors and actresses. A contract to perform on premises which are not licensed, or in a play which has not been approved by the lord chamberlain will be void for illegality (*Gallini* v. *Laborie*, 1793, 5 T.R. 242; *Gray* v. *The Oxford* [*Ltd.*], 1906, 22 T.L.R. 684, etc.). Similarly the presence of a "barring" clause (a form of restrictive covenant which prevents a performer from performing elsewhere within a certain area and within a specified time of the particular engagement) may vitiate the contract as being in restraint of trade, if its terms are too wide or unreasonable (*Tivoli* [*Manchester*] *Ltd.* v. *Colley*, 1904, 20 T.L.R. 436). A term in a contract restricting an actor from using his stage name has been held to be void (*Hepworth Manufacturing Co.* v. *Ryott*, 1920, 1 Ch. 1).

Outside the law of contract, a theatrical employee is in practically the same position as the ordinary employee. The management is liable for negligent or tortious acts committed by him in the course of his employment (*e.g.*, an infringement of copyright; see *Performing Right Society, Ltd.* v. *Mitchell, etc.*, 1924, 1 K.B. 762). The management is also liable for the personal safety of the performers, unless the injury is occasioned by the negligent or wrongful act of a fellow performer or fellow employee, *e.g.*, a scene shifter (see *Burr* v. *Theatre Royal, Drury Lane, Ltd.*, 1907, 1 K.B. 544).

The Employer's Liability Act, 1880, does not appear to apply to an actor or similar performer; but might apply to other classes of theatrical employees. The Workmen's Compensation Acts have been held to apply to various classes of theatrical employees.

(*b*). The customs of the theatrical profession will govern contractual and other legal relations between performers and management, providing they fulfil the usual legal requirements as to custom. The following theatrical customs have been upheld by the courts: That an engagement to perform in a play in the West End of London is for the run of the piece (*George Edwardes' [Daly's Theatre] Ltd.* v. *Comber*, 1926, 42 T.L.R. 247); that an engagement to perform elsewhere for an indefinite period may be terminated by either side giving two weeks' notice; that, in an engagement for one or more years, no payment of salary is payable during vacation when the theatre is closed (*Grant* v. *Maddox*, 1846, 15 M. and W. 737); that a manager who engages a theatrical company to perform for one week must not allow another company to perform at that theatre during the same week, either by means of a "flying matinee" or otherwise (*Cotton* v. *Sowes*, 1902, 18 T.L.R. 456); that a variety or music-hall artist shall be advertised in a manner suitable to his professional reputation.

(*c*). During recent years a great deal of legislation has been passed, with the object of protecting theatrical performers. The Theatrical Employers Registration Act, 1925 (which was intended to protect theatrical performers against unreliable and unscrupulous managers), requires every person who employs at one time three or more theatrical performers, to be registered in accordance with the procedure laid down by the Act. The Act also makes it an offence for theatrical employers to abandon the performers during the course of an engagement, and imposes penalties on persons who carry on business as theatrical employers without being registered, or who procure registration by supplying misleading information, etc. Furthermore, a theatrical employer may be struck off the register if he is shown to have attempted to evade payment of his employees. Theatrical agents who carry on (within the administrative county of London) the business of teaching or of finding employment for those desirous of obtaining employment as singers, dancers, etc., at theatres or in connection with film production, must be licensed for the purpose by the London County Council or by the City Corporation (*see* the London County Council (General Powers) Act, 1921, ss. 11, 14). The Performing Animals (Regulation) Act, 1925, provides for the registration of performing animals and for inspection of them by duly authorized officers; so as to ensure that their training and exhibition is not accompanied by cruelty. A whole group of recent enactments protect children who are employed in theatrical, etc., performances The Children's Dangerous Performances Act, 1879 (as amended by the Dangerous Performances Act, 1897), makes it an offence to cause any male person under the age of 16 years, or any female person under the age of 18 years, to take part in any public performance or exhibition which is dangerous to life or limb. The parent or guardian who aids or abets such an offence is liable to a penalty; and if any actual injury is sustained, the employer may be indicted for assault and ordered to pay compensation not exceeding £20.

The Children (Employment Abroad) Act, 1913, makes it necessary for a licence to be obtained from a police magistrate to enable any young person under the age of 16 to go out of the United Kingdom for the purpose of singing, playing, performing or being exhibited for profit. This licence will only be granted upon the conditions prescribed by the act, which include supervision by consular officers. The Education Act, 1921 (s. 100), limits the hours in which children may be employed in public theatrical, or other performances. These restrictions may be relaxed but, apparently, no child under 12 years may be employed at *any* time on any public premises to which the public is admitted on payment.

The Dramatic and Musical Performers Protection Act, 1925, prohibits the reproduction of the performances of actors, singers, etc., by mechanical means for the purposes of trade without their written consent. But this Act only provides a criminal remedy and does not confer any rights, either contractual or copyright upon the performers. See *Musical Performers Association* v. *British International Pictures*, 1930, 46 T.L.R. 485. (S. C. I.)

United States.—In the United States questions of licensing theatres involve statutes in 48 States. Where the licensing power has been delegated to the municipalities, ordinances in the various cities are likewise involved "Little Theatres," springing up in great numbers throughout the United States, ordinarily avoid requirements of a licence (as well as building regulations) by organizing as a club whose members subscribe for tickets.

Although a theatre is a private enterprise (*Tyson and Brother* v. *Banton* [1927], 273 U.S. 418), yet it is subject to State control through the licensing power, the taxing power and the police power. The right of governmental authority to require a licence for the privilege of conducting business is not peculiar to the theatre, but exists likewise in many other private enterprises. The taxing power affects theatres in the same manner as it affects other private concerns The police power goes further in that the State has a right of increased control, since the health or morals of people may be affected. Censorship, in the sense of prior restraint, has been held constitutional as applied to motion pictures (*Mutual Film Corporation* v. *Industrial Commission of Ohio* [1915], 236 U.S. 230). There is no such censorship of the theatre but productions are subject to penal statutes prohibiting obscenity. Where the statutes are drastic, as in New York State under the Wales law (Penal Law, Sect. 1140-A), those engaged in a play may be prosecuted if a line, scene or incident is indecent, and in case of conviction of those charged, the licence to operate the theatre may be revoked for a year. In a sense this is more drastic than any censorship since, because of the rigorous penalty, a mere threat by a prosecuting official may result in stopping a play.

A theatre ticket may be in the form of a revocable licence or of a contract. If the former it may be revoked at the will of the proprietor; if the latter it may be non-transferable or otherwise conditioned (*Tyson and Brother* v. *Banton* [1927], 273 U.S 418, 440). The producer is entitled to bar any person from the premises (*Woollcott* v. *Shubert* [1916], 217 N.Y. 212). If this is done the purchaser of a ticket may merely claim breach of contract and demand the return of his money and the repayment of any ex-

pense incurred (*Luxenberg* v. *Keith and Proctor Amusement Co.* [1909], N.Y. 64 Misc. 69; *People ex rel. Burnham* v. *Flynn* [1907], 189 N.Y. 180). The auditor, however, may acquire greater rights if once he has taken a seat (see *Cremore* v. *Huber* [1897], 18 N.Y. A.D. 231). A theatre has the right to refuse to accept tickets purchased from a speculator (*Collister* v. *Hayman* [1905], 183 N.Y. 250).

The only limitation upon the right of a theatre to discriminate is found in "civil rights" laws which exist in a large number of States (*see* New York Civil Rights Law, Section 40, for type of statute), which laws provide that no discrimination shall be made in any place of public accommodation, resort or amusement because of race, creed or colour. Violation is ordinarily a misdemeanour and subjects the wrongdoer to penalty payable to the party aggrieved (*Joyner* v. *Moore-Wiggins Co. Ltd.* [1912], 152 N.Y. App. Div. 266, affirmed 211 N.Y. 522). Under these laws a dance hall is not regarded as a place of public accommodation (*Johnson* v. *Auburn and Syracuse Electric R R. Co.* [1915], 169 A.D. 1864).

A law providing for the limitation of the amount that speculators or agencies may charge has been held unconstitutional (*Tyson and Brother* v. *Banton* [1927], 273 U.S. 418). On the other hand, tax laws assessing agencies to an almost prohibitive amount have been held constitutional by the circuit court of appeals in New York (*Alexander Theatre Ticket Office, Inc*, v. *United States*, 23 Fed., 2d series [1927], p. 44). The proprietor is not an insurer of persons or property in the theatre. As respects either, he is liable only in case of negligence (property: *Pattison* v. *Hammerstein* [1896], N.Y. 17 Misc. Rep. 375. Person: *Dunning* v. *Jacobs* [1895], N.Y. 15 Misc. 85; *Flanagan* v. *Goldberg* [1910], 137 N.Y. App. Div. 92), although it has been held that he warrants the premises to be reasonably safe (*Weiner* v. *Scherer* [1909], N.Y., 64 Misc. 82).

Laws providing for Sunday closing have been held constitutional (*Lindenmuller* v. *The People* [1861], 33 Barb. [N.Y.] 548).

Questions concerning relations between managers and authors, actors and others connected with the profession depend upon contract. Within recent years in the United States various groups have been organized. The Actors' Equity Association, which includes practically all actors of note and which is affiliated with the American Federation of Labor, demands a certain type of contract for actors. The Dramatists' Guild of the Authors' League of America, which in its membership includes practically all playwrights, insists upon a minimum basic agreement limiting the rights of managers in dealing with its members. The Authors' and Composers' League includes in its membership all musical writers of note, and controls the "small rights" connected with presentation.

See *Encyclopaedia of Law* and cases above cited. (A. G. H.)

Other Countries.—In Scotland the Theatres Act, 1843, and the Burgh Police Act, 1892, regulate the licensing of theatres and other places of public entertainment. Sections 395 to 402 of the latter act provide for the licensing and control of places of public resort which are used for the performance of stage plays, as a circus or for any other similar purpose. There is no stage censorship in Ireland.

In Continental Europe Sunday performances in theatres and other places of a similar character are lawful. In most continental European countries (but Denmark is an outstanding exception) there is no State censorship of theatres, the regulation and supervision of various stage plays and of other public entertainments of the kind being placed in each country either in the hands of the police or in those of the local municipal authorities.

See also MOTION PICTURES; LIQUOR LAWS AND LIQUOR CONTROL; ENTERTAINMENTS DUTY.

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(S. C. I.)

THEATRICAL MAKE-UP AND COSMETICS: *see* MAKE-UP; MOTION PICTURES. *Make-up.*

THEBAINE, an opium alkaloid, $C_{19}H_{21}NO_3$, of the phenanthrene group (*see* ALKALOIDS and MORPHINE).

THEBES, an ancient Greek city in Boeotia (anciently Θῆβαι *Thebae*), is situated on low hilly ground a little north of the Asopus valley, overlooking the Ismenian plain, about 44 m. from Athens, whence it is reached by two carriage-roads and by railway It has about 4,800 inhabitants, and is the seat of a bishop. The present town occupies the site of the ancient citadel, the Cadmea; two fragments of ancient wall are visible on the N. and another, belonging either to the citadel or the outer wall, on the S. There are remains of a Minoan "palace," and chamber-tombs. The church of St. Luke, south-east of the Cadmea, is believed to contain his tomb. Two streams, rising a little south of the town, flow on the two sides, the ancient Ismenus on the east and Dirce Δίρκη on the west. The "waters" of Thebes are celebrated by Pindar and the Athenian poets, and the site is still, as described by Dicaearchus (3rd century B.C.), "all springs," κάθυδρος πᾶσα. From the abundance of water the neighbouring plain is extremely fertile. But the population is scanty, and the town unimportant.

History.—The record of the earliest days of Thebes was preserved in a mass of legends. Five main cycles of story may be distinguished: (1) the foundation of the citadel Cadmeia by Cadmus; (2) the building of a "seven-gated" wall by Amphion, and the cognate stories; (3) the tale of the "house of Laius," culminating in the adventures of Oedipus and the wars of the "Seven" and the Epigoni; (4) the advent of Dionysus; and (5) the exploits of Heracles. It is difficult to extract any historical fact out of this maze of myths; at most it seems safe to infer that it was one of the first Greek fortified cities.

In the period of great invasions from the north Thebes received settlers of that stock which spread over Boeotia. The military security of the city tended to raise it to a commanding position and its inhabitants endeavoured to establish a complete supremacy over the outlying towns. In the late 6th century the Thebans were brought into hostile contact with the Athenians, who helped the small fortress of Plataea to maintain its independence against them. The aversion to Athens explains the attitude of Thebes during the great Persian invasion, though it should be remembered that Herodotus, our chief authority for the period, wrote this part of his history in all probability at a period when feeling between Athens and Thebes was bitter in the extreme. Though a contingent of 400 was sent to Thermopylae (480 B.C.) and remained there with Leonidas to the end, the governing aristocracy soon after joined the enemy and fought zealously on his behalf at the battle of Plataea (479 B.C.). The victorious Greeks punished Thebes by depriving it of the presidency of the Boeotian League. In 457 B.C. Sparta, needing a counterpoise against Athens in central Greece, reinstated Thebes as the dominant power in Boeotia. The great fortress served this purpose well by holding out when the Athenians overran and occupied the rest of the country (457–447 B.C.). In the Peloponnesian War (*q.v.*) the Thebans, embittered by the manner which Athens gave to the smaller Boeotian towns, and especially to Plataea, were firm allies of Sparta, which helped them to besiege Plataea and allowed them to destroy the town after capture (427 B.C.). In 424 B.C. at the head of the Boeotian levy, they inflicted a severe defeat upon an invading force of Athenians at Delium. After the downfall of Athens at the end of the Peloponnesian war the Thebans, finding that Sparta intended to protect the states which they desired to annex, broke off the alliance. In 404 B.C. they had urged the complete destruction of Athens, in 403 B.C. they secretly supported the restoration of its democracy in order to find in it a counterpoise against Sparta. A few years later, they forced on the so-called Corinthian War and formed the nucleus of the league against Sparta. The result of the war was disastrous to Thebes as the settlement of 387 B.C. stipulated the autonomy of all Greek towns and so withdrew the other Boeotians from its political control. Its power was further curtailed in 382 B.C., when a Spartan force occupied the citadel by a treacherous *coup-de-main*. Three years later the Spartan garrison was expelled;

in the consequent wars with Sparta the Theban army, trained and led by Epaminondas and Pelopidas (*q.v.*), proved itself the best in Greece. Some years of desultory fighting culminated in 371 B.C. in a victory over the Spartans at Leuctra (*q.v.*). The winners carried their arms into Peloponnesus and at the head of a large coalition permanently crippled the power of Sparta. But the predominance of Thebes was short-lived. The states which she protected were indisposed to commit themselves permanently to her tutelage, and the renewed rivalry of Athens prevented the formation of a Theban empire. With the death of Epaminondas in 362 B.C. the city sank again to the position of a secondary power. In a war with Phocis (356–346 B.C.) it could not even maintain its predominance in central Greece, and by inviting Philip II of Macedon to crush the Phocians it extended that monarch's power within dangerous proximity to its frontiers. In 338 B.C. the orator Demosthenes persuaded Thebes to join Athens in a final attempt to bar Philip's advance upon Attica The Theban contingent fought bravely in the decisive battle of Chaeroneia (*q.v.*). Philip was content to deprive Thebes of her dominion over Boeotia; but a revolt against Alexander was punished by the complete destruction of the city. Thebes never again played a prominent part in history. It suffered from the establishment of Chalcis as the chief fortress of central Greece, and was severely handled by the Roman conquerors Mummius and Sulla. In Pausanias's time (A.D. 170) its citadel alone was inhabited. During the Byzantine period it served as a place of refuge against foreign invaders, and from the 10th century became a centre of the new silk trade. In 1311 it was destroyed by the Catalans and passed out of history.

The most famous monument of ancient Thebes was the outer wall with its seven gates, which even as late as the 6th century B.C. was probably the largest of artificial Greek fortresses. Two of the springs have been identified with some probability—that of St. Theodore with the Oedipodeia, in which Oedipus is said to have purged himself from the pollution of homicide, and the Paraporti with the dragon-guarded fountain of Ares (*see* CADMUS). From the interest of the site in history and still more in literature, as the scene of so many dramas, the temptation to fix details has been specially strong. There are two main difficulties to contend with. The description of Pausanias was written at a time when the lower city was deserted, and only the temples and the gates left; and the references to Thebes in the Attic dramatists are, like those to Mycenae and Argos, of no topographical value.

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Ancient authorities are Herodotus, v.–ix.; Thucydides and Xenophon (*Hellenica*), *passim*; Diodorus, xvii., xix.; Pausanias, ix., 5–17.

THEBES (Θῆβαι), the Greek name of the ancient capital of Upper Egypt. It occurs in Homer (*Il.* ix. 381–4) where it has the epithet ἑκατόμπυλος, "hundred-gated," probably derived in the first place from the gateways of its endless temples, for Thebes was never a walled city with gates, though its vast temple enclosures in different quarters would form as many fortresses in case of siege or tumult. Its Egyptian name was Wesi (or Wis?), later Ne, "the city" (sometimes Ne-Amun, hence No-Amon in Nahum iii. 8). Ammon, Amen-Ra, or Amenrasonther ("Ammon-Ra king of the gods") was its deity, with his consort Mût and their child Khons. Mont also was a local deity and Hathor presided over the western cliffs of Thebes. In very ancient times the city lay on the east bank, the necropolis on the west. The chief nucleus of the ancient Wêsi was a town about the temple of Karnak: it probably reaches back to the prehistoric period. At Drah abu'l nagga, opposite to it, are tombs of its princes under the VIth Dynasty. The temple of Karnak is no doubt of immemorial antiquity. In it Senusret I. dedicated statues to his predecessors of the Vth Dynasty who had probably showed their devotion to Ammon in a substantial manner, and Cheops of the IVth Dynasty is named in it. After the end of the Old Kingdom Thebes grew from an obscure provincial town to be the seat of a strong line of princes who contended for supremacy with Heracleopolis and eventually triumphed in the XIth Dynasty The most important monument of the Middle Kingdom now extant at Thebes is the funerary temple of Mentuhotep III. at Deir el Bahri. The name Amenemhet, so common in the XIIth Dynasty, shows the importance of the Theban god at this time. It was, however, the early rulers of the XVIIIth Dynasty down to Tethmosis III. who developed Karnak, and on the west bank built the great funerary temple of Deir el Bahri and smaller temples as far south as Medinet Habu, and began the long series of royal tombs in the lonely Valley of the Kings far back in the desert. Amenophis III. continuing, transformed western Thebes monumentally: built three great temples in addition, that of Mont on the north of Karnak, the temple of Mût on the south and the temple of Ammon at Luxor, and connected the last two with the state temple of Karnak by avenues of sphinxes. The city and its monuments now covered an area about three miles square. After this Thebes experienced a serious set-back with the heresy of Ikhnaton, the son of Amenophis III. He moved his capital northward to Akhetaton (El Amarna) and strove to suppress the worship of Ammon, doing infinite damage to the monuments of Thebes by defacing his name and figure. After about twenty years, however, the reaction came, Thebes was again the capital, and a little later under Seti (Sethos) I. and Rameses II. of the XXth Dynasty it was raised to greater architectural magnificence than ever. These two kings built the great columnar hall of Karnak, added a large court with pylons to Luxor, and on the west bank built the funerary temple of Seti at Kurna, and the Ramesseum with its gigantic colossus, besides other edifices of which only traces remain. Under the XVIIIth and XIXth Dynasties Thebes was at the height of its greatness Conquering Pharaohs brought home trains of prisoners and spoil, embassies came thither of strange people in every variety of costume and of every hue of skin, from Ethiopia, Puoni (Punt), Mesopotamia, Asia Minor, Libya, and the islands of the Mediterranean, bringing precious stones, rare animals, beautiful slaves, costly garments and vessels of gold and silver. The tombs of the XVIIIth Dynasty on the west bank and the sculptures in the temples reflect the brilliancy of these days, but with Rameses II came the turning-point of its glories, and the efforts of all his successors combined could add little to the wonders of Thebes. The temple and tower of Rameses III. (XXth Dynasty) at Medinet Habu, his tomb in the Biban el Moluk, the temple of Khons (Rameses III. and later) and the court of Sheshonk I. (XXIInd Dynasty) at Karnak are the only great achievements.

The tide of prosperity was now flowing northward and such monumental energy as remained was expended more widely. For several centuries after the fall of the New Empire Thebes was but one of several alternating or contemporaneous capitals. Memphis, Tanis, Bubastis, Sais, Heracleopolis had at one time or another at least equal claims. The Ethiopian conquerors of Egypt made Thebes their Egyptian capital, but in 668 Assur-bani-pal sacked the city. Psammetichus did not neglect it, but Ptolemy I. gave a new capital to the upper country in the Greek foundation of Ptolemais, and thus struck a fresh blow at the prosperity of Thebes. For a short period in the reign of Epiphanes, when Upper Egypt was in rebellion against the Ptolemaic rule, Thebes was the capital of independent native dynasts. In a later rebellion, Thebes was captured after a three years' siege and severely punished by Lathyrus (Ptolemy X., Soter II.). In the reign of Augustus, having joined in the insurrection against the tax-gatherers, it was destroyed by Cornelius Gallus and became a collection of villages. Though its vast buildings have since served as quarries for mill-stones and for the lime-burner, Thebes still offers the greatest assemblage of monumental ruins in the world.

We will now briefly enumerate the principal groups of monuments. On the east bank at Karnak stand the great state temple of Amen-Ra with its obelisks of Hatshepsut and Tethmosis I. and the vast columnar hall of Rameses II; the temple of Mût and the well-preserved temple of Khons; the temple of Luxor and avenues of rams and sphinxes connecting all these. On the west bank, in front of the necropolis, on the edge of the desert or projecting into the cultivation, was a low row of temples: the north-

ernmost, placed far in front of the others, is the well-preserved temple of Seti I at Kurna; then follow the Rameseum and Medinet Habu, and the foundations of many others can be traced. The temple of Amenophis III, to which the colossi of "Memnon" were attached, was again far forward of the line. The Rameseum contains the remains of a stupendous seated colossus, in black granite, of its builder Rameses II., thrown on its face. When perfect it was probably 57 ft. high and weighed about 1,000 tons, surpassing the "Memnon" statues of Amenophis III in size and weight The temple of Rameses III. at Medinet Habu, sculptured with very interesting scenes from his Syrian, Libyan and other wars and from religious festivals, is remarkable also for the unique entrance-tower which probably formed part of the royal palace. Northward and far back in the foot-hills is the Ptolemaic temple of Deir el Medina, and beyond under the cliffs of Deir el Bahri the terrace temple of Queen Hatshepsut, the walls of which are adorned with scenes from her expedition to Puoni (Somaliland) in search of incense trees, and many other subjects. Far behind Medinet Habu are the Tombs of the Queens, where royal relatives of the XXth Dynasty are buried; and immediately behind the lofty cliffs of Deir el Bahri, but accessible only by a very circuitous route from Kurna, are the Tombs of the Kings (from Tethmosis I. onward to the end of the XXth Dynasty) in the Biban el Moluk and the Western Valley. Those of Seti I. and Rameses III. are the most remarkable These royal sepulchres are long galleries excavated in the rock with chambers at intervals: in one of the innermost chambers was laid the body in its sarcophagus. In the XXIst Dynasty, when tomb robberies were rife and most of their valuables had been stolen, the royal mummies were removed from place to place and at last deposited for safety in the tomb of Amenophis II. and in the burial-place of the priest-kings at Deir el Bahri The finding of the two *cachettes* nearly intact has been among the greatest marvels of archaeological discovery. The systematic exploration of the Valley of the Tombs of the Kings has been annually rewarded with results of the highest interest. The greatest as well as the most recent of these is the discovery in Oct. 1922 of the tomb of Tutankhamun (reigned 1360–1350 B.C) with its magnificent equipment almost intact.

See Baedeker's *Egypt*; E. Naville, (Temple of) *Deir el Bahari*, introduction and parts i.–v. (London, 1894–1906); Sir W. M. F. Petrie, *Six Temples at Thebes* (ruined temples on west bank) (London, 1897); G. Daressy, *Notice explicative des ruines de Médinet Habu* (Cairo, 1897); G. Maspero, "Les Momies royales de Deir el Bahari" in *Mémoires de la mission archéologique française au Caire*, tome I.; and many other works. (F. LL. G.; X.)

THECLA, ST., one of the most celebrated saints in the Greek Church (where she is commemorated on Sept. 24) and in the Latin Church (where her festival is Sept. 23). She is honoured with the title of "protomartyr." The centre of her cult was Seleucia, in Isauria. Her basilica, south of Seleucia, on the mountain, long a popular place of pilgrimage, is mentioned in the two books of St. Basil of Seleucia. According to her *Acta*, Thecla came under the personal teaching of the apostle Paul at Iconium. In spite of their highly fabulous character (Thecla escaped from burning, from wild beasts, bulls and serpents), which caused them to be more than once condemned by the Church, the *Acta* of Paul and Thecla, which date back to the 2nd century, are interesting monuments of ancient Christian literature

See *Acta Sanctorum*, September, vi. 546–568; J. A. Lipsius, *Acta apostolorum apocrypha* (Leipzig, 1891), i 235–269; C Schmidt, *Acta Pauli* (Leipzig, 1905), where an attempt is made to prove that the *Acta* of Paul and Thecla formed an integral part of the *Acta Pauli*, *see* also APOCRYPHAL LITERATURE; C. Holzey, *Die Thekla-Akten, ihre Verbreitung und Beurtheilung in der Kirche* (Munich, 1905).

THEGN or **THANE,** an Anglo-Saxon word meaning an attendant, servant, retainer or official. From the first, however, it had a military significance, and its usual Latin translation was *miles*, although *minister* was often used The word is used only once in the laws before the time of Aethelstan (*c.* 895–940), but more frequently in the charters

The thegn became a member of a territorial nobility, and the dignity of thegnhood was attainable by those who fulfilled certain conditions. In like manner a successful thegn might hope to become an earl. There were others who were thegns on account of their birth, and thus thegnhood was partly inherited and partly acquired The thegn was inferior to the aethel, the member of a kingly family, but he was superior to the ceorl. The status of the thegn is shown by his wergild Over a large part of England the amount of this was fixed at 1,200 shillings, or six times that of the ceorl. He was the twelfhynde man of the laws.

The increase in the number of thegns produced in time a subdivision of the order There arose a class of king's thegns, corresponding to the earlier thegns, and a larger class of inferior thegns, some of them the thegns of bishops or of other thegns. A king's thegn was a person of great importance, the contemporary idea being shown by the Latin translation of the word as *comes*. He had certain special privileges. No one save the king had the right of jurisdiction over him, while by a law of Canute we learn that he paid a larger heriot than an ordinary thegn

The 2 senior thegns of the hundred play a part, the nature of which is rather doubtful, in the development of the English system of justice. By a law of Aethelred they "seem to have acted as the judicial committee of the court for the purposes of accusation" (Holdsworth, *Hist Eng. Law*, vol. i., 1921), and thus they have some connection with the grand jury of modern times.

The word thane was used in Scotland until the 15th century to describe an hereditary non-military tenant of the Crown

THEINNI (now **HSENWI**): *see* SHAN STATES.

THEISM, in the broadest sense, means belief in God. The word, however, is used generally with the implication that the belief is held in a conscious and rational manner, and hence Theism is usually applied only to a system of beliefs which has some claim to be regarded as a philosophy. According to the Oxford Dictionary the first occurrence of the word is in Cudworth's *Intellectual System of the Universe* (1678). The etymology of the word (*θεός*) would suggest that it might cover any conception of the universe which admitted the existence of Deity; but in practice Theism has come to mean a belief in one God, and the word is not easily distinguished from Monotheism, save that Theism has a more theoretical implication.

Theism as a philosophical and theological position may be distinguished from other theories It is, of course, the direct antithesis to Atheism (*q.v.*), which, strictly speaking, is the denial that God exists. It is to be distinguished, again, from Agnosticism (*q.v.*), the view that there is no sufficient ground for either an affirmative or negative answer to the question: Does God exist? and that the only rational attitude is absolute suspense of judgment. It should be observed, however, that there is a sense of the word Agnosticism which is not wholly incompatible with Theistic belief. The theory of Herbert Spencer, that we can know that an Ultimate Reality exists but can also know that that Reality is unknowable, is sometimes described as agnosticism. Herbert Spencer's theory, as it stands, is plainly absurd, because in order to know that the Ultimate Reality is unknowable we must know enough of the nature of the Unknowable to be justified in making this assertion about it. All reflective Theists would acknowledge, however, that there is an element of truth in the Agnostic position—the human mind is incapable of grasping completely the nature of the Divine, and though there is a genuine knowledge of God, for finite mind that knowledge must always be incomplete It is customary to distinguish Theism from Deism (*q.v.*).

The Deists were writers on natural religion in the 18th century who shared the desire to set religion on a purely rational basis and tended, in a greater or less degree, to exclude the ideas of revelation and mystery, reducing Christianity to those truths which, it was alleged, could be attained by the unaided reason. Though some of these authors had pantheistic tendencies, the name Deism has been given to that type of theology which considers God and the world to be absolutely distinct from one another, thus conceiving the Deity as an external Creator and Governor. In the language of modern philosophy Deism is the view which emphasises the transcendence of God but denies His immanence. In contrast to Deism, Theism affirms the presence of God in the world, holding both immanence and transcendence Pantheism (*q.v.*) presents a contrast to Theism of the opposite kind to that which we have found in Deism. Pantheistic systems,

though widely different from one another in spirit and presentation, agree in making an identification between God and the Universe. It is sometimes said that Pantheism maintains divine immanence while eliminating from its creed every vestige of divine transcendence. This manner of expression, though open to criticism, has the merit of making clear the main difference between Pantheism and both Deism and Theism. Certain philosophical systems may be classified for this purpose under the head of Pantheism. Spinoza's philosophy of God as the Infinite Substance and some forms of Absolute Idealism, as for example, that represented in England by the late F. H. Bradley cannot be described as theistic in the narrow sense of that word and are, theologically considered, pantheistic in tendency. Dualism is to be regarded as another theory which, in some of its forms, has affinities with Theism but is in essence different. Properly, Dualism means a view of the world which attributes its existence to two different or possibly antagonistic principles both equally ultimate, whether those principles be conceived as two deities, as in some forms of Zoroastrianism, or God and matter as in Manichaeism A modified Dualism enters into most Theistic theories, but no theory could be called fully Theistic which was satisfied with a final Dualism

We may now proceed to state in a positive manner the general tenets of Theism It must be remembered that pure Theism has never been a widely influential religious belief. In the historical religions Theism is mixed with other elements, or rather perhaps is the basis of them Thus Christianity is a Theistic religion, but its distinctive characteristic is the doctrine of the Incarnation. In the same way, Mohammedanism is Theism modified by special beliefs about the revelation of Allah through Mohammed The fundamental conception of Theism in all its developed forms is that of a Being who is at once the supreme Value and the Source of all finite existence. Theism has usually thought of the Supreme Being as in some sense personal, or at least as One with whom personal relations were possible. This Supreme Being, in Anselm's phrase, *id quo majus cogitari non potest*, is, in the Theistic view, neither identical with the Universe nor wholly aloof and separate from it. The relation of God as Cause with the world has been conceived in various ways, the most common being creation, which itself may be capable of more than one interpretation. The idea of emanation, however, has also been employed, as in the Neo-Platonic philosophy (chief exponent Plotinus, A.D. 204–270) which exercised a considerable influence upon Christian theology. The peculiarly Theistic doctrine of the relation of God with the world is often expressed by the phrase, "God is both transcendent and immanent"

ARGUMENTS FOR THEISM

Theism, being a reflective theory and not simply a religious faith, has sought to defend its position by rational arguments Historically, three arguments have been supremely important and are sometimes known as the "traditional proofs." They are the Cosmological, the Teleological, and the Ontological arguments.

The first philosopher, at least in the West, to state an argument which he held to be demonstrative of the existence of God is Plato. The proof which he gives (in the *Laws* X.) is the starting point of the rational theology or "natural" theology which claims to establish the being of God on the ground of reason The *Laws* is universally admitted to be the work of Plato's old age. In his earlier writings Plato had made use of the idea of God and indeed the conception was central in his thought. He had constantly protested against unworthy ideas of the divine and asserts both in the *Republic* and *Theaetetus* that God is perfectly good and cannot be the cause of evil. The proof in the *Laws* may be regarded as the fruit of long reflection on the problem and contains the germ of much subsequent development. The proof turns upon the existence of motion and change. Motions and changes may be divided into several classes, but there is one fundamental distinction, that between spontaneous and communicated motion. It can be shown that spontaneous motion must be prior to communicated motion, since if there is motion at all it cannot all be communicated. Now the soul is the source of spontaneous motion, as distinguished from matter which can only receive communicated motion Hence the soul is prior to the body. The motions in the Universe which have no human origin must likewise be referred to a soul We are thus led to the conception of a Soul of the world. But the motions of the Universe, and in particular of the heavenly bodies, are orderly and thus indicate that the World Soul is rational and good, the "mind which ordered the universe." In Plato's argument two of the "rational" proofs are joined—the Cosmological (from the existence of a universe in which motion exists to a Source of motion), and the Teleological (from the existence of order to the Divine Mind as its ground). It will be convenient to consider these arguments in their subsequent formulations separately.

The Cosmological Argument.—The philosophy of Aristotle is not, like that of Plato, profoundly religious in spirit, and the concept of God in Aristotle's thought has little religious significance, being mainly a metaphysical conclusion, but the formulation of the cosmological argument by Aristotle has been of primary importance for Christian philosophy Like his master Plato, Aristotle rises to the thought of God from the fact of change and motion (*κίνησις*) which means for him much more than change of place. Motion is conceived by Aristotle as the passage from potentiality to actuality (*δύναμις* and *ἐνεργεία*) Every change which actually occurs is the realization of a potentiality which was hitherto latent Associated with this conception is Aristotle's doctrine of "form" and "matter" Every concrete and finite existence is composed of matter and form and it is the latter which gives to it a specific nature. In "sublunary" existences the expression of form is always imperfect, the matter never being absorbed in the form completely The motion and change of the world are therefore explained as the striving of the potential to become actual, of the forms to become fully realised. The universe which is in constant motion is not, however, self-explanatory; the change must have some source beyond itself. This source is God, who must be conceived as at once the First Mover and the Unmoved. There can be nothing higher than God, otherwise He himself would be moved towards that higher being God must exist or there would be no movement God is therefore pure form and pure actuality, in Him there is no "matter" and no potentiality. He is the realization of all form and of all potentiality. Thus God moves the world *ὡς ἐρώμενον*, as an object of desire; but it is an essential part of Aristotle's view that God does not desire or need the world. The world is not even known to Him as it exists in actuality. He contemplates the pure forms which are the content of His own intellect. The outcome of Aristotle's reflection is then a Deity who is completely transcendent and pure thought. All personal relations with the world, every trace of emotion and even moral goodness is excluded from his nature which is described as a thinking of thought (*νόησις νοήσεως*) (Aristotle, *Physics*, Bk. VIII., *Metaphysics*, Bk. XII.).

It is one of the curiosities of history that a theology so "intellectualist" should have profoundly influenced the thought of Christianity which is in spirit widely different from that of Aristotle. Yet the Aristotelian logic and metaphysics formed the basis of the great constructive systems of the middle ages, the scholastic theology, of which the greatest representative is St. Thomas Aquinas (1227–1274). The cosmological argument forms the basis of St. Thomas's rational theology. It was a fundamental conviction with him that the *praambula fidei*, the foundation truths of religion, were demonstrable by the human reason without the aid of Revelation. In his greatest, though unfinished work, the *Summa Theologica* (Pt. I., Quaest. ii., art. 3), he gives five proofs of the existence of God, of which four are versions of the cosmological argument. (1) The argument from *motion:* "Any thing which is moved is moved by some other thing . . . one thing moves another in so far as the former is in actuality, for to move is nothing else than to draw anything from potentiality to actuality. But nothing can be brought from potentiality into actuality except by means of something which is already in actuality. . . . It is impossible that in the same respect and the same manner anything should be both moving and unmoved, or be self-moved." We cannot go on to infinity in the series of

"movers" which are themselves moved, for in that case there would be no first source of movement and consequently no movement at all. We must then conclude that there is a first source of movement which is moved by nothing else—*i e*, God (2) The argument from *Efficient Causes:* Experience shows that there is an order of efficient causes. Nothing can be the cause of itself, for that would imply that it was prior to itself We cannot rest content with an indefinite series of causes and effects, because if there is no First Cause there can be no last effect. Hence we conclude that there is a First and Uncaused Cause—*i e*, God. (3) Argument from *possible and necessary existence·* Some existences are possible and not necessary, *i e*, they may exist or not exist, being generated and corrupted. But all existence cannot be of this nature, for unless there were necessary existence there would be no ground for possible existence If there are necessary existences there must be an existence which is necessary in itself and does not derive the necessity of its existence from some other necessary existence An indefinite regress is as impossible here as in the case of efficient causes There must therefore be Something which is necessary *per se—i.e.*, God. (4) Argument from *degree of quality or value:* We find things more or less "good," "true" and "excellent." "More" or "less" is predicated according to degree of approach to a "greatest." There is therefore something which is most true, good and excellent—*i.e.*, God.

It should be observed that the first two forms of Aquinas' cosmological argument lead to the conception of a purely Transcendent Deity while the latter two suggest immanence

The cosmological argument, very much in the form which was given to it by Aristotle and Aquinas, appears as a fundamental element in many philosophies Mention must be made of Leibniz who supplemented it by laying down a new law of thought—the law of "sufficient reason"—according to which "for everything there must be a sufficient reason why it is so and not otherwise," thus making it clear that, for him, the basis of the cosmological argument was not empirical observation but a rational and self-evident principle—that of universal causation.

The objections to the traditional cosmological argument have been formulated by Hume and Kant The former struck a blow at the simplest and most obvious version of the argument—that to a First Cause—by his sceptical analysis of the ideas of cause and necessary connection, though it should be noticed that he himself appears to have retained the conviction that the conception of a First Cause could not wholly be abandoned In Hume's view, however, there is no universal principle of causation. The idea of necessary connection between phenomena is derived from habit breeding expectation, and the so-called "principle of causation" is due to nothing more than "the mind's propensity to feign," *i.e.*, it is a convenient fiction. Obviously this view, which was but the logical conclusion of the empirical movement in English philosophy, undermines the whole of our knowledge of the natural order and physical science, but it has also a direct bearing on the cosmological argument, for if causation is a principle on which we cannot rely when dealing with phenomena, we cannot use it to take us beyond phenomena to God Kant attempted to save our knowledge of Nature from Hume's sceptical objections. He did so in a somewhat equivocal fashion. He held that the "categories" which the mind employs in synthesizing perception (cause, substance, etc.) are *a priori* in the sense that the mind does not derive them from experience but necessarily uses them in ordering experience—in short that Nature apart from Mind has no existence, but in some sense "Mind makes Nature." Kant is emphatic, however, in his limitation of this principle. The categories of the understanding are confined to dealing with phenomena. The use of such a category as causation to carry us beyond phenomena to a super-phenomenal Reality is an illegitimate—a "transcendent"—use. This is the real ground of Kant's objection; it is based upon his rigid limitation of the understanding to phenomena. Some special criticisms are also of permanent interest. Kant points out that the argument, in the only form which he discusses (that of efficient causation), does not, even if sound, lead to the conclusion that God exists, but only that a First Cause of some kind exists, and in order to attain the conception of God we need another argument—the Ontological. With reference to the alleged impossibility of conceiving an infinite series of causes, Kant remarks that the inconceivability attaches also to the idea of an uncaused cause, and there is therefore no reason why the mind should embrace one alternative rather than the other.

In spite of the objections to which the traditional form is open, the cosmological argument in a wider application has kept its power In modern philosophy all those systems which employ the idea of an Absolute Reality arrive at the Absolute by some kind of cosmological argument. An important example of this is found in the Theistic philosophy of Hermann Lotze. The impossibility of rendering intelligible the fact of "transeunt" causation (*i e*, that change in one thing is the occasion of change in another thing), so long as we conceive the ultimate reality to consist of a collection of independent "reals" leads to the conception of an all embracing Absolute of which the particular things and their changes are modifications. Arguments of this type lead rather to an Immanent Deity than to the transcendent God of Aristotle and Aquinas.

The cosmological argument has permanent value, though it has not the demonstrative force which was formerly attributed to it It serves to substantiate the conclusion that "nature," whatever we may mean by that term, is not a self-explanatory system, and therefore to support the Theistic view as preferable on rational grounds to rival hypotheses The form of the cosmological argument which begins with the apprehension of values, such as goodness and truth, has received little attention in the history of thought, but is one which has most positive weight for modern philosophy Modern Theism would lay great stress on the contention that the existence of goodness, beauty and truth in finite experience compels us to postulate an absolute Goodness, Beauty and Truth

The Teleological Argument.—This argument, sometimes called "the argument from design," is rightly described by Kant as the most impressive, the most easily comprehended of the traditional "proofs." Like the cosmological argument it is *a posteriori* in character, since it starts with the observed facts of adaptation to ends in the natural world. As we have seen, however, when referring to Plato, the teleological argument may be based upon the more general consideration of the order of the universe. The purposive character of the events of the world was a common topic of Stoic philosophers in connection with their doctrine of Providence Here again we may turn to Thomas Aquinas for a succinct statement of the argument in its common form. It is the fifth proof of the existence of God given by that philosopher —the proof from the *gubernatio* of things "Some things which have no power of knowing, such as natural bodies, work for ends, as is manifest from their constantly, or at least frequently, working in the same way for the attainment of that which is best. . . . . Now such things as have no power of knowing do not tend towards an end unless they are directed by some being which has knowledge and intelligence" (*Summa Theologica*, Pt I Quaest ii. art. 3.) It will be noticed that there are two elements in this argument (a) the observation of "working for ends"; (b) the inference from this to a directing Intelligence.

The evidence for working for ends or the adaptation to purposes on which stress is laid has varied; at times the main emphasis has been on general adaptation of the Universe to the existence and well-being of men or, more abstractly, to the production of values; at other times the argument has turned chiefly upon special instances of apparent design as, *e.g.*, the human eye. The latter type of reasoning was prominent among the rationalist Theologians of the 18th and 19th centuries Paley's *Natural Theology*, with its famous analogy between the eye and a watch, is a familiar example of this kind of presentation.

Before proceeding to a discussion of the present position of the teleological argument it will be well to note the objections and limitations which arise on a consideration of the argument itself. These again have been clearly stated by Kant. It is obvious that the argument by itself is not sufficient to demonstrate the existence of God Even if it be admitted that there are evidences of design, it does not follow that they are due to one Mind. The facts

might be explained on the hypothesis of several intelligences. It is only when we have reached the conclusion on other grounds that the Source of Being is one, that the teleological argument may tend to show that Source to be intelligent. The argument again, tends to suggest an analogy with the carpenter or sculptor who makes the best of his material and thus to lead to the conception of God as the Architect of the Universe working upon alien material. It may be alleged further, that the argument is based upon purely subjective estimates, and implies an absurdly anthropocentric conception of the universe. It cannot be denied that the teleological conception has frequently been carried to ridiculous extremes, and attempts have been made to show that this is the "best of all possible worlds" in the sense that all its features minister to human convenience; but these extremes are no necessary part of the argument, and it may be observed that Kant himself, in the *Critique of Judgement*, allowed that the teleological judgment is necessary and inevitable in dealing with living beings and the appreciation of the beautiful.

A permanent difficulty for the teleological argument is the existence of evil, particularly of pain, waste, and the missing of apparent ends. If stress is laid on the "working towards ends" which are good, stress should equally be laid upon the working towards ends which to us appear to be bad Additional weight has been given to this objection by the evolutionary theory of the origin of species through the struggle for existence and the survival of the fittest. The Darwinian theory of evolution seems to make death, defeat, and their concomitant pain, a necessary part of the evolutionary process. On these and other grounds it has been held, by Guyau, Bertrand Russell and many others, that there is neither beneficent nor maleficent purpose in the world, but that Nature is indifferent to the hopes, aspirations and needs of man. Some answer to these objections may be attempted. It is argued, for example, that the amount of pain in the lower orders of creation has been greatly exaggerated by the tendency to interpret the experience of the lower animals in terms of our own, and by the neglect of the consideration that the pains of anticipation are absent in sub-human creatures. Suffering in human beings again may be supposed to serve spiritual ends (*see* James Martineau, *A Study of Religion*). The most conclusive answer attempted to the problem of evil as an objection to a teleologically ordered universe is that of Leibniz, who maintained that this is the "best of all possible worlds" Any other world would have contained more evil and less good than the actually existing one This view depends upon Leibniz's conception of the nature of possibility which, according to him, is determined, not by the arbitrary will of God, but by "eternal verities" which are absolutely valid for the Eternal Mind. Thus out of an infinite number of possible worlds the Creator chose that which included the greatest sum of good, and the evils in it exist as necessary conditions for the greater sum of good. This theory has been somewhat unfairly summed up by F H. Bradley in the epigram, "The world is the best of all possible worlds, and everything in it is a necessary evil."

We may remark here that our view of the teleological argument will be profoundly affected by our view of the meaning of "good" and "value." If we are "hedonists," believing that good means pleasure and the absence of pain, the teleological argument will have little weight. The Universe is plainly not designed to afford the greatest possible degree of pleasurable feeling. If on the other hand, we conceive that value means the development of spiritual and moral persons the argument will appear in a different and more favourable light.

The rise of the evolutionary concept has had another and even more important effect on the teleological argument The principle of the adaptation of species to their environment by survival of those best adapted has removed the favourite examples of teleology, such as the eye, from the sphere of directly created things and offered a "natural" explanation of their delicate adjustment. The Darwinian and post-Darwinian theories of biological evolution seemed to destroy the basis of the most popular argument for Theism. It was evident that if the argument was valid at all it needed complete restatement. Post-evolutionary exponents of the teleological argument have consequently laid stress, not on particular instances of apparent design, but on the general trend of evolution which, it is maintained, can only be explained by the hypothesis of Divine Providence A subtle statement of this line of thought is to be found in Lord Balfour's writings, the *Foundations of Belief* and *Humanism and Theism*, in which he urges that, unless there is some intelligent guidance of evolution, the values of truth and beauty cannot be maintained.

The philosophical analysis of the idea of evolution in the present century has led many thinkers to abandon a purely mechanical conception of its method The problem of newness and the development of values has engaged attention M Bergson has completely abandoned the mechanical view and substituted the idea of "creative evolution," new types of existence being in his theory the result of the effort of the *Élan Vital* to achieve freedom. Somewhat analogous is the conception of "emergent evolution" which was worked out by Professor S. Alexander and Professor C. Lloyd Morgan and adopted by several other English authorities. The "emergent" theory of evolution distinguishes between two types of effect, "resultants" which are the predictable outcome of previously existing conditions, and "emergents" which are specifically new and not completely predictable New species, and in particular new types of being, such as life, consciousness and self-consciousness, would thus belong to the "emergent" type of effect. None of these writers would describe his view of evolution as definitely teleological, and Bergson is as much opposed to teleology as to mechanism; but it is obvious that such conceptions of evolution are leading in the direction of at least "immanent teleology"; and it may be argued that a purely immanent teleology is not by itself an *intelligible* conception On the whole then, it may be said that the movement of thought is in favour of a restatement of the teleological argument

The inherent tendency of the human mind to think in the teleological mode suggests that there is really an *a priori* element in the argument. The mind is irresistibly impelled to regard the Universe as rational, *i.e.*, as pervious to its categories and methods of thought On this irresistible assumption or "act of faith" the whole structure of science is built It is one further step in the same process to regard the Universe as rational in the fullest sense, *i.e.*, as a teleological system which exists for an end which we can accept as reason for its existence—the production of values or of good

The Ontological Argument.—This is the only one among the traditional "proofs" which is explicitly *a priori* It is the inference from the idea of God to the existence of God, and does not employ any data derived from observation. The argument, though adumbrated by S Augustine, was first clearly presented by S. Anselm (1033–1109) in his work the *Proslogium*. Even the fool "who says in his heart, there is no God" has the idea of God, otherwise he would not be able to deny His existence. The idea of God is the idea of "that than which no greater can be conceived" (*id quo nihil majus cogitari potest*). Now this idea cannot be in the understanding alone, because if it were, it would not be the idea of that than which there can be nothing greater, for a Being who existed would be greater than a being who did not exist (It should be noticed that *majus* does not mean simply magnitude but includes value.) In other words, the idea of the greatest conceivable implies the existence of that Greatest. The obvious objection to this line of reasoning was raised by Gaunilo during Anselm's lifetime in his *Liber pro Insipiente* Gaunilo dissented from the passage from idea to existence, and adduced the famous illustration of the "perfect island," which he argued, on Anselm's principle, must exist. The essence of Anselm's reply to this objection is to draw a distinction between that which is the greatest conceivable absolutely and that which is the greatest only relatively as the member of a class. The idea of God is the idea of "that than which nothing greater can be conceived" absolutely, and to this idea alone the ontological argument applies

The subsequent history of the ontological argument has been curious. It has been rejected by many considerable thinkers as a patent fallacy and by others regarded as the foundation of constructive thought. Descartes, who is sometimes held to be the

father of modern philosophy, adopted it in two forms as the corner stone of his system, the bridge by which he passed from universal doubt to confidence in the possibility of knowledge. Descartes places in the forefront the consideration of the possession by the mind of the idea of an infinite and perfect being, and the question how this idea can originate. I cannot derive it from myself, because I am certainly neither infinite nor perfect. The idea then implies a really existent Infinite and perfect Being as its source. Descartes adds an important element to the argument by distinguishing between the positively infinite and the merely "indefinite." The latter is a negative idea implying simply the absence of limits, the former is concrete, and is the idea of God. Unless I were in possession of the positive idea of infinity and perfection I should not know myself to be finite and imperfect. Descartes also states the ontological argument very much in the form given to it by Anselm. Though in all other instances it is possible to distinguish between essence and existence and to conceive of a being as not existing, this is not possible in the single case of the idea of God "The existence can no more be separated from the essence of God than the idea of a mountain from that of a valley. . . . It is not less impossible to conceive a God, that is, a being supremely perfect to whom existence is wanting, or who is devoid of a certain perfection than to conceive a mountain without a valley." (*Meditations* III. and V.) The ontological argument was also adopted by Leibniz, who made the addition to it that we need first to demonstrate that the idea of God is the idea of a possible existence.

The great flaw in the argument in its traditional form was clearly shown by Kant, who pointed out that it implies existence to be an attribute of the same nature as other attributes the absence of which would constitute imperfection, whereas this is not the case, since every concept we form is of a being as existing in some sense. Kant's illustration however, of the "hundred thalers," which are the same in properties in the imagination as in the pocket though not the same in usefulness, seems to miss the point even more obviously than Gaunilo's perfect island The permanent value in the ontological argument has been emphasised by Hegel. It is the necessary attempt to bridge the gulf between thought and things, between concept and reality. In this sense it is really at the root of all thought. However we may express it, we are compelled to hold that what the mind necessarily thinks *qua* mind is real, that there is no impassable chasm between the "*ordo idearum*" and the "*ordo rerum*." All philosophies which distinguish between appearance and Reality on the ground that the irrational cannot be the real, rest upon something akin to the ontological argument. Probably it would be better to say, "upon an ontological assumption." The ontological argument is, in truth, an attempt to put into the form of a train of reasoning a postulate without which the mind is helpless. It may be questioned therefore whether the ontological argument or postulate leads us directly to the God of religious experience It leads rather to the conception of an absolute or rationally coherent system of being.

Before leaving the famous "three proofs" a remark must be made on their value for modern Theism. Before Kant's drastic criticism they were taken to be demonstrative proofs of the existence of God at least by the rational theologians. It is clear that as demonstrations they are unsatisfactory. This does not mean, however, that they are devoid of value. The post-Kantian Theist would, in most cases, adopt a different approach to his problem. The central question of constructive philosophy does not present itself to him in the form: given the idea of God as a belief, to find some rational proof of His existence. Rather the problem presents itself as analogous to the scientific problem: given the universe as disclosed in experience, to find the most reasonable account of it Several hypotheses present themselves for consideration, among them Theism. The question before the mind of the philosopher, therefore, is to decide which of the possible hypotheses squares most adequately with the whole experience of the universe which is open to us. The Theist maintains that his hypothesis is the most rational in this sense. The traditional arguments, on this view, call attention to various aspects of the universe which, when taken up into reflective thought, go to support the Theistic view. Thus in spite of their failure as demonstrative arguments they have great value as indicating lines of thought, suggested by experience, which tend to substantiate the Theistic theory. (For a fuller statement of this *see* W. R. Sorley, *Moral Values and the Idea of God*, and W. R. Matthews, *Studies in Christian Philosophy*.)

The change in the method of approach to which we have referred in the preceding paragraph is reflected in the type of argument on which modern Theism has laid greatest stress. Though not putting on one side the "rational" proofs, the main appeal in the philosophy of Theism has been to considerations drawn more directly from experience, and particularly from moral and religious experience.

The Moral Argument.—Kant is the historical turning-point in the philosophy of religion. His criticism of the Theistic proofs was not made in the interest of Atheism, and he was an agnostic only in the technical sense that he denied the possibility of arriving at a knowledge of God by the pure or speculative reason. Religion belongs to the sphere of moral faith, of the "practical reason." There are three postulates of the moral reason, God, Freedom and Immortality; these cannot indeed be proved in any scientific manner, but the consideration of the limits of theoretical knowledge leads us to see that the pure reason cannot disprove their validity. It remains neutral. We are therefore free to affirm the three ideas without which our moral experience of the authority of the moral law and the inexhaustible ideal of holiness could not be conceived as rational This is Kant's fundamental position. The train of reasoning by which he seeks to establish the necessity of the postulate of God is less important, being complicated by his peculiar views of the nature of the moral experience. The argument turns on the alleged moral demand that the highest holiness should ultimately coincide with the highest happiness.

The moral argument has been presented in various forms by important writers of the 19th and 20th centuries. Theories of ethics naturally fall into two classes, (1) those which take the fundamental concept in morals to be duty and the moral law; (2) those which take the idea of the Good to be fundamental. From both of these standpoints Theistic conclusions have been defended. James Martineau in his *Types of Ethical Theory* and *A Study of Religion* adopts on the whole the first, T H. Green's *Prolegomena to Ethics* and W. R. Sorley's *Moral Values and the Idea of God* are salient representatives of the second, while Dr. Hastings Rashdall's *Theory of Good and Evil* combines to some extent both points of view.

There are three elements in the moral consciousness on which stress is laid in Theistic arguments. (a) The authority which the conscience attributes to the moral ideal This unique authority cannot, it is urged, be explained on any view which does not allow us to find the moral law in some way built into the structure of the world, grounded in Reality. Other possible accounts of the source of the sense of obligation really issue in an explaining away of the moral "ought," and hence in the consequence that the fully moral life is irrational. Further, it is urged, the Theistic view is the view which most clearly enables us to hold that the moral law is not simply imposed externally but is the expression of the deepest self and also that it is no mere individual product, but of universal validity. (b) The "objectivity" of the moral ideal. The conscience cannot be satisfied with the belief that the moral ideal is dependent upon opinion, whether of the individual or of groups. In spite of the obvious fact that moral ideas change, the moral life depends upon the conviction that the moral ideal itself is absolute. Though men's apprehension of it may grow, their apprehension does not create it It may be argued that Theism gives us the most rational account of this aspect of the moral consciousness, since it suggests that the moral ideal may exist in the thought of God. (c) The content of the moral ideal, particularly when viewed in its social aspect. Though we know what we mean by progress, we cannot conceive any temporal condition which would be the final goal of social progress. Unless therefore we are prepared to allow that progress is towards an end which is inherently unattainable, we are led to the thought of an End which is beyond the temporal order Here again the

theistic hypothesis appears to offer the most reasonable view, since it would hold that perfect communion with God and herein with all rational beings, is the nature of the highest Good. The central thought of the moral argument in all its forms is this. given man's moral experience at its highest we have the choice of regarding it as rational and significant, or of explaining it away as partially founded on a mistake with the probable consequence of weakening its effectiveness. If we choose to regard it as rational and significant Theism is the view of the world which will most adequately fulfil our demands

The Argument from Values in General.—Strictly speaking the moral argument is a special case of the line of reasoning which sets out from the existence of values The world manifests the character of having value, or of being the occasion of our apprehension of value. Truth, goodness and beauty are real in our experience. In every case however, we are led to the conception of an absolute value, a complete Truth, a perfect Good and Beauty. The very fact that we recognise degrees of truth, goodness and beauty, implies that we tacitly presuppose an absolute standard towards which the partial values which we enjoy are approximations. Nor again, can we suppose that in the end these values are opposed to one another, though in finite experience they may sometimes seem to conflict. On the contrary, the Ultimate values must form a Unity, or rather perhaps, be aspects or attributes of one Supreme Value, which is what we mean by God. This is the line of thought which carries on the Platonist tradition in Christian philosophy and is impressively stated by Dr. W. R. Inge in his *Philosophy of Plotinus* and other writings

Religious Experience.—Among the ancient arguments for Theism should be enumerated the argument *e consensu Gentium*, from the agreement of the nations. The evidence to be derived from the fact that all men everywhere believed in the Divine was insisted on by the Stoics and has been held to show that the idea of God is "innate" in the human mind. Precisely in this form the reasoning is open to objection. Locke, in his polemic against "innate ideas" in general, pointed out that the argument collapsed when we asked, what idea of God is innate? for the conceptions of the divine held by savages differ profoundly from those of civilized nations. The study of Comparative Religions since the time of Locke has served to support in detail his contention; but on the other hand it has shown that religion is practically a universal phenomenon wherever the human race is found. A new and more profound approach to Theism, which has some affinity with the old argument *e consensu Gentium*, has been opened by this enlarged knowledge. It is now possible to study the religious experience of mankind as a whole. When this is done we can discern an upward movement of the experience and of the concepts of the Divine in which it finds expression. This upward movement does not take place over the whole field, but certain principles of development may be noticed which are fully exemplified only where the religious impulse has free course. The primitive ideas of animism and polydaemonism, give place to polytheism, which in turn is displaced by monotheism either in the form of pantheism or ethical monotheism. It is always open to the critic to dismiss the whole religious experience of humanity as based on illusion and mistake; but such a drastic rejection of a universal type of consciousness is hard to justify If we base our knowledge of the Universe on experience, religious experience has a claim to be included If further, we find that the religious experience tends to pass from obviously inadequate forms to forms which lend themselves to rational presentation, we shall be justified in regarding the later and higher as the nearest approximations so far to adequate discriminations of the Object with which all religious experience is concerned.

Parallel to this consideration of the general development of religious experience runs the evidence to be derived from a study of the great religious personalities, and particularly of the mystics. The mystical type of religious "genius" seems to enjoy an immediate contact with the Divine, and the statements made by such persons have some general agreement. Too much stress should not be laid on their testimony to the truth of Theism, since some of the evidence would support Pantheism rather than Theism, and there is a tendency among mystics to interpret their experience in terms of the religious imagery in which they have been brought up The witness of the mystics to the supernatural is impressive, and they may be linked with the general argument from religious experience as salient instances of its power at every level It is urged by several Christian writers that the definitely Theistic mysticism of the Christian mystics is a higher and more complete type of mysticism than any other (*See*, for example, W. R. Inge, *Christian Mysticism*, E. Underhill, *Mysticism*, and R. Otto, *West Östliche Mystik*)

In concluding this summary of grounds of Theistic belief we must remark again that few philosophical Theists would rest their case on a direct demonstration or claim that they were in possession of an "apodeictic" argument; they would urge that the full force of the reasons in favour of Theism can only be appreciated when it is compared with other possible views of the Universe, and that several converging lines of thought form a cumulative argument which is difficult to resist

SOME PROBLEMS OF THEISM

The Theistic view of the world is naturally impelled to articulate itself by considering the problems of the nature of God and His relations with the world. Some of the more important of these problems must now be briefly indicated.

Divine Personality.—Most Theists, if not all, would agree that God is, in some sense, personal, or at least not of a nature inferior to personality. The latter tenet seems to be implied in the Theistic hypothesis, for otherwise God could not be thought of as the Supreme Value It is important however, to distinguish between the two propositions, "God is personal" and "God is a person" Though the second of these propositions has been held by many Theists, it is not an essential point. Orthodox Christianity cannot be cited on behalf of the belief that God is a person, for the doctrine of the Trinity would suggest that the Godhead is a Unity of Persons. No one, of course, would maintain that God is a person in precisely the same sense as human beings are persons, and in view of this some would prefer to speak of the Divine Nature as Supra-Personal, others, on the contrary, as for example Lotze, would hold that God alone is the perfect person and that finite selves are "pale shadows" of His personality No very vital principle is involved in this difference, so long as those who prefer the term "supra-personal" are clear that it is not a polite phrase for "impersonal" Theistic religion is profoundly concerned to maintain that God is a being with whom personal relations are possible; if that be abandoned we shall be compelled to dismiss that religious experience, which Theists take to be the highest and most significant, as illusion. The main theoretical ground for accepting Divine Personality is the contention that personality is the highest type of existence known to us, the "bearer," the discerner, and the creator of values, and also that personal life is the most conspicuous instance of multiplicity in unity, it is, as Plotinus called it, a πολλὰ ἐν : the category of personality would appear, in its ideal form, to suggest an ultimate solution of the problem of the One and the Many. A difficulty has been raised concerning the attribution of personality to God on account of the alleged necessity of a "not-self" distinguishable from the self in all cases of self-consciousness. The discussion of this problem by Lotze in his *Microcosmus* (Bk. IX, Chap. IV.), remains the classical authority. It is noteworthy however, that this special difficulty does not press with such force upon the Trinitarian form of Theism. On any Theistic view it would appear that the created order must be in some sense a "not-self" with respect to God, since the identification of the created order with the Being of God would be Pantheism.

Divine Attributes.—The Theistic doctrine of God has usually included an account of the Divine Nature under the title of "attributes," but the error must be carefully guarded against of conceiving the Divine Nature as the sum of the Divine Attributes. They are rather different aspects from which the Divine Being may be viewed by us. The traditional division is into Metaphysical and Moral. The Scholastic Theology considered the Metaphysical Attributes to be those which refer to God as He is in

Himself and the Moral Attributes those which refer to Him in relation with the world. It may be questioned however, whether the human mind is capable of having knowledge of God of that absolute character suggested by this definition of the Metaphysical Attributes. If the division be retained it is perhaps better to say simply that by Metaphysical Attributes we mean those which have a primarily intellectual importance, such as Unity and Infinity, while by Moral we mean those which have a directly practical bearing, such as Righteousness and Love. The classification, however, is of doubtful value, since even the attributes which are most evidently "metaphysical" have profound religious results, and those which are "moral" have metaphysical import.

Reflection upon the Being of God has followed along two paths —the *via negativa*, and the *via eminentiae*. The first of these methods turns on the conception of God as the Infinite and works with a negative conception of infinity. God, being infinite, cannot be described by any predicates which would imply limitation. All positive assertions, however, imply such a limitation. It follows therefore that no positive quality can be affirmed of God, not even goodness or indeed even being, so that if we say that God is τὸ ὄν we must also say that He is equally τὸ μὴ ὄν. Clearly this method leads to a position which is hardly distinguishable from Agnosticism. The *via eminentiae* starts with the conception of God as the Ground and Source of all existence and with the postulate that the Ground must be adequate to the consequences. All positive qualities, therefore, which occur in created existence must be ascribed to God; but plainly not *"simpliciter"*; they are, so to speak, raised to infinity. Knowledge is in God Omniscience, Will Omnipotence, Beauty perfect Loveliness. We must observe here that the *via eminentiae* really implies the view that evil is not positive being but privation or defect of being, a view which was held by Augustine and Aquinas; for if evil were a positive existence or quality of existence the argument of the *via eminentiae* would lead us to predicate evil of God.

The Divine Attributes have been the subject of much subtle and intricate speculation into which it is impossible to enter here. Brief remarks on two must be made, since they are of great importance in Theistic theory. Omniscience is the perfection of that quality of knowledge which is found imperfectly in some created beings. Evidently the Divine knowledge cannot suffer from the imperfections of human knowing. It is scarcely appropriate to imagine the Divine Intelligence engaged in "discursive" thought and pursuing trains of reasoning. The most adequate human knowledge is that described by Spinoza as *scientia intuitiva*, intuitive knowledge in which grounds and conclusion are apprehended in one intellectual act. Of this kind, it would seem, the Divine knowledge must be. We are brought here to the recognition of one aspect of the Divine Infinity and Eternity. Human knowing is a part of a temporal experience and therefore itself a temporal process. The Divine experience and knowledge cannot be temporal, or at least cannot be "in time." A recognition of this truth has important bearing on some of the puzzles of Christian and other Theologies connected with the Divine Foreknowledge. If the Divine Experience is not successive but simultaneous, the expression "foreknowledge" is evidently misleading and indicates that in presenting to ourselves the Divine Nature and Experience we are compelled to make use of inadequate concepts derived from our own experience, and hence to encounter problems which are insoluble because we have not the terms in which to state them accurately.

The same remarks apply to the attribute of Omnipotence in which we attempt to indicate the nature of the Divine Will. Clearly a supra-temporal will is beyond our powers of adequate conception. This does not prove, as Spinoza held, that will is absent from God's experience, but it certainly shows that we cannot transfer ideas derived from our experience of finite acts of will directly to the Divine Will. The conception of Omnipotence gives rise to problems which are, in their nature, not completely soluble by human reason Two possible meanings of the word have been suggested. It has been held, on the one hand, that omnipotence implies not only the power to do all that is possible but also that the determination of the possible is due to the will of God, so that the fundamental laws of thought and of morality are fiats of the Divine Will and not limitations upon it. On the other hand, it is held that the will of God is determined by the principles of reason and goodness which are inherent in His Nature and that omnipotence means the power to do all that is possible. Of these two views the latter is to be preferred, since the former asks us to conceive of the Divine Will as arbitrary and not in any intelligible sense either rational or good. Even so, however, it cannot be pretended that all difficulty has been removed from the conception of omnipotence, and we may perhaps be content to say, with Schleiermacher, that both omnipotence and omniscience are ways of expressing the fundamental conviction of Theism that all things ultimately depend upon God.

Creation and Self-limitation.—Theism does not identify God and the world. It maintains indeed that God is immanent in creation but also transcendent, and it holds therefore that there is a real distinction between God and the world. This distinction is expressed in the idea of Creation. Theism on the whole has preferred the idea of creation to that of emanation, which is the idea adopted by systems which lead to Pantheism. Emanation implies that the world proceeds from the Divine Being by a kind of necessary process, a common figure being that of the sun and its rays. Creation, on the other hand, emphasizes the factor of will and implies that the world exists as a result of an act of choice. Creation does not necessarily involve a belief that the world began at a definite moment of time or that the creative act of God is single; it is perfectly compatible with the belief in a continuous creation which would be in harmony with modern theories of evolution.

Any belief in creation, and indeed any belief in the reality of freedom, seems clearly to necessitate some limitation of the omnipotence and perhaps of the omniscience of God At the same time, Theism cannot admit that any portion of existence is absolutely independent of God. To meet this dilemma the thought of a divine "self-limitation" has been employed. Admittedly this is a thought which cannot be articulated in any detail. We cannot know the conditions of such self-limitation. But the conception itself is required by the facts as they appear in religious and moral experience We may urge that the idea is not really contradictory of omnipotence, for an omnipotence which could not limit itself would not be omnipotent. And there is no inherent difficulty in the moral attributes of God, for it may be argued that the development of free moral persons who can enter into communion with God is the ultimate purpose of creation, and that this end could not be attained apart from a limitation of the divine power which makes freedom possible and with it both moral good and moral disaster.

A difference of opinion among Theists exists on the question whether creation is in any sense necessary to God. On this point traditional Christian theology and some modern idealistic interpretations of Christianity (*e.g.*, Hegel's) are at variance. Christian theology on the whole has laid down that the world is in no way necessary to God and that its creation does not add to His perfection or satisfaction The opposite view, which emphasises the Divine immanence, holds that the world is as necessary to God as God to the world. A distinction should be made between the active and passive sense of "creation." Thus it might be conceived that creation is an essential attribute of God and at the same time that the present universe is not necessary to God, that to create is an eternal activity of God but no product of that activity is eternal. A theory of this kind would avoid the difficulties which arise when we attempt to conceive a beginning of creation. (On this point *see* further, *Studies in Christian Philosophy* by W. R. Matthews.)

A problem in Theistic philosophy closely connected with the foregoing is that of the place of suffering in the Divine Experience. Here again the weight of Christian thought is against the admission of anything which would seem to qualify the absolute self-sufficiency and perfection of the Divine Nature Suffering arises through frustration and limitation, conditions which are hardly to be thought of in connection with the Supreme Being. Against this may be set some considerations arising from the problem of evil

and the moral perfection which we believe God to possess. It would seem difficult to think of Divine Sympathy with suffering if suffering could not enter into the Divine Experience; and it would seem strange to ascribe moral perfection to God if self-sacrifice, which involves voluntary pain, were excluded. On these grounds many writers on Theism and Christian Theologians in the present century have argued that suffering must enter into the Divine Consciousness, and some have urged that this is really an essential element in the Christian view of the world. (For a survey of opinion on this subject *see* J. K. Mozley, *The Impassibility of God*.) It must be observed, however, that Theism could not admit that suffering is the dominant note of the Divine Experience. To do so would be to fall back upon the conception of a "God" so limited and struggling that He may be ultimately defeated. Our experience, however, offers us an analogy which throws light upon the problem. At the highest level of spiritual life a condition of "blessedness" has sometimes been attained which is far different from a condition of mere pleasure and absence of pain. Pain enters into it as an essential element, but the condition itself is not one of pain, rather it is one in which the self finds its truest satisfaction and which it would not exchange for any maximum of pleasant feeling. Of this kind, though in an infinitely higher degree, we may imagine the life of God to be.

BIBLIOGRAPHY.—Among other works *see* Caldecott and Mackintosh, *Selections from the Literature of Theism* (1904); A. S. Pringle-Pattison, *The Idea of God* (ed. 1920); James Ward, *The Realm of Ends* (3rd ed., 1920); Charles Gore, *Belief in God* (1921); C. C. J. Webb, *Divine Personality and Human Life* (1920); *Problems in the Relations of God and Man* (1911); G. Galloway, *The Philosophy of Religion* (1914); A. C. Fraser, *Philosophy of Theism* (1899); F. von Hugel, *Mystical Element in Religion* (1909), *Eternal Life* (1912); A. Caldicott, *Philosophy of Religion* (1901); W. Temple, *Mens Creatrix* (1917); H. Hoffding, *Philosophy of Religion* (1906), A. E. Taylor, art. "Theism" in Hastings' *Enc. Rel. Eth.* (W. R. M.)

THEISS: *see* TISA.

THELEPTE, an ancient Roman city in western Tunisia, 35 m. S.W. of Sufetula (Sbeitla), 2,650 ft. above sea-level. The ruins are extensive, but most of the buildings are almost entirely destroyed, and only their ground plan can be recognized. To the south-west are some massive remains of baths.

THEMIS. (1) An ancient goddess, often identified with Ge, said to have been the occupier of Delphi in days before Apollo (*see* ORACLES). She is the mother of Prometheus (*q.v.*). (2) A goddess of justice (*cf.* NEMESIS). In Homer θέμις is used both as a common noun (doom, decree; *cf.* GREEK LAW) and as a proper name; Themis is the servant or companion of Zeus, her chief function being to summon the assemblies of both gods and men (*Odyssey*, ii. 68). In the Hesiodic theogony, she is the daughter of Uranus and Ge, and according to Pindar the wife of Zeus, by whose side she sits, assisting him with her advice, which is even better than that of any of the gods. She is the mother of the Horae and of the Fates (*q.v.*). Her opposite is Hybris (ὕβρις), insolent encroachment upon the rights of others. The exact relation between (1) and (2), save that they have in common the idea of stability (θέμις, root θε, place) is obscure. Orphic poetry makes her a daughter of Helios.

See R. Hirzel, *Themis, Dike, und Verwandtes* (1907); L. Weniger in Roscher's *Lexikon*, *s.v.* (bibliography).

THEMISTIUS (317–?387), named εὐφραδής ("eloquent"), statesman, rhetorician and philosopher, was born in Paphlagonia and taught at Constantinople, where, apart from a short sojourn in Rome, he resided during the rest of his life. Though a pagan, he was admitted to the senate by Constantius in 355. He was prefect of Constantinople in 384 on the nomination of Theodosius. His paraphrases of Aristotle's *Posterior Analytics*, *Physics* and *De Anima* are valuable; but the orations in which he panegyrizes successive emperors, comparing them to Plato's "true philosopher," and even to the "idea" itself, are servile and unworthy. Themistius's paraphrases of the *De Coelo* and of book Λ of the *Metaphysics* have reached us only through Hebrew versions. In philosophy Themistius was an eclectic.

See E. Zeller, *Philosophie der Griechen* (1881). *See* also H. Schenkl, *Beiträge zur Textgeschichte der Reden des Themistios* (Vienna, 1919).

THEMISTOCLES (*c.* 514–449 B.C.), Athenian soldier and statesman in some respects probably the ablest and most far-sighted whom Greece produced in the first half of the 5th century. He was the son of Neocles, an Athenian of no distinction and moderate means, his mother being a Carian or a Thracian. Hence according to the Periclean law ἐξ ἀμφοῖν ἀστοῖν he would not have been a free Athenian at all (*see* PERICLES). Thucydides observes that, though he lacked the culture typical of the Periclean age, he displayed a marvellous power of analysing a complex situation together with a genius for rapid action. Plutarch similarly enlarges on his consuming ambition for power both personal and national, and the unscrupulous ability with which he pursued his ends. Of his early years little is known. He may have been strategus of his tribe at Marathon.

At all events the death of Miltiades left the stage to Aristeides and Themistocles. It is sufficiently clear that their rivalry turned largely on the fact that Themistocles was the advocate of a policy of naval expansion. This policy was unquestionably of the highest importance to Athens and indeed to Greece. Athens was faced by the equal if not superior power of Aegina, while the danger of a renewed Persian invasion loomed large. Themistocles persuaded his countrymen to put in hand the building of 200 triremes, and to fortify the three natural harbours of Peiraeeus (*see* E. Gardner, *Ancient Athens*, 562 f.) in place of the open roadstead of Phalerum. For the building of the ships Themistocles persuaded the Athenians to allocate 200 talents obtained from the new silver mines at Laureium (*Ath. Pol.* 22) which were about to be distributed to the citizens (10 drachmae each). One hundred of the proposed 200 were built.

He may or may not have been archon in 483, according to the *Ath. Pol.*, when this programme began. Dionysius of Halicarnassus places his archonship in 493–92, in favour of which are several considerations. In 487 the office lost much of its importance owing to the substitution of the lot for the election; the chance that the lot would at the particular crisis of 483 fall on Themistocles was obviously remote. In any case, the chief men of the other side disappear one by one—culminating in the ostracism of Aristeides in 482, and the year prior to the invasion of Xerxes found Themistocles the chief man in Athens if not in Greece. Though the Greek fleet was nominally under the control of the Spartan Eurybiades, it was Themistocles who forced the indecisive battle of Artemisium, and by his threat that he would lead the Athenian army to found a new home in the West, and by his treacherous message to Xerxes, precipitated the engagement at Salamis (*see* P. W. Dodd in *Class. Rev.* 27, p. 117). The retirement of the Persians left the Athenians free to restore their ruined city (*see* ATHENS). Sparta opposed the rebuilding of the walls, but Themistocles by a subterfuge got the walls built high enough to be defensible. He also carried out his original plan of making Peiraeeus a harbour and fortress for Athens. Athens thus became the finest trade centre in Greece, and this fact, coupled with Themistocles' remission of the allen's tax (μετοίκιον) induced many foreign business men to settle in Athens.

After the crisis of the Persian invasion Themistocles and Aristeides appear to have composed their differences. But Themistocles soon began to lose the confidence of the people, partly owing to his boastfulness (it is said that he built near his own house a sanctuary to Artemis Aristoboulē "of good counsel") and partly to his alleged readiness to take bribes. Diodorus (xi. 54) and Plutarch (*Themist.* 23) both refer to some accusation levelled against him. There is, however, much difficulty regarding this accusation; it may be simply a misunderstanding of his ostracism. Some time between 476 and 471 he was ostracized. He took refuge eventually in Asia Minor, and was proclaimed a traitor in Athens. He was well received by the Persians and was allowed to settle in Magnesia on the Maeander. He died at Magnesia at the age of 65, and a splendid memorial was raised by the people of the town, though it is said that his bones were secretly transferred to Attica. He was worshipped by the Magnesians as a god, as we find from a coin on which he is shown with a patera in his hand and a slain bull at his feet (hence perhaps the legend that he died from drinking bull's blood: *cf.* Aristoph. *eq.* 83;

Diod. xi. 58, Plut *Them.* 31).

Though his end was discreditable, though his great wealth can hardly have been obtained by loyal public service, there is no doubt that his services to Athens and to Greece were great. He created the Athenian fleet and with it the possibility of the Delian League (*q.v.*) which became the Athenian empire, and there are many indications (*e.g.*, his well-attested plan of expansion in the west) that the later imperialist ideal originated in his fertile brain.

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THÉNARD, LOUIS JACQUES (1777–1857), French chemist, was born on May 4, 1777, at Louptière (Aube), the son of a poor peasant, who made great sacrifices for his son's education. He worked in a humble capacity in the laboratory of L. N. Vauquelin, who procured for him various teaching posts. In 1804, when Vauquelin retired from the chair of chemistry at the Collège de France, he used his influence to secure Thénard's succession to the post. Later, Thénard held the chair of chemistry at the Ecole Polytechnique and at the Sorbonne. He was a member of the Academy, a peer of France (1832), deputy for Yonne (1827–30), and a member of the council of education. He died in Paris on June 21, 1857, and the name of his native village was changed (1865) to Louptière-Thénard in his honour.

Thénard was a great teacher, and his *Traité de chimie élémentaire* (4 vols., 1813–16), which was the standard text-book for a quarter of a century, did more, perhaps, than even his many important original discoveries to advance the cause of science. With his lifelong friend, Gay-Lussac (*q.v.*), he carried out many researches. His researches on esters (1807), sebacic acid (1802) and on bile (1807), his discovery of peroxide of hydrogen (1818) and his work on organic phosphorus compounds (1846) deserve mention. The substance known as "Thénard's blue," he prepared in 1799 in response to a peremptory demand by J. A. Chaptal for a cheap colouring matter, as bright as ultramarine and capable of standing the heat of the porcelain furnace.

A list of Thénard's memoirs may be found in the Royal Society's *Catalogue of Scientific Papers.*

THEOBALD (d. 1161), archbishop of Canterbury, was of Norman parentage, but the date of his birth is unknown. Early in life he entered the abbey of Bec, of which he became prior in 1127 and abbot ten years later. In 1138 he was elected to the see of Canterbury, and as archbishop he behaved with a moderation which is in striking contrast to the conduct of his rival, Henry of Blois, bishop of Winchester. During the struggle between Stephen and Matilda it was Bishop Henry who fought for the privileges of the Church; Theobald, while showing a preference for Stephen's title, made it his rule to support the *de facto* sovereign. But as Stephen's cause gained ground the archbishop showed greater independence. He refused to consecrate the king's nephew to the see of York, and in 1148 attended the papal council of Reims in defiance of a royal prohibition. This quarrel was ended by the intercession of the queen, Matilda of Boulogne, but another, of a more serious character, was provoked by Theobald's refusal to crown Count Eustace, the eldest son of Stephen, the archbishop pleading the pope's orders as the excuse for this contumacy. In 1153 Theobald succeeded in reconciling Stephen with Henry of Anjou, and in securing for the latter the succession to the throne. He placed the interests of the Church in the hands of Thomas Becket, his archdeacon. Theobald died on April 18, 1161.

In history Theobald lives chiefly as the patron of three eminent men: Becket, who began life as a clerk in his household; Master Vacarius, the Italian jurist, who was the first to teach Roman law in England; and John of Salisbury, the learned scholar. Theobald's household was a university in little; and in it were trained many leading prelates of the next generation.

See the *Vita Theobaldi* printed in J. A. Giles, *Lanfranci Opera*, vol. i. (Oxford, 1844), W. Hook, *Lives of the Archbishops of Canterbury*, ii. c. vi. (London, 1862), and K. Norgate, *England under the Angevin Kings*, vol. i. (London, 1887). (H. W. C. D.)

THEOBALD, LEWIS (1688–1744), English man of letters, playwright and Shakespearian commentator, the son of an attorney, was born at Sittingbourne, Kent. He was baptized on April 2, 1688, and was educated for the law. He translated the *Phaedo* of Plato in 1713, in 1714–15 the plays of Sophocles and of Aristophanes, and in 1716 the first book of the *Odyssey*. Meanwhile he had got into trouble in 1716 on a charge of plagiarism in his play *The Perfidious Brother*. But Theobald is remembered neither as translator, nor as original author, but for his work on the text of the Shakespeare plays.

In 1726 he produced *Shakespeare Restored, or a Specimen of the many Errors as well Committed as Unamended by Mr. Pope in his late edition of this Poet; designed not only to correct the said Edition, but to restore the true Reading of Shakespeare in all the Editions ever published* (1726). Some of his happiest emendations are to be found in this work, which conclusively proved Pope's incompetence as a Shakespearian editor.

In 1731 Theobald undertook to edit Shakespeare for Tonson the publisher. The work appeared in seven volumes in 1734, and completely superseded Pope's edition. Subsequent editors reaped, in many cases without acknowledgment or with actual scorn, the fruit of Theobald's painstaking labour, his wide learning and his critical genius.

His correspondence with Matthew Concanen, Styan Thirlby and William Warburton is to be found in Nichols's *Illustrations of Literature* (ii. 204–654), which also gives the fullest account of his life. *See* also R. F. Jones, *Lewis Theobald; his contribution to English Scholarship* (N.Y. 1919).

THEOCRITUS, the creator of pastoral poetry, flourished in the 3rd century B.C. Little is known of him beyond what can be inferred from his writings. We must, however, handle these with some caution, since some of the poems ("Idylls") commonly attributed to him have little claim to authenticity. It is clear that at a very early date two collections were made, one of which included a number of doubtful poems and formed a *corpus* of bucolic poetry, while the other was confined to those works which were considered to be by Theocritus himself. The record of these recensions is preserved by two epigrams, one of which proceeds from Artemidorus, a grammarian, who lived in the time of Sulla and is said to have been the first editor of these poems. He says, "Bucolic muses, once were ye scattered, but now one byre, one herd is yours." The second epigram is anonymous, and runs as follows:—"The Chian is another. I, Theocritus, who wrote these songs, am of Syracuse, a man of the people, the son of Praxagoras and famed Philina. I never sought after a strange muse." The last line may mean that he wrote nothing but bucolic poems, or that he only wrote in Doric. The statement that he was a Syracusan is confirmed by allusions in the "Idylls" (xi. 7, xxviii. 16–18). A larger collection, possibly more extensive than that of Artemidorus, and including poems of doubtful authenticity, was known to Suidas, who says: "Theocritus wrote the so-called bucolic poems in the Dorian dialect. Some persons also attribute to him the following: *Daughters of Proetus, Hopes, Hymns, Heroines, Dirges, Lyrics, Elegies, Iambics, Epigrams.*" The first of these may have been known to Virgil, who refers to the *Proetides* in the *Eclogues* (*Ecl.* vi., 48). The spurious poem xxi. may have been one of the *Hopes* (*cf.* l. 66, ἐλπὶς τῶν ὑπνων), and poem xxvi. may have been one of the *Heroines* (*cf.* l. 36, ἡρωΐναι): elegiacs are found in viii. 33–60, and the spurious epitaph on Bion may have been one of the *Dirges*. The other classes are all represented in the larger collection which has come down to us.

The poems which are generally held to be authentic may be classified thus:—

I. **Bucolics and Mimes.**—The distinction between these is that the scenes of the former are laid in the country and those of the latter in a town. The most famous of the *Bucolics* are i., vii., xi. and vi. In i. Thyrsis sings to a goatherd how Daphnis, the mythical herdsman, having defied the power of Aphrodite, dies rather than yield to a passion with which the goddess had

inspired him. In xi Polyphemus is depicted as in love with the sea-nymph Galatea and finding solace in song: in vi he is cured of his passion and naively relates how he repulses the overtures now made to him by Galatea. The monster of the *Odyssey* has been "written up to date" after the Alexandrian manner and has become a gentle simpleton. Idyll viii., the "Harvest Feast" (Θαλύσια), is the most important of the bucolic poems. The scene is laid in the isle of Cos. The poet speaks in the first person and is styled Simichidas by his friends. Other poets are introduced under feigned names. Thus ancient critics identified Sicelidas of Samos (l 40) with Asclepiades the Samian, and Lycidas, "the goatherd of Cydonia," may well be the poet Astacides, whom Callimachus calls "the Cretan, the goatherd." Theocritus speaks of himself as having already gained fame, and says that his lays have been brought by report even unto the throne of Zeus (possibly Ptolemy: *cf.* Horace, *Ep* i 19, 43, *Iovis auribus ista Servas*, where *Iuppiter*=Augustus). He praises Philetas, the veteran poet of Cos, and criticizes "the fledgelings of the Muse, who cackle against the Chian bard and find their labour lost."

The other bucolic poems need not be further discussed. Several of them consist of a singing-match, conducted according to the rules of amoebean poetry, in which the second singer takes the subject chosen by the first and contributes a variation in the same air. It may be noted that the peasants of Theocritus differ greatly in refinement. Those in v are low fellows who indulge in coarse abuse. This Idyll and iv. are laid in the neighbourhood of Croton, and we may infer that Theocritus was personally acquainted with Magna Graecia. Suspicion has been cast upon poems viii. and ix. on various grounds. An extreme view holds that in ix we have two genuine Theocritean fragments, ll. 7–13 and 15–20, describing the joys of summer and winter respectively, which have been provided with a clumsy preface, ll. 1–6, while an early editor of a bucolic collection has appended an epilogue in which he takes leave of the Bucolic Muses. On the other hand, it is clear that both poems were in Virgil's Theocritus, and that they passed the scrutiny of the editor who formed the short collection of Theocritean Bucolics.

The mimes are three in number, viz., ii., xiv., xv. In ii. Simaetha, deserted by Delphis, tells the story of her love to the moon; in xiv. Aeschines narrates his quarrel with his sweetheart, and is advised to go to Egypt and enlist in the army of Ptolemy Philadelphus; in xv. Gorgo and Praxinoë go to the festival of Adonis. It may be noticed that in the best mss. ii. comes immediately before xiv., an arrangement which is obviously right, since it places the three mimes together. The second place in the mss. is occupied by Idyll vii., the "Harvest Feast." These three mimes are wonderfully natural and lifelike. There is nothing in ancient literature so vivid and real as the chatter of Gorgo and Praxinoë, and the *voces populi* in xv.

It will be convenient to add to the *Bucolics* and *Mimes* three poems which cannot be brought into any other class, viz., xii. (Ἀΐτης), a poem to a beautiful youth; xviii., the marriage-song of Helen (Ἐπιθαλάμιος); and xxvi., the murder of Pentheus (Δῆναι). The genuineness of the last has been attacked by U. von Wilamowitz-Mollendorff on account of the crudity of the language, which sometimes degenerates into doggerel. It is, however, likely that Theocritus intentionally used realistic language for the sake of dramatic effect, and the mss. evidence is in favour of the poem. Eustathius quotes from it as the work of Theocritus.

II. Epics.—Three of these are Hymns, viz., xvi., xvii. and xxii. In xvi. the poet praises Hieron II. of Syracuse, in xvii. Ptolemy Philadelphus, and in xxii. the Dioscuri. The other poems are xiii., the story of Hylas and the Nymphs, and xxiv. the youthful Heracles. It cannot be said that Theocritus exhibits signal merit in his *Epics*. In xiii. he shows some skill in word-painting, in xvi. there is some delicate fancy in the description of his poems as "Graces" (Χάριτες), and a passage at the end, where he foretells the joys of peace after the enemy have been driven out of Sicily, has the true bucolic ring. The most that can be said of xxii. and xxiv. is that they are very dramatic. Otherwise they differ little from work done by other poets, such as Callimachus and Apollonius Rhodius. The flattery heaped upon Ptolemy is somewhat nauseous. From another point of view, however, these two poems xvi. and xvii. are supremely interesting, since they are the only ones which can be dated. In xvii Theocritus celebrates the incestuous marriage of Ptolemy Philadelphus with his sister Arsinoë. This marriage is held to have taken place in 277 B.C., and Arsinoë died in 270. This poem, therefore, together with poem xv., which Theocritus wrote to please Queen Arsinoë (*Schol.* χαριζόμενος τῇ βασιλίδι) must fall within this period. The encomium upon Hiero II. would from internal reasons seem prior to that upon Ptolemy, since in it Theocritus is a hungry poet seeking for a patron, while in the other he is well satisfied with the world. Now Hieron first came to the front in 275 B.C. when he was made "General" (στρατηγός): Theocritus speaks of his achievements as still to come, l. 73, and the silence of the poet would show that Hieron's marriage to Philistis, his victory over the Mamertimes at the Longanus and his election as "King" (βασιλεύς), events which are ascribed to 270 B.C., had not yet taken place. If so, xvii. and xv. can only have been written within 275 and 270.

III. Lyrics.—Two of these are certainly by Theocritus, viz., xxviii. and xxix. The first is a very graceful poem presented together with a distaff to Theugenis, wife of Nicias, a doctor of Miletus, on the occasion of a voyage thither undertaken by the poet. The theme of xxix is similar to that of xii. A very corrupt poem, only found in one very late ms., was discovered by Ziegler in 1864. As the subject and style very closely resemble that of **xxix**, it is assigned to Theocritus by recent editors.

IV. The Epigrams.—These do not call for detailed notice. They do not possess any special merit, and their authenticity is often doubtful. It remains to notice the poems which are now generally considered to be spurious. They are as follows:—

xix. "Love stealing Honey" (Κηηοκλέπτης). The poem is anonymous in the mss. and the conception of Love is not Theocritean.

xx. "Herdsman" (Βουκολίασκος), **xxi.** "Fishermen" (Ἁλιεῖς), **xxiii.** "Passionate Lover" (Ἐρωστής). These three poems are remarkable for the corrupt state of their text, which makes it likely that they have come from the same source and possibly are by the same author. The "Fishermen" has been much admired. It is addressed to Diophantus and conveys a moral, that one should work and not dream, illustrated by the story of an old fisherman who dreams that he has caught a fish of gold and narrates his vision to his mate. As Leonidas of Tarentum wrote epigrams on fishermen, and one of them is a dedication of his tackle to Poseidon by Diophantus, the fisher (*Anth. Pal.* vi. 4, 7), it is likely that the author of this poem was an imitator of Leonidas. It can hardly be by Leonidas himself, who was a contemporary of Theocritus, as it bears marks of lateness.

xxv. "Heracles the Lion-slayer" (Λεοντοφόνος). This is a long poem consisting of two episodes, viz., the interview of Heracles with the bailiff of Augeas and his recital to Phyleus, son of Augeas, of the story of the Nemean lion. The composition is not unworthy of Theocritus. It is, however, anonymous in the mss. and comes next to another anonymous poem called "Megara, the wife of Hercules." It is probable from some metrical and linguistic peculiarities that xxv. and the "Megara" are by the same author.

xxvii. "The wooing of Daphnis" (Ὀαριστύς) is also anonymous. It contains imitations of Theocritus, but the tone and the language betray a later writer.

We have no sure facts as to the life of Theocritus beyond those supplied by Idylls xvi. and xvii. It is quite uncertain whether the bucolic poems were written in the pleasant isle of Cos among a circle of poets and students, or in Alexandria and meant for dwellers in streets. The usual view is that Theocritus went first from Syracuse to Cos, and then, after suing in vain for the favour of Hiero, took up his residence permanently in Egypt. Some have supposed on very flimsy evidence that he quarrelled with the Egyptian court and retired to Cos, and would assign various poems to the "later-Coan" period. Wilamowitz-Möllendorff, laying stress on the fact that in the best ms. the poem to Ptolemy (xvii) comes before that to Hieron (xvi.), puts the Egyptian period first and supposes it to have been of very short duration (*i.e.*, 277 to 275), and then makes the poet, after his unsuccess-

ful appeal to Hieron, retire to Cos for the rest of his life. This view would enable us to see a reference to Ptolemy in vii 93, and even to Apollonius Rhodius in 47–48 of the same poem.

The poems of Theocritus were termed *Idylls* (εἰδύλλια), by the grammarians. The word is a diminutive from εἶδος, and is supposed to mean "little poems" The use of εἶδος in the sense of "poem" is somewhat doubtful, and so some have referred εἰδύλλια to εἶδος in its usual sense of "form" or "type" Thus εἶδος βουκολικόν, ἐπικόν, λυρικόν might be used to classify various kinds of poetry, and these poems might be called εἰδύλλια, since they include so many types

Language and Metre.—Theocritus wrote in various dialects according to the subject. The Lyrics xxviii, xxix. (and xxx.) are in Aeolic, that being the traditional dialect for such poems. Two poems, xii ('Ἄστρῳ) and xxii. ("To Castor and Pollux"), were written in Ionic, as is stated in titles prefixed to them, though a number of Doric forms have been inserted by the scribes. The epics in general show a mixture of Homeric, Ionic and Doric forms. The *Bucolics*, *Mimes*, and the "Marriage-song of Helen" (xviii) are in Doric, with occasional forms from other dialects.

The metre used by Theocritus in the *Bucolics* and *Mimes*, as well as in the *Epics*, is the dactylic hexameter. A feature in his versification which has attracted much attention is the so-called bucolic caesura. The rule is that, if there is a pause at the end of the fourth foot, this foot must be a dactyl. This pause is no new invention, being exceedingly common in Homer. Theocritus uses it so frequently in the *Bucolics* that it has become a mannerism. In the *Epics* his practice agrees with that of Homer

We always think of Theocritus as an original poet, and as the "inventor of bucolic poetry" he deserves this reputation At the same time he had no scruple about borrowing from predecessors or contemporaries, in fact he did so in the most open manner. Thus xxix begins with a line of Alcaeus, and xvii, as the Scholiast points out, with words used by Aratus at the beginning of the *Phenomena*. The love of the Cyclops for Galatea had been treated by Philoxenus, and fragments quoted from this show that Theocritus copied some of his phrases closely. In the mimes Theocritus appears to have made great use of Sophron. Idyll ii. is modelled upon a mime of this writer which began in a very similar way. The Scholiast thought that Theocritus showed want of taste in making Thestylis a *persona muta*, instead of giving her a share in the dialogue as Sophron had done. The famous poem about Gorgo and Praxinoë at the feast of Adonis was modelled on one by Sophron about women looking on at the Isthmian games ('Ἰσθμιάζουσαι), and fragments quoted from this are closely imitated by Theocritus It is extremely interesting to find a similar poem in the recently discovered mimes of Herondas, the fourth of which is termed "Women making offerings to Asculapius" ('Ἀσκληπιῷ ἀναθέται καὶ θυσιάζουσαι). The relation of Theocritus to Herondas is a subject of great interest. Herondas must have been a contemporary, as he refers to Ptolemy Philadelphus (l. 30) and was a native of Cos, so that he and Theocritus must have been acquainted. There are some curious parallels in the language and idioms of the two poets, but which of them copied the other it is impossible to determine.

BIBLIOGRAPHY.—(i) Editions: (*a*) Critical, H. L. Ahrens (1855); Ch. Ziegler, (1879); U. von Wilamowitz-Möllendorff, in Oxford Classical Texts (1901). (*b*) Epexegetical, E. Hiller (1881; German notes); R. J. Cholmeley (ed. 2, 1919; English notes) (ii.) Translations: A Lang (1880; prose); J. H. Hallard (ed. 4, 1924; verse). (iii.) Subject-matter: Ph. E. Legrand, *Étude sur Théocrite* (1898); (iv.) Textual Questions: E. Hiller, *Beiträge zur Textgeschichte der Griechischen Bukoliker* (1888); U. von Wilamowitz-Mollendorff, *Die Textgeschichte der Griechischen Bukoliker* (1906). (v.) Metre: C. Kunst, *De Theocriti versu heroico* (1887). (vi.) Scholia: C. Wendel (1914).

THEODOLITE, a surveying instrument consisting of two graduated circles placed at right angles to each other, for the measurement of horizontal and vertical angles, a telescope, which turns on axes mounted centrically to the circles, and an alidade for each circle, which carries two or more verniers. The whole is supported by a pedestal resting on footscrews, which are also employed to level the instrument.

Theodolites are designed to measure horizontal angles with greater accuracy than vertical, because it is on the former that the most important work of a survey depends; measures of vertical angles are liable to be much impaired by atmospheric refraction, more particularly on long lines, so that when heights have to be determined with much accuracy the theodolite must be discarded for a levelling instrument When truly adjusted the theodolite measures the horizontal angle between any two objects, however much they may differ in altitude, as the pole star and any terrestrial object The instrument is made in many forms and modern surveying has introduced a great degree of accuracy. For the uses of the theodolite and other details *see* SURVEYING The name has been a puzzle to etymologists. Various ingenious explanations have been given, all based on the apparent Greek form of the word; thus it has been derived from θεᾶσθαι, to see, ὁδός, way, and λιτός, smooth, plain; from θεῖν, to run, and δολιχός, long, and in other ways equally fanciful Another imaginary origin has been suggested in a corruption of "the O deleted," *i.e.*, crossed out, the circle being crossed by diameters to show the degrees, others have found in it a corruption of "the alidade" (*q.v.*) It would appear, however, to be taken from the O Fr. *theodolet* or *theodelet*, the name of a treatise by one Theodulus, probably a mathematician (see *Notes and Queries*, 3rd series, vii. 337, 428, etc. Skeat, *Etym. Dict.*, 1910).

THEODORA, the wife of the emperor Justinian (*see* JUSTINIAN I), was born probably in Constantinople, though according to some in Cyprus, in the early years of the 6th century, and died in 547. According to Procopius, our chief but by no means a trustworthy authority for her life, she was the daughter of Acacius, a bear-feeder of the amphitheatre at Constantinople, and while still a child appeared on the stage. Becoming a noted courtesan, she accompanied a certain Hecebolus to Pentapolis (in North Africa), of which he had been appointed governor, and, having quarrelled with him, betook herself first to Alexandria, and then back to Constantinople through the cities of Asia Minor In Constantinople she attracted the notice of Justinian He desired to marry her, but could not overcome the opposition of his aunt, the empress Euphemia. After her death (usually assigned to the year 523) the emperor yielded, and as a law forbade the marriage of senators with women who had followed the stage, this law was repealed. Thereupon Justinian married Theodora. They were some time after (527) admitted by Justin to a share in the sovereignty; and, on his death four months later, Justinian and Theodora became sole rulers of the Roman world He was then about forty-four years of age, and she some twenty years younger. Procopius relates in his unpublished history ('Ἀνέκδοτα) many repulsive tales regarding Theodora's early life, but his evident hatred of her, though she had been more than ten years dead when the *Anecdota* were written, and the extravagances which the book contains, oblige us to regard him as a very doubtful witness. James Bryce discovered in Rome what is believed to be the only ms. of this so-called life of Justinian; he considered it worthless as an authority.

Theodora speedily acquired unbounded influence over her husband. She had a right to interfere, for she was not merely his consort, but empress regnant. In the most terrible crisis of Justinian's reign, the great Nika insurrection of 532, her courage and firmness in refusing to fly when the rebels were attacking the palace saved her husband's crown, and no doubt strengthened her command over his mind Officials took an oath of allegiance to her as well as to the emperor (*Nov.*, viii.) Procopius describes her as acting with the greatest cruelties The city was full of her spies, who reported to her everything said against herself or the administration She surrounded herself with ceremonious pomp, and required all who approached to abase themselves in a manner new even to that half-Oriental court. She constituted herself the protectress of faithless wives against outraged husbands, yet professed great zeal for the moral reformation of the city, enforcing severely the laws against vice, and immuring in a "house of repentance" on the Asiatic side of the Bosphorus five hundred courtesans whom she had swept out of the streets of the capital. How much of all this is true we have no means of determining,

for it rests on the sole word of Procopius. But there are slight indications in other writers that she had a reputation for severity.

In the religious strife which distracted the empire Theodora took part with the Monophysites. As Justinian was a warm upholder of the decrees of Chalcedon, this difference of the royal pair excited much remark and indeed much suspicion, and if it is true that Theodora disapproved of Justinian's western conquests, her judgment must be acknowledged to have been correct. In other matters also the wife spoke and acted very differently from the husband; but their differences do not seem to have disturbed either his affection or his confidence.

Theodora bore to Justinian no son, but one daughter—at least it would seem that her grandson, who is twice mentioned, was the offspring of a legitimate daughter, whose name, however, is not given. According to Procopius, she had before her marriage become the mother of a son, who when grown up returned from Arabia, revealed himself to her, and forthwith disappeared for ever; but this is a story to be received with distrust. That her behaviour as a wife was irreproachable may be gathered from the fact that Procopius mentions only one scandal affecting it, and that with some hesitation, the case of Areobindus. Her health was delicate, and, though she took all possible care of it, frequently quitting the capital for the seclusion of her villas on the Asiatic shore, she died comparatively young. Theodora was small in stature and rather pale, but with a graceful figure, beautiful features, and a piercing glance. There remains in the apse of the famous church of S. Vitale at Ravenna a contemporaneous mosaic portrait of her, to which the artist, notwithstanding the stiffness of the material, has succeeded in giving some character.

Nearly all the evidence against Theodora is derived from the violently-written *Anecdota* of Procopius, and has therefore been suspected. (*See* esp. Débidour's *L'Impératrice Théodora*.) Modern researches, particularly those of Panchenko, the Russian scholar, have vindicated the general credibility of Procopius. Of course, he can frequently be convicted of unfairness; he always attributes the worst motives. His description of the profligacy of Theodora only proves his familiarity with the pornography of Constantinople. But it rests on the solid witness of John of Ephesus that Theodora's youth was disreputable. We gather too from other writers that she was by no means tyrannical, as, for instance, from the references to her in the lives of the popes in the *Liber Pontificalis* (which used to pass under the name of Anastasius, the papal librarian) Her threat to the person whom she commanded to bring Vigilius to her was "nisi hoc feceris, per Viventem in saecula excoriari te faciam." Much of what we find in these lives is legendary, but they are some evidence of Theodora's reputation. Again, (3) the statute (*Cod*, v. 4, 23) which repeals the older law so far as relates to *scenicae mulieres* is now generally attributed to Justin, and agrees with the statement of Procopius that an alteration of the law was made to legalize her marriage. There is therefore reason for holding that she was an actress. About the beauty, the intellectual gifts, and the imperious will of Theodora there can be no doubt. She was evidently an extraordinary person, born to shine in any station of life.

Her fortunes have employed many pens. Among the later serious works dealing with them may be mentioned M. Antonin Débidour's *L'Impératrice Théodora: Étude Critique* (1885), which endeavours to vindicate her from the aspersions of Procopius; and among more imaginative writings are Sir Henry Pottinger's interesting romance *Blue and Green* (1879), M. Rhangabé's tragedy Θεοδώρα (Leipzig, 1884), and M. Sardou's play *Théodora*, produced in Paris in 1884. *See* also Dr. F. Dahn's *Prokopius von Cäsarea* (1865) and B. Panchenko in "Vizant Vremennik" vols. ii, iii and, in addition, the works cited under JUSTINIAN I.

THEODORE, the name of two popes. Theodore I., pope from November 642 till May 649, succeeded John IV. He was the son of a bishop, and was born in Jerusalem. A zealous opponent of monothelitism, in the course of the protracted controversy he in a Roman synod excommunicated Pyrrhus, patriarch of Constantinople, and signed the document with ink mingled with consecrated wine. Theodore II. had a pontificate of only twenty days (Nov.–Dec. 897).

THEODORE I. (1557–1598), tsar of Russia, the son of Ivan the Terrible and Anastasia Romanova, nominally succeeded his father in 1584, but being of weak intellect was governed throughout his reign by the boyar, Boris Godunov, whose sister Irene he married in 1580. On his death-bed he is said to have left the throne to his consort, with the Patriarch Job, Boris Godunov, and Theodore Romanov, afterwards the Patriarch Philaret, as her chief counsellors. Irene, however, retired into a monastery and her brother Boris stepped into her place.

THEODORE II. (1589–1605), tsar of Russia, was the son of Tsar Boris Godunov and one of the daughters of Malyuta-Skuratov, the infamous favourite of Ivan the Terrible. Passionately beloved by his father, he received the best available education for those days, and from childhood was initiated into all the *minutiae* of government, besides sitting regularly in the council and receiving the foreign envoys. He seems to have been precociously intelligent, and the first map of Russia by a native, still preserved, is by his hand. On the sudden death of Boris he was proclaimed tsar (April 13, 1605). On July 10, he was murdered in his apartments in the Kremlin.

THEODORE III. (1661–1682), tsar of Russia, was the eldest surviving son of Tsar Alexius and Maria Miloslavskaya. In 1676 he succeeded his father. He had received an excellent education at the hands of Simeon Polotsky, the most learned Slavonic monk of the day, knew Polish, and even possessed the unusual accomplishment of Latin; but, disfigured and half paralyzed by disease, he had been an invalid from his birth. In 1679 he married his first cousin Agatha and assumed the sceptre. His native energy was not crushed by his disabilities; and he soon proved as thorough a reformer as a man incompetent to lead armies and obliged to issue his orders from his litter, or his bed-chamber, could be. His consort, Agatha, shared his progressive views. On her death (July 4, 1681) Theodore married Martha Apraksina. He died on April 27, 1682, without issue.

THEODORE (602–690), seventh archbishop of Canterbury, was born at Tarsus in Cilicia in 602. On the death of Wighard, who had been sent to Pope Vitalian by Ecgberht of Kent and Oswio of Northumbria in 667, apparently for consecration as archbishop, Theodore, who had become prominent in the Eastern work of the church, was recommended by Hadrian of Niridanum to fill the vacant see. Vitalian consecrated Theodore in April 668 on condition that Hadrian, afterwards abbot of St. Peter's, Canterbury, should go with him. Hadrian was detained for some time by Ebroin, the Neustrian mayor of the palace, but Theodore reached England in May 669. According to Bede's account he made a tour of the whole of Anglo-Saxon England, reforming abuses and giving instruction as to the monastic rule and the canonical Easter. Bede also declares that he was the first archbishop to whom all the "church of the Angles" submitted.

In 673 Theodore presided at the first synod of the clergy in England which was held at Hertford. Various disciplinary regulations were emphasized, and an annual meeting arranged at a place called Cloveshoe. After this council Theodore revived the East Saxon bishopric, to which he appointed Earconwald. Soon after the first expulsion of Wilfrid in 678 he divided the Northumbrian diocese, appointing Trumwine bishop to the Picts. This led to a quarrel with Wilfrid which was not finally settled until 686–687. In 679 Theodore intervened to make peace between Ecgfrith of Northumbria and Aethelred of Mercia. He presided at other synods held in 680 at Hatfield and in 684 at Twyford, and died in 690. A penitential composed under Theodore's direction is still extant.

See Bede, *Hist. Eccl.*, edited by C. Plummer (Oxford, 1896); Eddius, *Vita Wilfridi* in J. Raine's *Historians of the Church of York*, vol. i. (London, 1879); *Anglo-Saxon Chronicle*, edited by Earle and Plummer (Oxford, 1899); Haddan and Stubbs, *Councils and Ecclesiastical Documents* (Oxford, 1869–78), iii. 173–213.

THEODORE LASCARIS (d. 1222), emperor of Nicaea, was born of a noble Byzantine family. He became the son-in-law of the emperor Alexius III. and distinguished himself during the sieges of Constantinople by the Latins (1203–04). After the capture of the city he gathered a band of fugitives in Bithynia and established himself in the town of Nicaea. Relieved of the danger of invasion, owing to an incursion of Bulgarians into the Latin empire, he set to work to form a new Byzantine state in

Asia Minor, and in 1206 assumed the title of emperor. He defended himself stubbornly against the Latin emperor Henry, defeated his rival Alexius Comnenus of Trebizond, and carried out a successful counter-attack upon Gayath-ed-din, the sultan of Konuah. His crowning victory was gained in 1210, when in a battle near Pisidian Antioch he captured the deposed emperor Alexius III. and wrested the town itself from the Turks.

See A. Meliarakes, Ἱστορία τοῦ Βασιλείου τῆς Νικαίας καὶ τοῦ Δεσποτάτου τῆς Ἠπείρου (Athens, 1898).

Theodore's grandson, THEODORE II. (Lascaris), emperor from 1254 to 1258, is chiefly noticeable for two brilliant campaigns by which he recovered Thrace from the Bulgarians (1255–56). His ill-health and early death prevented his making full use of his ability as a ruler.

THEODORE OF MOPSUESTIA (*c.* 350–428/9), early Christian theologian, the most eminent representative of the so-called school of Antioch, was born at Antioch about the middle of the 4th century and was a friend of John Chrysostom; in rhetoric the celebrated Libanius was his teacher. Soon, however, he attached himself to the school of the great exegete and ascetic, Diodorus, a presbyter in Antioch, and with only a transitory period of vacillation, from which he was won back by Chrysostom, he remained faithful to the theology and ascetic discipline of this master. Under Diodorus he became a skilful exegete, and ultimately outstripped his master in biblical learning. About 383 Theodore became a presbyter in Antioch, and began to write against Eunomius the Arian and against the christology of Apollinaris. Soon after 392 he became bishop of Mopsuestia in Cilicia (the modern Missis near Adana). As such he was held in great respect, and took part in several synods, with a reputation for orthodoxy that was never questioned. It was greatly to his advantage that in the Eastern Church the period between the years 390 and 428 was one of comparative repose. He was on friendly terms even with Cyril of Alexandria. He died in 428 or 429.

Theodore wrote commentaries on almost every book of the Old and New Testaments, of which, however, only a small proportion is now extant, as at a later period he lost credit in the church. We still possess in Greek his commentary on the Minor Prophets, in a Syriac version his commentary on St John[1], and, in Latin translations, commentaries on the shorter Pauline epistles, besides very many fragments, especially on the epistle to the Romans. Theodore's importance as an exegete lies in two characteristics: (1) in opposition to the allegorical method he insists on getting at the literal meaning, and adheres to it when found; (2) in his interpretation of the Scriptures he takes into account the historical circumstances in which they were produced, and substitutes the historical-typological for the pneumatico-christological interpretation of prophecy; in other words, he interprets all Old Testament passages historically in the first instance, and sees the fulfilment of Old Testament prophecy in the history of Christ and His church only in so far as the entire Old Testament is a "shadow of things to come."

Theodore also was the author of a special dissertation against the allegorists, *i.e.*, against Origen and his followers, which, however, has unfortunately perished. The comparative freedom of Theodore's view of inspiration is also noteworthy. He discriminates between historical, prophetical and didactic writings, and in accordance with this distinction assumes varying degrees of inspiration. Finally, he entertained very bold opinions about the canon and several of the books included in it. He esteemed very lightly the Solomonic writings and the book of Job; Canticles he explained as a nuptial poem of Solomon's; the book of Job appeared to him in many places hardly worthy of its subject, and he censures the writer sharply; Chronicles, Ezra and Nehemiah he entirely rejected; he denied the accuracy of the titles of the Psalms, anticipated the hypothesis that many of them belong to the Maccabean age, and referred the so-called Messianic element almost invariably to the kings of Israel; he even criticized the Catholic epistles and rejected the epistle of James. Characteristics such as these bring Theodore, of all patristic writers, nearest to the modern spirit.

[1] Ed. P. B. Chabot (Paris, 1897).

LITERATURE.—Migne, *Patrol.*, ser. Gr, lxvi. The Greek fragments of Theodore's New Testament commentaries have been collected by O. Fr. Fritzsche (*Theod. Mops. in N.T. Comm*, Turm, 1847). The commentaries on the Pauline epistles (Pitra, *Spicilegium Solesmense*, Paris, 1852, i. 49 *seq.*) have been edited by H. B. Swete (*Theod. Mops. in Epp. B. Pauli Comm.*, i., ii., Cambridge, 1880–82), along with the Greek fragments and the fragments of the dogmatical writings, on this edition, *see* E. Schürer, *Theol. Lit. Ztg.*, 1880–82. The commentary on the Minor Prophets will be found in Mai's *Nov. Patr. Biblioth.*, vii. 1854 (Berlin, 1834; Mai, *Script. Vet. Nov. Coll.*, vi., 1832). *See* also E. Sachau, *Theod. Mops. Fragm. Syriaca* (Leipzig, 1869); Fr. Bathgen, "Der Psalmencommentar des Theod. v. Mops. in Syr. Inaugural-Beitrag," in *Ztschr. f. Alt-Test. Wissensch.*, v. 53 *seq.*, vi., 1–288, vii. 1–60; and H. Lietzmann in *Sitzungsberichte der Kgl preuss. Akad. der Wissensch., zu Berlin*, 1902, pp. 334 *seq.* Extracts from the writings of Theodore occur in the *Catenae* of Marus Mercator, in the *Acta* of the third and fifth oecumenical councils in Facundus, Liberatus, and Theodore's chief adversary Leontius Byzantinus. E. von Dobschutz, in *Amer. Journ. of Theol*, ii. 353–387, published the Greek prologue of a commentary on *Acts* that is probably the work of Theodore.

The principal monograph on Theodore, apart from the prolegomena of Swete, and the same writer's article in *Dict. Christian Biog.*, iv. (1887), is that of H. Kihn (*Th. v. Mops. u. Junilius Afric. als Exegeten*, Freiburg, 1880). On his importance for the history of dogma *see* the works of Baur, Dorner, Harnack, Loofs and Seeberg. Literary and biographical details will be found in O. Fr. Fritzsche, *De Theod Mops. Vita et Scriptis* (Halle, 1836), F. A. Specht, *Theod. v. Mops u. Theodoret* (Munich, 1871); H. Kihn in the *Tub. Quartalschr.*, 1879; E. Nestle in *Theol. Stud. aus Würtemb.*, ii. 210 *seq.*; P. Batiffol, "Sur une Traduction Latine de Th. de Mops.," in *Ann. de Philos Chrét.*, 1885; Th. Zahn, "Das N. T. Theodors von Mop.," in *Neue Kirchl. Zeitschr.*, 1892, 788–806; W. Wright, *Syriac Literature* (London, 1894); R. Duval, *La littérature syriaque* (Paris, 1899).

(A. HA.; X.)

THEODORET, bishop of Cyrrhus, an important writer in the domains of exegesis, dogmatic theology, church history and ascetic theology, was born in Antioch, Syria, about 386. At an early age he entered the cloister; and in 423 he became bishop of Cyrrhus, a small city in a wild district between Antioch and the Euphrates, where, except for a short period of exile, he spent the remainder of his life. The date of his death is uncertain, but it must have been not earlier than 457.

Commentaries.—As an exegete Theodoret belongs to the Antiochene school, of which Diodorus of Tarsus and Theodore of Mopsuestia were the heads. He was not actually the personal disciple of either, but he adopted their methods, though without the consistency and boldness of the first-named. His extant commentaries (those on Canticles, on the Prophets, on the book of Psalms and on the Pauline epistles) are brief.

Dogmatic Works.—Theodoret's chief importance is as a dogmatic theologian, as the most considerable opponent of the views of Cyril and Dioscurus of Alexandria. For more than twenty years he maintained the struggle against the Alexandrian dogmatic and its formulae (θεοτόκος, ἕνωσις καθ' ὑπόστασιν, μία ὑπόστασις ἔνωσις φυσική, and the like), and taught that in the person of Christ we must strictly distinguish two natures (*hypostases*), which are united indeed in one person (*prosopon*), but are not amalgamated in essence. For these years his history coincides with that of the Eastern Church from 430 to 451, and for this very reason it is impossible to sketch it even briefly here. (*See* Hefele, *Conc.-gesch.*, vol. ii.) The issue was not unfavourable to Theodoret's cause, but melancholy enough for Theodoret himself: the council of Chalcedon condemned monophysitism, but he unhappily yielded to pressure so far as also to take part in pronouncing "anathema upon Nestorius, and upon all who shall not the Holy Virgin Mother of God, and who divide the one Son into two."

Some of Theodoret's dogmatic works are no longer extant: of his five books *On The Incarnation*, for example, directed against Cyril after the council of Ephesus, we now possess fragments merely. A good deal of what passes under his name has been wrongly attributed to him. Certainly genuine are the refutation (Ἀνατροπή) of Cyril's twelve ἀναθεματισμοί of Nestorius, and *The Mendicant*, or Πολύμορφος (written about 446), consisting of three dialogues, entitled respectively *Immutability*, *Inconfusibility* and *Apathy*, in which the monophysitism of Cyril is opposed, and its Apollinarian character insisted on. Among the apologetico-

dogmatic works of Theodoret must be reckoned his ten discourses *On Providence*.

Other Works.—The 30 ascetic biographies of his *Religious History*, which has been widely read, form a pendant to the *Historia Lausaica* of Palladius and the monkish tales of Sozomen. For the East it has had the same importance as the similar writings of Jerome, Sulpicius Severus and Cassian for the West.

BIBLIOGRAPHY.—The edition of Sirmond (Paris, 1642) was afterwards completed by Garnier (1684), who has also written dissertations on the author's works. Schulze and Nosselt published a new edition (6 vols., Halle, 1769–74) based on that of their predecessors, a glossary was afterwards added by Bauer. The reprint will be found in vols lxxx.–lxxxiv. of Migne, and considerable portions occur in Mansi. The church history has been published frequently in connection with the histories of Socrates, Sozomen and others, e.g., by Valesius (1693) and Reading (1720). There is an English translation of the history by Bloomfield Jackson in the *Nicene and Post-Nicene Fathers*, series ii., vol. iii.; the translation including also the dialogues and letters.

Besides the earlier labours of Tillemont, Cellier Oudin, Du Pin and Fabricius and Harless, *see* Schrockh, *Kirchengesch.*, vol. xviii; Hefele, *Conc.-gesch.*, vol ii.; Richter, *De Theodoreto Epp Paul. Interprete* (Leipzig, 1821); Binder, *Etudes sur Théodoret* (Geneva, 1844), Stäudlin, *Gesch u Lit. der Kirchengesch* (Hannover, 1827); Kihn, *Die Bedeutung der antioch. Schule* (1866); Diestel, *Das A. T. in der christl Kirche* (Jena, 1869); Specht, *Theodor v Mopsuestia u Theodoret v. Cyrus* (Munch, 1871); Roos, *De Theodorito Clementis et Eusebii Compilatore* (Halle, 1883); Nöite in the *Tübing. Quartalschr.* (1859), p. 302 *seq*; Möller, art. "Theodoret," in Herzog-Hauck's *Realencykl.*; Venables's article in Smith and Wace's *Dict of Christian Biography*; also Bardenhewer's *Patrologie*, p. 345 ff. (A. HA.; X.)

THEODORIC, king of the Ostrogoths (*c.* 454–526). Referring to the article GOTHS for a general statement of the position of this, the greatest ruler that the Gothic nation produced, we add here some details of a more personal kind. Theodoric was born about the year 454, and was the son of Theudemir, one of three brothers who reigned over the East Goths, at that time settled in Pannonia. The name of Theodoric's mother was Ereleva, and she is called the concubine of Theudemir. The Byzantine historians generally call him son of Walamir, apparently because the latter was the best known member of the royal fraternity. At the age of seven he was sent as a hostage to the court of Constantinople, and there spent ten years of his life. Soon after his return to his father he secretly attacked the king of the Sarmatians, and wrested from him the important city of Singidunum (Belgrade). Theodoric took the chief part in an expedition into Moesia and Macedonia, the result of which was to settle the Ostrogoths as *foederati* in the heart of the empire. About 474 Theudemir died, and for the fourteen following years Theodoric was chiefly engaged in a series of profitless wars, partly against the emperor Zeno, but partly against a rival Gothic chieftain, another Theodoric, son of Triarius. In 488 he set out, with the sanction of the emperor, to win Italy from Odoacer. The invasion and conquest of Italy occupied more than four years (488–493). Theodoric, who marched round the head of the Venetian Gulf, had to fight a fierce battle with the Gepidae, probably in the valley of the Save. At the Sontius (Isonzo) he found his passage barred by Odoacer, over whom he gained a complete victory (28th of August 489). A yet more decisive victory followed on the 30th September at Verona. Odoacer fled to Ravenna, and it seemed as if the conquest of Italy was complete. At length (26th of February 493) the long and severe blockade of Ravenna was ended by a capitulation, the terms of which Theodoric disgracefully violated by slaying Odoacer with his own hand (15th of March 493). (*See* ODOACER.)

The thirty-three years' reign of Theodoric was a time of unexampled happiness for Italy. Unbroken peace reigned within her borders (with the exception of a trifling raid made by Byzantine corsairs in 508). The venality of the Roman officials and the turbulence of the Gothic nobles were sternly repressed. Marshes were drained, harbours formed, the burden of the taxes lightened, and the state of agriculture so much improved that Italy, from a corn-importing, became a corn-exporting country. Moreover Theodoric, though adhering to the Arian creed of his forefathers, was during the greater part of his reign conspicuously impartial in religious matters. At the time of the contested papal election between Symmachus and Laurentius (496–502), Theodoric's mediation was welcomed by both contending parties. At the close of his reign (524), the emperor Justin's persecution of the Arians led him into a policy of reprisals. He forced Pope John to undertake a mission to Constantinople to plead for toleration, and on his return threw him into prison, where he died. Above all, he sullied his fame by the execution of Boethius and Symmachus. (*See* BOETHIUS, ANICIUS MANLIUS SEVERINUS.) Theodoric's death, which is said to have been hastened by remorse for the execution of Symmachus, occurred Aug 30, 526. He was buried in the mausoleum which is one of the marvels of Ravenna (*q v.*), and his grandson Athalaric, a boy of ten years, succeeded him, under the regency of his mother Amalasuntha.

AUTHORITIES.—The most important source for Theodoric's life reign (ed. in *Monumenta Germaniae Historica*, vol. xii.) is the *Variae* (state-papers) of Cassiodorus, chief minister of Theodoric. The most modern work is Hartmann's *Geschichte Italiens im Mittelalter*, vol. i. (Stuttgart, 1923). The English reader may consult Gibbon's *Decline and Fall*, chap. xxxix., and Hodgkin's *Italy and her Invaders*, vol. iii. (1885), his introduction to *Letters of Cassiodorus* (1886) and *Theodoric the Goth* (London and New York, 1891).

THEODORUS STUDĪTA [Theodore of the Studion] (A.D. 759–826), abbot of the monastery of the Studion, Constantinople, succeeded his uncle Plato, as head of the monastery of Saccudium in Bithynia in 794. He was banished to Thessalonica in connection with the marriage of Constantine VI. After the emperor's death in 797 he was recalled and removed with his monks to the monastery of the Studion in Constantinople, where he carried on a vigorous campaign in favour of asceticism and monastic reform. In 809 he was again banished in consequence of his refusal to hold communion with the patriarch Nicephorus, who had pardoned the priest Joseph for his part in the marriage of Constantine and Theodote. In 811 he was recalled by Michael Rhangabes, and again banished in 814 for his opposition to Leo the Iconoclast. He was liberated in 821 by the Emperor Michael the Stammerer (Balbus). In 824 he violently attacked Michael for iconoclasm and was forced to leave Constantinople. He lived at various monasteries until his death on Nov. 11, 826. He was buried at Chalcitis, but his body was afterwards (Jan. 26, 844) removed to the Studion. He subsequently received the honours of canonization. Of his extant works the following are the most important:—The three Λόγοι ἀντιρρητικοί and other works in defence of images and his *Letters*. He was also the composer of hymns; many of which are still extant. Like all the monks of the Studion, Theodore was famous for his calligraphy and industry in copying mss.

BIBLIOGRAPHY.—General edition of his works in J. P. Migne, *Patrologiæ Græca*, xcix., to be supplemented (for the *Letters*) by J. Cozza-Luzzi, *Patrum Nova Bibliotheca*, viii. (1871); hymns in J. B. Pitra, *Analecta Sacra*, i. (1876). *See* also Alice Gardner, *Theodore of Studium: his Life and Times* (1905). For further bibliographical details *see* C. Krumbacher, *Gesch. der byz. Lit.* (2nd ed., 1897) and article by Von Dobschütz in Herzog-Hauck's *Realencyclopädie für protestantische Theologie*, xix. (1907).

THEODOSIA, formerly Kaffa, a seaport and watering-place of South Russia, on the east coast of the Crimea, in 45° 3′ N., 35° 22′ E., and on the railway. It has an excellent modern harbour, which is never frozen and has a floating crane lifting 40 to 50 tons. Pop. (1939) 48,200.

The ancient Theodosia, the native name of which was Ardabda, was a colony founded from Miletus. Archaic terra-cottas show it to have been inhabited in the 6th century B.C., but it is first heard of in history as resisting the attacks of Satyrus, ruler of the Cimmerian Bosporus, *c.* 390 B.C. His successor Leucon took it and made it a great port for shipping wheat to Greece, especially to Athens. This export of wheat continued until the days of Mithradates VI. of Pontus, against whom the city revolted. Later it became a special part of the Bosporan kingdom with its own governor. In the 3rd century A.D. it was still inhabited, but seems to have been deserted not long afterwards. Besides the terra-cottas and pottery, very beautiful Greek jewellery has been found near Theodosia. It coined silver and copper during the 5th and 4th centuries B.C. The name Kaffa (Genoese *Caffa*, Turk *Kefe*) is first mentioned in the 9th century. The Genoese established themselves on the site shortly after 1266, and the settlement flourished exceedingly, being the depôt of a trade route reaching

China It became the head of the Genoese establishments in aria, the sec of a bishop, and the chief port on the northern e of the Black sea, surpassing the Venetian Tana. When the ks took Constantinople the colony was almost cut off from mother city, which handed it over to the enterprising bank of George; but it could not be saved and fell in 1475 to the ks, who sometimes called it Kuchuk-Stambul (Little Stambul) Constantinople, or Krym-Stambul (Stambul of Crimea). In r it was taken by the Russians, and in 1783 annexed by them, reupon the greater part of its population deserted it.

se E von Stern, *Theodosia* (German and Russian, 1906); E. H. ns, *Scythians and Greeks* (1909); *M* Rostovtzeff, *Iranians and eks in South Russia* (1922); for the history of Kaffa, *see* Heyd, *oire du commerce du Levant au moyen âge* (1886).

THEODOSIUS, the name of three Roman emperors of the t.

THEODOSIUS I., "the Great," son of Theodosius, Valentinian's it general, who in 368–69 saved Britain from the Picts, and pressed the revolt of Firmus in Mauretania (372). Shortly r (376), the elder Theodosius was put to death, perhaps by er of Valens. The younger Theodosius was born about the year . He was a native of Spain, but the exact place of his birth ncertain. He accompanied his father into Britain (368), and a e later defeated the Sarmatians who had invaded Moesia 4). On his father's death he retired to his native place, where lived quietly till after the great battle of Adrianople (Aug. 9,), when Gratian summoned him to share the empire. After ning some fresh victories over the Sarmatians, Theodosius was de Augustus at Sirmium on Jan. 19, 379, and was assigned all eastern provinces, including part of Illyricum. In 379 Theodius, after reorganizing the army at Thessalonica, carried on a cessful campaign of skirmishes along the Danube and induced nerous Gothic bands to give in their allegiance; his lieutenant odares, a Gothic refugee, defeated the invaders severely in race. In 381 he was called upon to meet two armies of invaders. conducted in person the war against the Visigoths under itigern, this campaign, being only ended by Fritigern's death. e defence of the Danube against the Ostrogoths under Alatheus d Safrax was entrusted to the general Promotus, who severely feated the enemy in an attempt to cross the river. Theodosius tained even greater successes by his diplomacy. He persuaded e fugitive Visigoth king Athanaric to enter his service, and ested 40,000 of his former enemies as *foederati*, providing them ith settlements in various parts of the realm.

In 383 Theodosius created his eldest son Arcadius Augustus. The same year saw the revolt of Maximus in Britain and the murder of Gratian. For five years Theodosius consented to accept the usurper as his colleague; but when Maximus attempted a few years later to make himself master of Italy Theodosius advanced against the invader and overthrew him near Aquileia (July 28, 388). This victory was followed by the murder of Maximus and his son Victor, after whose death Theodosius conferred upon Valentinian II. all that part of the empire which his father had held. After celebrating a triumph in Rome (389) he stayed to arrange the government of Italy for another two years. If we may trust the evidence of Zosimus, from the end of the year 388 Theodosius resigned himself to gluttony and voluptuous living, from which he was only roused by the news that in the Western empire Arbogast had slain the young Emperor Valentinian and set up the grammarian Eugenius in his stead (May 15, 392).

Theodosius at once marched out against Eugenius. The armies met near the river Frigidus, some thirty-six miles distant from Aquileia. On the first day Theodosius' barbarians, engaging with those of the hostile army, were almost destroyed, and the victory seemed to be with Eugenius. After a night of prayer, towards cockcrow the emperor was cheered by a vision of St Philip and St. John, who, mounted on white steeds, promised him success. On the second day the issue was doubtful till, if we may trust the concurrent testimony of all the contemporary church historians, a sudden gust of wind blew back the enemy's arrows on themselves This was the turning-point of the battle: Eugenius was slain by the soldiers; and two days later Arbogast committed suicide (Sept 5–9, 394). From the north-eastern parts of Italy Theodosius passed to Rome, where he had his son Honorius proclaimed emperor under the guardianship of Stilicho Thence he retired to Milan, where he died of dropsy (Jan 17, 395), leaving the empire to be divided between his two sons Honorius and Arcadius

The chief authorities for the age of Theodosius are Ammianus Marcellinus, Zosimus, Eunapius and the ecclesastical historians (Socrates, Sozomen, Theodoret). Much information may also be gleaned from the writings of St Ambrose, St Gregory of Nazianzus, Isidore of Seville, and the orators Pacatus, Libanius, Themistius. Among modern authorities see: E Gibbon, *The Decline and Fall of the Roman Empire* (ed Bury, 1909), chaps. 25 and 27, T. Hodgkin, *Italy and her Invaders* (Oxford, 1892), chaps 5, 6, 8–11, A Güldenpenning and J. Ilfand, *Der Kaiser Theodosius der Grosse* (Halle, 1878); G. R. Sievers, *Studien zur Geschichte der römischen Kaiser* (Berlin, 1870), pp. 283–333, and Van Ortroy, *St. Ambroise et l'Empereur Théodose*, Analecta Bollandiana (1904).

THEODOSIUS II. (401–450) succeeded his father Arcadius as emperor of the East in 408. During his minority the empire was ably ruled by the praetorian prefect Anthemius and Pulcheria, who became her brother's guardian in 414. Under his sister's care the young emperor grew up into a weak though amiable character. Through his generals Ardoburius and Aspar he waged two fairly successful wars against the Persians (421 and 441), and after the failure of one expedition (431) by means of a gigantic fleet put an end to the piracies of the Vandal Genseric A Hunnish invasion in 408 was skilfully repelled, but from 441 the Balkan country was repeatedly overrun by the armies of Attila, whose incursions Theodosius feebly attempted to buy off with ever-increasing payments of tribute. His internal administration was upright and thoughtful. Among its chief events may be mentioned the council of Ephesus (434) and the publication of the *Codex Theodosianus* (438), a collection of imperial constitutions for the benefit of public officials. Theodosius died in 450.

See E. Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, London, 1909) 406–414; 440–470; J. B Bury, *Later Roman Empire*, vol. i. (1923); A. Güldenpenning, *Geschichte des oströmischen Reiches unter den Kaisern Arkadius und Theodosius II.* (Halle, 1885), pp. 172 *sqq*; T. Mommsen and P. Meyer, *Theodosii libri XVI.* (Berlin, 1904–05, in course of revision by E. Kiegel, 1926).

THEODOSIUS III., emperor of the East (716–717), was a financial officer whom a Byzantine army rebelling against Anastasius III. unexpectedly proclaimed monarch in his stead. He captured Constantinople after a six months' siege and deposed Anastasius, but in the following year was himself forced to resign by a new usurper, Leo III (*see* LEO III., THE ISAURIAN). Theodosius ended his life in a monastery. 64110

See G. Finlay, *History of Greece* (ed. 1877, Oxford), i. p. 396).

THEODOSIUS, Greek geometer and astronomer, was the author of three works included in the collection of treatises known as the "Little Astronomy" or "Astronomer" (*ὁ μικρὸς ἀστρονόμενος* or *ἀστρονόμος*). He was not "of Tripolis," but came from Bithynia, as we gather from Strabo, who mentions, among natives of Bithynia famous for their learning, "Hipparchus, Theodosius and his sons, mathematicians"; he is also evidently the Theodosius mentioned by Vitruvius as the inventor of a universal sun-dial (*horologium πρὸς πᾶν κλίμα*). He lived, therefore, not later than the 1st century B.C.

His chief work, the *Sphaerica*, in three books, is a tolerably complete treatise on the pure geometry of the sphere, and was still the classical book on the subject in Pappus's time. It does not contain (except for a faint suggestion in iii. 11–12) any trace of spherical trigonometry, which, on the other hand, was the special subject of the work with the same title by Menelaus of Alexandria, who lived at the end of the 1st century.

From the fact that both Autolycus of Pitane in his *Moving Sphere* and Euclid in his *Phaenomena* assume without proof various propositions given by Theodosius, we conclude that already in the 4th century B.C. there existed a textbook on *Sphaerica* scarcely differing, in its essential contents, from Theodosius's work; the rôle of Theodosius was therefore mainly that of editor and elaborator of previously existing material. The *Sphaerica* was translated into Arabic in the 9th century, in part by Qusṭa b. Lūqā, and

in part by Thābit b Qurra Latin translations were made from the Arabic in the 12th century by Plato of Tivoli (Tiburtinus) and Gherard of Cremona, and various editions in Latin appeared from 1518 onwards, including one by Barrow (*Theodosii Sphaerica, Methodo Novo Illustrata et Succincte demonstrata*, London, 1675). We now have a definitive Greek text (with Latin translation) by J. L. Heiberg (Berlin, 1927).

The two other works of Theodosius which have come down to us were first published in a Latin translation by Joseph Auria, *On Days and Nights*, in two books (with scholia, etc.) in 1591, and the tract *On Habitations* (Περὶ οἰκήσεων) in 1587 (Rome), a critical edition of the Greek text of both (with Latin translation) by Rudolf Fecht appeared in Berlin in 1927. (T. L. H.)

THEODULF, bishop of Orleans, was born about the middle of the 8th century, of a noble family of Gothic extraction, probably in Spain. He was made abbot of Fleury and of Saint-Aignan, and in 781 became bishop of Orleans. He supported Charlemagne's principles of government and educational reforms; he established schools, and was a member of the learned circle which graced the Carolingian court. In 798 he was appointed *missus dominicus*, and two years later performed so great services for Leo III. as judge in the cause between the pope and his enemies, that he returned from Rome with the pallium. After the death of Alcuin he became the king's principal theological adviser; it was he who made, on Charlemagne's request, a collection of the opinions of the fathers on the much-disputed point of the procession of the Holy Ghost. After the death of Charlemagne, he was accused, probably quite unjustly, of having taken part in the conspiracy of Bernard of Italy, and in 818 was deposed and imprisoned in a monastery at Angers. He died in prison, probably from poison, in 821.

The complete works of Theodulf are in J. P. Migne, *Patrol. Lat.*, vol. 105 (Paris, 1851). The best edition of his poetry is that of E. Dummler in the *Mon. Germ. Hist. Poetae latini aevi carolini*, vol. I. (Berlin, 1881).

See C. Cuissard, *Théodulphe évêque d'Orléans, sa vie et ses oeuvres*, (Orleans, 1892), and a critical study of the writings by M. Manitius in *Neues Archiv der Ges. für ä. deutsche Gesch.* xi. (1886).

THEOGNIS OF MEGARA (6th century B.C.), Greek poet. More than half the elegiac poetry of Greece before the Alexandrian period is included in the 1,400 lines ascribed to Theognis. This collection contains several poems acknowledged to have been composed by Tyrtaeus, Mimnermus and Solon; with two exceptions (T. W. Allen in *Classical Review*, Nov. 1905, and E. Harrison) modern critics unanimously regard these elegies as intruders, that is, not admitted into his works by Theognis himself; for this and other reasons they assume the existence of further interpolations which we can no longer detect.

The best-attested elegies are those addressed to Cyrnus, the young friend to whom Theognis imparts instruction in the ways of life, bidding him be true to the "good" cause, eschew the company of "evil" men (democrats), be loyal to his comrades, and wreak cruel vengeance on his foes. Theognis lived at Megara on the Isthmus of Corinth during the democratic revolution in the 6th century B.C.; some critics hold that he witnessed the "Persian terror" of 500 and 480; others, including the present writer, place his *floruit* in 545 B.C.

There is neither profound thought nor sublime poetry in the work of Theognis; but it is full of sound common-sense embodied in exquisitely simple, concise and well-balanced verse. In his day verse was the recognized vehicle for political and ethical discussion, and the gnomic poets were in many ways the precursors of the philosophers and the sophists, who indeed often made their discourse turn on points raised by Theognis and his fellow-moralists. For many generations Theognis was to the Greeks the moralist *par excellence;* Isocrates says that Hesiod, Theognis and Phocylides were admitted to be the best teachers of practical morality; and the Emperor Julian in his defence of paganism asks whether "the most wise Solomon is equal to Phocylides or Theognis or Isocrates."

Besides the elegies to Cyrnus the Theognidea comprise much miscellaneous verse that may well have come from Theognis.

Editions by Imm. Bekker (1815, and ed. 1827); F. G. Welcker (1826), both these are epoch-making books which no serious student can ignore; Th. Bergk (1843, 4th ed. 1882; re-edited by E. Hiller, 1890, and O. Crusius, 1897), J. Sitzler (1888); E. Harrison, *Studies in Theognis*, with text (1902), T. Hudson-Williams (1910). For further bibliographical references *see* the two last-mentioned books. There is a prose translation by J. Banks in Bohn's Classical Library (1856), which also includes verse translations by J. Hookham Frere.

(T. H.-W.; X.)

THEOLOGICAL ARTICLES: *see* RELIGION AND THEOLOGY, ARTICLES ON.

THEOLOGY, in the comprehensive sense of the name, embraces so much of philosophy as is concerned with explanation of the world in terms of a supreme mind or spirit, with the being and attributes of the Deity and His relation to Nature and man and with the grounds and the limits of knowledge or belief as to such matters. It also includes the comparative study of religions and the psychology of religious experience. Specifically Christian theology, which is often what is denoted by the word "theology," sets forth the contents and implications of the revelation in Christ. It consists of a systematic exposition of doctrine and of the course of its development (*dogmatic theology* or *dogmatics*), the historical, critical and exegetical study of the Bible, and the history of the Church, its institutions, etc. Thus theology is a science, or a group of connected sciences, that, on the one hand, is in touch with general philosophy—as indicated by the name of the department called "philosophy of religion," or "philosophical theology"—and, on the other hand, is more or less isolable in that it deals with the deliverances of distinctively religious experience and its pre-eminent manifestations.

The Relation of Theology to Religious Experience.—It is commonly held that religious experience contains data other than those of natural knowledge, enabling it to possess insight into reality otherwise unattainable. And we may first note the implications of this belief in their bearing on the position of theology amongst other departments of thought such as natural science and philosophy. All natural knowledge, *i.e.*, knowledge of the physical world and mankind, is now generally believed by philosophers to be derived originally from the impressions of sense, between which the understanding establishes relations. Out of these relations are constructed the body of common-sense knowledge, the sciences and metaphysics. Sensory perception in the first instance, and then ideas distilled from percepts, evoke the feelings, desires and valuations, of which aesthetic and ethical sentiments and principles are the outcome. According to this science or theory of knowledge, then, religious beliefs and theological doctrines can only be mediated by reflection on the sensible world, the mind of man and human history. On the other hand it is often claimed by theologians that religious experience is founded on apprehension of another species of the objective than the sensory or the sense-derived, and on feelings, etc., induced thereby. This objective datum, evocative of unique emotional states and dispositions, is asserted to be apprehended with the same immediateness as is the sensory and so to afford a basis of knowledge about ultimate reality, independent of that on which the natural sciences are built.

If this view were beyond criticism, it would suffice to explain the uniqueness of religious experience and consequently the special characteristics of theology. And one ingredient in it certainly seems to be beyond reasonable doubt. This is that whatever there is, on the affective or emotional side of religious experience, that renders it an experience *sui generis*, or distinct from cognate kinds of experience, that peculiarity must be accounted for by the distinctiveness of the object or objects eliciting the subjective response. Religious experience, on its affective side, comprises sentiments such as loyalty and love, awe and adoration, none of which is peculiar to religion, but each of which differs somewhat from other instances of love, reverence, etc., solely in virtue of the object—deity—towards which the religious emotion is a response. Even those who incline to the opinion that there is one kind of valuation, viz., appreciation of sacredness, that is peculiar to religion throughout all the stages of its development, ascribe its peculiarity and its forthcomingness to the unique object that evokes it. But doubtfulness attaches to the

further representations that this sacred, numinous or supernatural object is immediately apprehended as such; that it is irreducibly different in psychological nature from the sensory, or rather from the image or the idea which are derived from the sensory, and that its apprehension involves a special faculty, not included among those known to ordinary psychology In the primitive stages of religion the supernatural object seems always to be lodged in some natural object or phenomenon, which inspired emotion such as awe, as is evinced in the notions of clean and unclean, worship of animals, the dead, etc Thus the numinous, or divine, reality, devoid of the concrete particularity that characterizes an immediate sensation or percept, and capable of entering into diverse mythologies and religions, seems rather to be of the nature of the vague generic image, derived by human imagination and idealization from impressive phenomena And it is not enough to point to the indubitable objectivity (in the psychological sense) of this alleged numinous reality. For images and ideas, as well as percepts, are also objective; and they are as potent as actualities or real things in eliciting valuation and emotional response, provided that belief in their reality is entertained Immediacy is a conception which plays important parts in connection with religion and theology; and attention may here be called to the ambiguity which lurks in it and is wont to be overlooked. At the moment when a particular experience, such as perceiving a familiar thing, takes place, we are not aware of performing any synthetic activities; the percept has the unity and the instantaneousness of a flash-photograph, and the whole act of perceiving seems as if unanalysable and unconditioned by previous experiences. From the standpoint of such an experience, the perception is immediate But from the standpoint of subsequent reflection on that experience, especially if we happen to be versed in the science of psychology, the perception in question was not immediate. It was not a simple, unanalysable, unity nor unconditioned by previous mental processes and present interpretation. Its immediacy thus resolves into our unawareness, at the moment, of real mediation Now in order to maintain that religious experience, as illustrated by the primitive instance that has been mentioned consists in immediate apprehension of a spiritual environment or a supernatural beyond, that is real or actual and not imaginal or ideal, it is essential that the immediacy involved be accounted such from the latter of the two points of view that have just been distinguished. Yet it is from the former of them alone that it can be vouched for by the religious experient, appealing only to his religious experience. Thus it is doubtful, on more than one ground, whether apprehension of the sacred and supernatural is essentially different from sensory knowledge, eked out with interpretative notions derived from human analogy, constructive imagination and idealization. It may be that the primitive notion of a god, precursor of the later conception of God, was derived by such processes from current knowledge of man, and read into some impressive natural object, constituting it numinous and capable of eliciting religious emotion.

If this view be adopted, religious experience, on its first emergence in mankind, will, *mutatatis mutandis*, have been grounded in a way similar to that in which theistic belief is grounded by the philosopher. It was the outcome of what may be called primitive philosophizing on Nature and man, and not of the exercise of an alleged transcendent faculty of intuition. Indeed it would seem that such direct touch of God upon the human soul as religion and theology imply does not admit of being discerned with real immediacy. it is a case of causal activity, which admittedly is never perceptible. And as for the rest that has been said above, its gist is contained in the generally endorsed dictum, "no man hath seen God at any time." The mystic, it is true, claims to be an exception. But it is not necessary here to weigh his testimony, partly because he can only assert, on the strength of his peculiar experiences, the specious kind of immediacy which has already been shown to be irrelevant, and partly because mystical experience seems never to have issued in theological insight and doctrine that was unknown before and otherwise. Knowledge of God would seem to be in the same case with knowledge of our own souls and of other selves, as distinct from their material bodies. In each of these instances the object is not apprehended with directness, but read in analogically; and the reading or interpretation is justified or verified (never logically certified) by cumulative practical success. There well may have been, from the infancy of our race, a touching of man by God, even before man arrived at belief in the daemonic or the divine; but such *rapport* would not be religion until man had come to believe in such beings as gods "He who cometh to God must believe that He is." That is to say, religion or religious experience presupposes, and is constituted distinctive, by a theological notion or concept. This concept cannot be in the first instance derived from religious experience, because religious experience cannot exist till the idea is forthcoming.

It is very generally taught that theology presupposes religious experience and is but the explication of it. But it is all a matter of where, in a long chain of development, we fix our starting point for consideration. In the series of natural numbers, every odd number precedes an even number and every odd number also succeeds an even number until we work back to 1. Similarly, the "Athanasian" creed presupposes much Christian experience while the religious experience of Paul the Apostle differed from that of Paul the Rabbi in virtue of his acquired doctrinal belief as to the Person of Christ But if we go back to the beginning of the series in which theology determines religious experience and in turn is determined by such experience, pursuing psychological beginnings since historical origins are beyond our ken, it would seem that, originally, some crude equivalent to natural theology must have preceded and caused the emergence of distinctively religious experience. But religious experience once having arisen in this way, it will determine theological thought; and the new thought will render possible a further advance in religious experience, and so on. Thus there is as much truth in the statement that theological doctrine determines the quality of religious experience as in the statement that religious experience and faith are presupposed by theological dogmas When, *e.g.*, the Christian asserts that he has experience of the indwelling Christ, he is obviously interpreting his really immediate experiences, which consist in consolations, joy, peace, uplifting of the will, etc. He would not so interpret such mental happenings had not Christ been preached to him, and had he not received doctrine as to the Person of Christ which he did not make out of his individual experience Nevertheless, it is a fact that the idea of God, both in dogmatic theology and in philosophy, was moulded by religious experience, guided both by morality and intellect, after the initial stage of the long course of religious development.

The Relation of Theology to Philosophy.—From the earliest times philosophy has had a theological side. Since the dawn of Greek science and metaphysic, philosophy, Greek and other than Greek, has produced copious speculation concerning the existence and nature of God, as well as a vast volume of thought bearing more or less direct relevance to theological problems, such as the origin, destiny and meaning of the world and human life The greatest of philosophers have dealt with these problems and it has often been from the side of religion that great thinkers have received their chief impulse towards philosophy. Moreover theology and philosophy are largely identical in that theology is essentially metaphysics. No doubt the majority of those who profess theological beliefs hold their beliefs in complete absence of metaphysical reasoning; in that sense their belief—*i.e.*, believing—is non-metaphysical. But their beliefs—*i.e.*, their *credenda* —are all metaphysical dogmas or assertions about ultimate reality They are religious beliefs in so far as they are metaphysical. For instance, that Jesus "suffered under Pontius Pilate" is, as a bare historical fact, of no religious import; but when it is intended to imply further that He suffered for us—*i.e.*, for our salvation—it is a metaphysical statement concerning the relation of God to human souls and, in virtue of that metaphysical content, is a religious doctrine

Besides being concerned with the same metaphysical subject-matter, philosophy is involved in theology and can aid its work in various ways. Firstly, in respect of the systematization and unification of knowledge. Christian theology needs must connect

its more or less separate and independently elaborated doctrines into a coherent whole Thus Origen, one of the first Fathers to present an ordered system of Christian dogma, tells us that while the Apostles delivered themselves clearly on certain points necessary for all to understand, they left the grounds of their utterances and the more precise determination and demonstration of many doctrines to the more zealous of their successors who should be "lovers of wisdom"; and he expresses his desire to form a connected series of truths or one body of doctrine That is the goal of dogmatic theology which would relate, *e.g.*, the doctrine of the Atonement with that of the Incarnation or the doctrine of Sin with that of Creation, and obviously such connection involves resort to philosophy Again, the exposition of any single doctrine involves the use of interpretative ideas, such as can only be supplied by the science and philosophy current in a given age Several doctrines that purport to be deduced from scripture alone are less the result of strict exegesis than the result of speculation applied to such material as secular knowledge was believed to have established. To give one example. the doctrine of Original Sin is not contained in the Old Testament and the only unmistakable presentation of it that can be found in the New does not appear to have been the starting-point for the first framers of the ecclesiastical doctrine. Tertullian set out from stoic psychology, Origen from the institution of infant-baptism and also from the myth of Plato concerning the fall of the soul from the celestial sphere into earthly life. But of greater importance than cases of this kind is the fact that the very terms and conceptions, requisite as a mould into which the relatively undefined traditional beliefs of the early Church must be cast in order to yield explicit and definite doctrine and, appropriated for that purpose, were supplied by Greek philosophy

The office of philosophy within the sphere of theology, with which we have thus far been concerned, may be described as that of interpreting to the reason the contents of religious experience. The philosophy of religion seeks to show that the fundamental ideas of religion, so far from being contrary to reason or from being ideas begotten of faith indifferent to knowledge, are capable of receiving a rational, or at least a reasonable, justification in terms of philosophical principles Philosophy, or even theology, is no substitute for religion, and, of course, does not profess to be. It professes, rather, to show the compatibility of faith with reason and knowledge and to interpret the contents of faith to the reason

Another function of philosophy is the undertaking of a critical examination of the processes involved in what we call knowing and of the various conceptions that enter into the knowledge claimed either by common sense or the sciences, with a view to disclosing the nature, validity and limits of human knowledge. And this function has a necessary place also in the sphere of theology. There we require to understand the precise relations between what are respectively called knowledge and faith; and it is necessary to pursue the "critical regress" within the field of dogmatic theology because, as history shows, the legitimate desire for completeness of system and knowledge and for definiteness of dogmatic expression is apt to become the wish to know more than, perhaps, can be known and to know too definitely. In the middle ages, when theology was more ambitious than critical, fulness and precision were claimed in so inordinate a degree that, as a sympathetic historian has observed, an agnostic reaction was necessary in the interests of reverence. And it is always natural for theologians to betake themselves too exclusively to the drawing of inferences when more attention might profitably be devoted to the sifting of premisses. Thus it is that the word "dogmatic," which technically indicates one province of theology, has come sometimes to bear a less noble signification; and dogmatic theology has been distrusted as requiring assent to doctrines that are not self-evident and for which no proof can be supplied

But while philosophy, as a critical method, is a corrective of dogmatism in the foregoing sense, philosophical theology is not necessarily hostile to dogma. Individual philosophers have doubtless tended to set up empty abstractions, as will presently be seen, in place of positive facts and concrete existents; but that is no necessity inherent in philosophy itself, as a pursuit

Hegel observes in his *Philosophy of Religion* that in his day an anti-dogmatic spirit was abroad among dogmatic theologians, who at the same time charged philosophy with merely negative or destructive tendencies These, he said, have thrust dogmas into the background, pronouncing them unimportant and extraneous definitions or mere phenomena of past history Christ's work of redemption had received a very prosaic and merely psychological significance and the doctrines of the Trinity, etc, were neglected as matters of indifference, even by pious theologians This spirit was by no means confined to Hegel's day It might be called the temper of indefiniteness It is met with in the supposed antitheses between kernel and husk—as if kernels ever grew without husks—and between the life and the creed—as if Christianity were not a life based on a creed, and Christian ethic did not owe its distinctiveness to its dependence on Christian doctrines In recoiling from dogmatism such as would be over-precise, it distrusts precision of expression as such.

The necessary and intimate connection of theology, even dogmatic theology, with philosophy now having been illustrated from several sides, the two main types of method that have been employed in philosophical theology may in turn be described: they are respectively called the *a priori* and the empirical.

The a priori Method and Rational Theology.—Of the phrase *a priori* we can distinguish two meanings that are apt to be confounded It may have a psychological sense, when the phrase means "contributed by the mind itself," and so is generally equivalent to "innate" It may also bear a logical sense, as when *a priori* truth is described as truth characterized by universality such as, in contrast with mere generality, bespeaks intrinsic or unmediated necessity In the former case, contrast with the empirical and sense-given is pointed, in the latter case, contrast with the contingent—*i.e.*, with what is, but conceivably might have been otherwise

It may be said, with accuracy sufficient for the present purpose, that the *a priori* method was introduced into philosophy and theology by Plato. He took the ideal or pure science of mathematics, which deals with the non-actual, to be the paradigm of knowledge of the actual—science and philosophy. Despising the sensory, and empirical investigation, he valued only the relations and the universal qualities manifested in facts, so that these came to be considered, not as entering into the constitution of actuality, but as existing wholly independently, and this rational or intelligible world, as contrasted with the sensorily perceived, was accounted the truly existent or the "real" Thus arose the *a priori* method, in the logical sense of that phrase, and the rationalistic theory of knowledge, which, without much qualification, may be said to have dominated philosophy for centuries. So long as it did not and could not—till analytical psychology was born—be suspected that sense and understanding may have a common root and that between understanding and reason there is continuity rather than disparateness, the rationalist's belief in a faculty called reason, capable of functioning in independence of sensation and sensory data, was possible and natural. This faculty was regarded by the ancient philosophers as the sole source of real, *i e*, higher, knowledge; as independent of body and "animal soul," and even as a participation in the Divine Reason, a "spark of Deity" Christian theologians, who found much in Plato's system that they could assimilate, also appropriated this ancient doctrine as to reason Augustine applied it to explain the reception of supernatural truth and the divine illumination of the mind of man, and it coalesced with the Logos-doctrine of the Church. From Augustine and neoplatonism it was accepted by Descartes and so became entrenched in early modern philosophy. The existence of a *lumen naturale*, a faculty innate as instinct, but mediating necessary and eternal truths, was one of the tenets of rationalism and one that theologians were naturally inclined to adopt. Hence *a priori* theology, in the psychological as well as the logical sense of the phrase, flourished long Another feature of the rationalistic and *a priori* theory of knowledge is its tendency to identify knowledge and thought. Knowledge (of actuality) is pre-eminently

thought, but since the 18th century we have been compelled to recognize that it is also more. Further, the consistency of thought with itself was often confounded with validity—*i.e.*, with "holding of" actual things. But fiction can be consistent while not being truth about actual persons, and metageometries may be as consistent as Euclid without having any applicability to our world. Moreover, what were deemed to have been self-evident axioms, forming the basal principles of various sciences from mathematics to theology and purporting to be read off as necessary truths by pure reason, have in these latter days been accused of being either conventions, like the rules of a game, or disguised empirical inductions. These modern discoveries and the emergence of a genetic science of common or universal, as distinct from private or individual, experience have rendered tenet after tenet of the *a priori* school obsolete for many minds.

Turning now to the application of this method and type of philosophy to the sphere of theology, we may note that to it is due a large part of the content of the traditional conception of God and His attributes. From the patristic age to the modern period of philosophy philosophical theologians took over the concept of God as largely fashioned during the long development of religious thought, including the Hebrew thought in which Christianity has its roots And in Hebrew religion, the transcendent attribute of Jehovah is His holiness God is personal, not a cosmic force, interested in individuals, immanent in Nature and man. But the Greek philosophers, who founded philosophical theology, had relatively little concern with such qualifications of Deity. Greek philosophy began as cosmology and ethics was an after-development. And Greek theology was rather an academic product than born of personal experience and life. Hence, save for Plato's identification of God with the Good, it endowed God with what may roughly be called "the physical" attributes in a predominant degree The Greek mind, not the Hebrew, is responsible for the attribute of infinity, perhaps for those of omnipotence and omniscience in their absolute and rigorous senses, and for the qualities of immutability and impassibility, the taking over of which by Fathers of the Church involved them in the difficult task of reconciling such attributes with the nature of a living Spirit Some of the Greek theological ideas, *a priori* in character rather than derived from life and experience, proved to be a mould somewhat incongruous with the Hebrew-Christian content which philosophically-minded Christian doctors thrust into it. It was at once too large and too small. If immutability means more than self-consistency, and impassibility more than freedom from human anger and corporeal passions, they cannot be predicates of a God of love and a Father of spirits Like infinity, until that concept passes over into the idea of ethical perfection, they are derived from inert matter rather than active spirit and are quasimaterialistic or mathematical rather than spiritual and ethical conceptions. "Infinity" has borne several distinct meanings, both in Greek and in later philosophy. Originally its sense seems to have been that of indeterminateness or being devoid of any particular characters, formless, indefinite and indefinable: in which case it is, of course, not predicable of any actual being. Then it came to mean the endless or limitless, what cannot be reached by successive acts of addition or division. Infinity, in this sense of the endless in time, space or number, is only relevant in mathematics; it can have no application to God, who is without parts or magnitude. Lastly, "infinity" acquired the meaning of completeness, ethical perfection and immutability. Then, however, it became a redundant word; as properly used it can be dispensed with by theology.

Even more inapt to Christian or theistic theology than some of the Greek *a priori* concepts is the abstractive method of arriving at a conception of God, which passed, through Philo especially, from Greek thought to some of the Fathers of the Church. The rationalistic propensity to regard the most abstract conception as the ultimately real being, coupled with the formally intellectual tendency to oust from philosophy and theology not only the anthropomorphisms of vulgar thought but also the inalienable anthropic functions of human mentality, led to usage of "the negative way." That consists in repudiating all positive characterizations of God supplied by human analogies. It has aptly been described as a deification of the word "not" Everything, it is represented, that can be affirmed of the finite must be denied of the Infinite One. Thus God becomes conceived as an indeterminate absolute, ineffable and unknowable; the living Spirit is replaced by a pure idea The Fathers favourable to this method, who even when abstract philosophers were also pastors and curators of Christian tradition, were saved from propounding these extravagances by a wholesome inconsistency. But Philo, gnostics, and neoplatonists, who took the negative way more seriously, found it necessary, in order to bridge the impassable gulf which they set between the Infinite One and the finite world, to invent powers, aeons and emanations.

The Empirical Method and Natural Theology.—The phrase "natural theology" has usually been a synonym for "rational theology"; *e.g.*, the natural theology of the English deists, who may aptly be described as rational theists, consisted of doctrines supposed to have been discerned by human reason, its first principles being self-evident, and its secondary doctrines being deduced from them, in accordance with the *a priori* principle, that so and so is because it must be. But it is convenient to give to "natural theology" a distinctive meaning As a synonym for "rational theology" it is superfluous; while there is a theology derivable empirically from the study of Nature, man and human history, and consequently not "rational" and *a priori*, for which the title "natural" is the most appropriate. It will therefore be so used in the present context

The possibility of a theology of this kind was recognized at least as early as the time of St. Paul, who wrote that "the invisible things of [God] from the creation of the world are clearly seen, being understood by *the things that are made*" But though theology is thus derivable, it must be added that it has not as yet been derived, at least not with anything like the completeness and system possessed by some of the rational theologies that have been forthcoming between the times of, say, Aristotle and Hegel. Empiricism, in a nobler than its historical sense which degrades it to sensationism, yet awaits its master-mind comparable to a Plato or a Spinoza; hitherto, both in philosophy and theology, it has been represented but fragmentarily, and, if by able thinkers, scarcely by genius of the highest order. Some of the threads which await weaving into the texture of an empirically grounded philosophical theology by a future master-weaver are already within the common ken and may be briefly indicated.

It is admitted that theology rests on faith. Faith, in the first instance, creates ideas, such as that of God, and believes in real or actual counterparts to them. It claims to be knowledge, but is not knowledge or cannot be known to be knowledge, in the same sense that natural science is knowledge. Faith may issue in knowledge or it may not. The individual believer, whether a mystic or a non-mystic, may adopt, for the ordering of his own life, the attitude "I am certain." Therein he is invulnerable; but his faith will be a matter of personal biography and his certainty will be but subjective certitude or convincedness until reasons be forthcoming for taking the objects of his belief to be actual (as is the king of England) and not merely imaginal (as the mermaid) or purely ideal (as the line without breadth) Theology and philosophy are concerned with the knowability and the actuality of God and with the validity of statements about Him. Rational theology maintained that God's existence, etc., could be proved as coercively as a theorem in Euclid Empirical theology denies that this is so, and empiricism asserts that knowledge, in that sense, is not forthcoming even as to the existence of other subjects or souls than one's own. Empiricism can also assert that what is called scientific knowledge and what are our most assured convictions as to the physical world rest ultimately on indemonstrable postulates or an act of faith, and observes that there is no more a rational cosmology than there is a rational theology. In both spheres verification is pragmatic and is very different from logical certification, which would only be forthcoming if science were composed of deductions from axioms, instead of inductions from facts. Thus, in the entire realm of actuality, as distinguished from that of the pure or ideal sciences, what, of courtesy, we

call knowledge is after all but probable belief. We can only be reasonable, not rational.

Such is the empirical account of the relation of faith to reason, theology to science and philosophy It follows that no proof, in the most rigid sense, of the primary dogma of theism is possible. Such proof as may be had will consist in showing that theism is the most reasonable interpretation of the world and man, and in displaying the cumulative evidence for the assertion that the cosmos is due to the conspiration of innumerable causes and adaptations, by their united and reciprocal action, to issue in a general order of Nature, such as cannot reasonably be ascribed to fortuitousness but only to design by a supreme mind that must be intelligent and moral, the ground of the Good, the Beautiful and the True Philosophical theology will thenceforward consist in the reinterpretation of the world and human history in terms of that metaphysical conclusion.

Theology Based on Other Grounds.—After rational theology received the classic criticism of Hume and Kant, attempts were made to establish theology on a new basis. The old proofs having been shown to be either fallacious or insufficient, the theoretical knowledge-methods by which they had been mediated were renounced, as not the proper foundation of theology. But the empirical procedure, seeking for grounds of reasonable belief wherewith intellectually to justify faith, did not commend itself to the generations which succeeded Kant In the 19th century the discovery of the deists that revealed religion presupposes natural religion was ignored; and Butler's suggestion, that what he vaguely called probability constituted our guide, was deemed inadequate The latter line of thought was indeed pursued, without explicit awareness of the fact, by the numerous English writers who, from S. T. Coleridge onwards, developed the doctrine that religious truth can only be judged and accepted by "the whole man," and not by man as merely intelligent. Recoil from discredited 18th century rationalism, however, did not direct itself to the empiricism represented by Locke, and perhaps more faithfully, in the theological sphere, by Butler Confusing probability, as something pertaining to common or public beliefs and "knowledge," with acceptance as merely probable on the part of the individual believer, objectors generally submitted that ardent faith is not a weighing of probabilities, nor can faith be content to stake its vital convictions on what it merely deems probable.

Of course the faithful man is certain, in the sense of being privately convinced; but what he is confident about may not have logical or scientific demonstrability from the point of view of objective or common knowledge. And it is the latter issue, not the mentality of this or that individual, with which theology is concerned. But inasmuch as this confusion of standpoints was prevalent, it is not surprising that efforts were forthcoming to find a new basis for theology such as should constitute it a science, yet vindicate subjective certitude. Schleiermacher appealed to immediate experience. But it may perhaps be said that the immediacy of which he treated is but mediateness unrecognized, when he proceeded to draw out what was implicit in his fundamental immediate truths, he reveals the presupposing of a whole system of philosophy and science. Another such attempt was that of Ritschl, who sought to make theology independent of the sciences of Nature and historical criticism, of metaphysics or theoretical (by which he seems to have meant rational) knowledge, grounding it on judgments of worth. That theology derives its arguments largely from considerations as to values is of course true But these valuations must be appreciations of the actual, and so presuppose knowledge of the world and man, in order to yield any theistic argument. The existence of a real object, such as God or heaven, cannot be inferred from the worth of an ideal object or from doctrines about such objects An existential science, then, cannot be extracted from considerations as to worth alone. There is room, moreover, for nothing but private faith or blind hope in the realization and conservation of the valuable, until the universe has been found, by theoretical knowledge, at least not to be of such a nature as to involve extinction of the valuable. That the good *ought* to be conserved is irrelevant to whether it *will* be conserved, until we have established a reasonable belief in a good God Thus it would again seem that theology can only claim to be reasonable belief and that it can only provide itself with reasonable belief by interpreting the actual world Once severed from the kind of "knowledge" on which it is dependent, it is unable to find any criterion whereby to distinguish reasoned and reasonable belief from superstition, theology from rules for pious behaviour or for pious feeling towards objects that may be but fond imaginations.

Biblical and Dogmatic Theology.—Only a few words can be added here to what has been already said as to dogmatic and Biblical theology, subjects on which the special headings should be consulted There is, of course, no one theology of the Old Testament: that collection of books, belonging to different times, is constituted a unity by its record of how Hebrew monotheism gradually developed during several centuries. It describes man's groping after God, which, from the theistic point of view, is but the converse side of God's progressive revelation of Himself to man, imparting knowledge of Himself or inspiring the pursuit of religious discovery, not by over-riding human faculties but by adaptation or condescension to them. God, as a Christian Father expresses it, ever took man as he was, in order to make him what he was not Thus was gradually reached the lofty and ethical conception of God and His relation to humanity which was presented by the great prophets. The Old Testament contains the history of God's preparation for the reception by humanity of the highest and fullest revelation of Himself in a human personality The New Testament, again, contains the account of the impression produced by the life and teaching of Christ and the earliest extant interpretations of His Person. The relation of Christ to God came to be formulated in terms of the conception of incarnation; but though incarnation involves an event in "the fulness of time," the Incarnation has been by no means exclusively regarded by Christian doctors as a complete discontinuity or as but contingent on man's need of redemption. From antiquity there have been those who regard the Incarnation, on the one hand, as the last of many stages and, on the other, as part of the eternal counsel of God. The doctrine of the Incarnation and that of the Trinity which is intimately bound up with it are the two dogmas that are most distinctive of the Christian type of theism; and they are the two which for the first five centuries figure most prominently in the development of the Church's doctrine. In this connection it is interesting and important to observe that during this constructive period there was a considerable approach, within the Church, to that divergence as to philosophical method that has received notice in earlier sections of this article. The school of Alexandria was largely platonist in its theological conceptions; and, setting forth from the divinity of Christ as—in a sense—*a priori* datum or prior certainty, sought as best it could to account for Christ's human nature and to explain its union with the divine nature in one person. The school of Antioch, on the other hand, was more empirical. It pursued the scientific or historical, rather than the allegorical, method of exegesis of Scripture and, in Christology, it set out from the observed facts about Christ as man, seeking how to conceive of His deity compatibly with them. The Alexandrines cherished the metaphysical concepts of substance, etc., and spoke of the union of the two natures in Christ as "hypostatic"; the Antiochenes preferred to think in terms of the ethical and spoke of a "moral harmony." For better or for worse, the former school exerted the dominating influence in the final and oecumenical formulation of orthodoxy. It transmitted doctrines expressed in terms of philosophical conceptions which the modern mind sometimes evinces a desire to discard or supersede, on the ground that they do not take account of distinctions which, once emergent, cannot be ignored, and otherwise present difficulties which, unsuspected in the past, to-day are felt to be acute.

Returning to the particular dogmas of the Trinity and the Person of Christ, we may observe that in the case of the elaboration of the former of them the search was made for a conception of the Persons of the Triune God such as should avoid the implication that God is a divine society of several individuals and also the implication that the Persons are merely temporal rôles or

modes of God In other words, the great doctors from Tertullian to Aquinas who have expounded Trinitarian doctrine were feeling for a mode of being intermediate between what can be denoted by a noun and what can be denoted by an adjective, such as an attribute or a relation. Since human experience knows of no such mode of being and the conception of it cannot be elucidated by any analogy, these teachers have recognized that, in the last resort, they were dealing with mystery or with what transcends the limits of the human mind to comprehend or conceive. And, shrinking more from intrinsic than from modalism, they gave to the orthodox formulation of the doctrine of the Trinity a meaning which it is not easy to distinguish in essence from the rigidly monotheistic or monarchian conception of God as undifferentiated, save in respect of possessing a plurality of attributes or relations that are eternal and intrinsic and not merely temporary, as heresiarchs had asserted. On the other hand the doctrine of the Person of Christ which received the consent of the universal Church implies that in Christ, as incarnate, there was but one subject—if this term of modern psychology accurately represents what was meant—viz., the Logos or pre-existent Son, and that our Lord's human nature was "impersonal" This would seem to involve a conception of the Trinity somewhat different from that contained in the dogma as just expounded, inasmuch as the Logos is now treated as an agent or subject and yet as distinct from God or the Father. Perhaps it is owing to a sense of discrepancy in this connection that recent thought has sometimes manifested a tendency to interpret the Incarnation of the Logos in terms of the notion of divine immanence in a human personality. From this point of view, "God was in Christ . . ." would better express the Incarnation-doctrine than "The Word became flesh." But the translation of these two fundamental Christian doctrines into terms of conceptions such as are serviceable in psychology and theology at the present day has not yet been accomplished.

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THEOPHANES, surnamed "the Confessor" (*c.* A.D. 758–818), Greek ascetic, chronicler and saint, belonged to a noble and wealthy family and held several offices under Constantine V., Copronymus (741–775). He subsequently founded a monastery (τοῦ Μεγάλου Ἄγρου) near Sigriane. He took a strong position against the Iconoclastic policy of Leo V. and was imprisoned in Samothrace, where he died (818). He subsequently received the honours of canonization He continued the Chronicle of George the Syncellus from the accession of Diocletian to the downfall of Michael I Rhangabes (284–813). The work, although wanting in chronological accuracy, is of great value as supplying the accounts of lost authorities.

There is also extant a further continuation, in six books, of the *Chronicle* down to the year 961 by a number of mostly anonymous writers (called Οἱ μετὰ Θεοφάνην, Scriptores post Theophanem), who undertook the work by the instructions of Constantine Porphyrogenitus

Editions of the *Chronicle*:—*Editio princeps*, J. Goar (1655); J. P. Migne, *Patrologia Graeca*, cvii.; J. Classen in Bonn *Corpus Scriptorum Hist Byzantinae* (1839–47); and C. de Boor (1883–85), with an exhaustive treatise on the mss and an elaborate index; E. W. Brooks in *Byzantinische Zeitschrift*, 15, p. 578 *et seq.*

Editions of the *Continuation* in J. P. Migne, *Patr. Gr.*, clx., and writer in *Sitzungsberichte der philos.-philol. und der hist. Cl. der k.* by I. Bekker, Bonn *Corpus Scriptorum Hist. Byz.* (1838); on both works and Theophanes generally, *see* C. Krumbacher, *Geschichte der byzantinischen Literatur* (1897); *Ein Dithyrambos auf Theophanes Confessor* (a panegyric on Theophanes by a certain *protoasecretis*, or chief secretary, under Constantine Porphyrogenitus) and *Eine neue Vita des Theophanes Confessor* (anonymous), both edited by the same writer in *Sitzungsberichte der Philos.-philol und der hist. Cl. der k bayer Akad der Wissenschaften* (1896, pp 583–625, and 1897, pp 371–399), Gibbon's *Decline and Fall* (ed Bury, 1896–1900), v p 530

THÉOPHILE, the name by which Théophile de Viau (or Viaud), French poet (1591–1626), is more commonly called He was born in 1591, at Clairac, near Agen, and was educated at the Protestant college of Saumur. In 1612 he met Balzac, with whom he made an expedition to the Netherlands, which ended in a serious quarrel. On his return he seems to have been for two years a regular playwright to the actors at the Hôtel de Bourgogne In 1615 he attached himself to Henry, duke of Montmorency (1595–1632), under whose protection he produced the tragedy of *Pyrame et Thisbé*, acted probably about 1617. This piece, written in the extravagant Spanish-Italian manner, was ridiculed by Boileau (Preface to his *Œuvres*, 1701). Théophile was a Huguenot and a freethinker, and had made unsparing use of his sharp wit in epigrams on the Church and on the government. In 1619 he was banished from Paris, but was allowed to return in the next year. He then served in that year in the campaign against the Huguenots, but in the autumn was an exile in England. He was recalled in 1621, and abjured Protestantism in 1622 In 1622 he had contributed four pieces to the *Nouveau Parnasse Satirique*, a miscellany of verse by many hands. In the next year a new edition appeared, with the addition of some licentious verse, and the inscription *par le sieur Théophile* on the title-page. Contemporary opinion justified Théophile's denial of this ascription, but the Jesuit father, François Garasse, published a tract against him entitled *La Doctrine curieuse* (1623). Théophile was again prosecuted. This time he fled from Paris, to the court of Montmorency, and was condemned in his absence (Aug 19, 1623) to death. On his flight to the border he was arrested, and imprisoned in the Conciergerie in Paris. He defended himself in an *Apologie au roi* (1625), and was liberated in September, his sentence being commuted to banishment for life. Under Montmorency's protection he hid in Paris for some time, and subsequently accompanied his friend and patron to the south. He died in Paris on Sept 25, 1626.

Forty-two pamphlets on the prosecution of Théophile, written between the dates 1622 and 1626, are preserved in the Bibliothèque Nationale in Paris. The standard modern edition of the works of Théophile is that of Alleaume in the *Bibliothèque Elzévirienne* (2 vols. 1856). Besides *Pyrame et Thisbé*, his works include a paraphrase, half verse, half prose, of the *Phaedo*. There are numerous French and Latin letters, his *Apologie*, a promising fragment of comic prose narrative, and a large collection of occasional verses, odes, elegies, stanzas, etc. *See* K. Schirmacher, *Théophile de Viau* (Leipzig and Paris, 1897).

THÉOPHILUS, East Roman emperor (829–842), the second of the "Phrygian" dynasty, a pronounced iconoclast. In 832 he issued an edict strictly forbidding the worship of images. His whole reign was occupied in war against the caliphs of Baghdad. (*See* CALIPHATE: *The Abbasid Caliphs*) This war was caused by Theophilus, who afforded an asylum to a number of Persian refugees. The Roman arms were at first successful; in 837 Samosata and Zapetra (Zibatra, Sozopetra), the birthplace of Motasim, were taken and destroyed. Eager for revenge, Motasim assembled a vast army, one division of which defeated Theophilus, who commanded in person, at Dasymon, while the other advanced against Amorium, the cradle of the Phrygian dynasty. After a brave resistance the city fell into Motasim's hands through treachery. Thirty thousand of the inhabitants were slain, and the city razed to the ground. Theophilus never recovered from the blow, and he died at the beginning of 842

See Gibbon, *Decline and Fall*, chaps 48 and 52; F. G. Schlosser, *Geschichte der bilderstürmenden Kaiser* (1812); G. Finlay, *History of Greece*, ii. (1877), p. 142; G. F. Hertzberg, *Geschichte der Byzantiner und des osmanischen Reiches*, bk. i (Berlin, 1883), H Gelzer, "Abriss der byzantinischen Kaisergeschichte" in C. Krumbacher's *Geschichte der byzantinischen Literatur* (2nd ed , 1897); and authorities under ROMAN EMPIRE, LATER. On the early campaigns against the Arabs *see* J. B. Bury, in *Journ. Hell. Stud.* xxix., 1909, pt. i.

THEOPHRASTUS, the successor of Aristotle in the Peripatetic school, a native of Eresus in Lesbos, was born *c.* 372 B.C. His original name was Tyrtamus, but he later became known by the nickname "Theophrastus," given to him, it is said, by Aristotle to indicate the grace of his conversation. After receiving his first introduction to philosophy in Lesbos from one Leucippus or Alcippus, he proceeded to Athens, and became a member of the Platonic circle. After Plato's death he attached himself to Aristotle, and in all probability accompanied him to Stageira. Aristotle in his will made him guardian of his children, bequeathed to him his library and the originals of his works, and designated him as his successor at the Lyceum on his own removal to Chalcis. Theophrastus presided over the Peripatetic school for 35 years, and died in 287 B.C.

The most important of the works of Theophrastus are two large botanical treatises, *On the History of Plants*, in nine books, originally ten, and *On the Causes of Plants*, in six books, originally eight, which constitute the most important contribution to botanical science during antiquity and the middle ages. We also possess in fragments a *History of Physics*, a treatise *On Stones*, and a work *On Sensation*, and certain metaphysical *Ἀπορίαι*, which probably once formed part of a systematic treatise. The writings of Theophrastus are accessible in the Teubner series.

The *Ethical Characters* (Ἠθικοὶ χαρακτῆρες) consist of brief, vigorous and trenchant delineations of moral types, which give a most valuable picture of the life of his time. They form the first recorded attempt at systematic "character" writing. The *Ethical Characters* was edited by Casaubon in 1592 and translated by La Bruyère (1688–89); the best modern translation (with introduction and notes) is that of Sir Richard Jebb (1870, rev ed J. E Sandys, 1909).

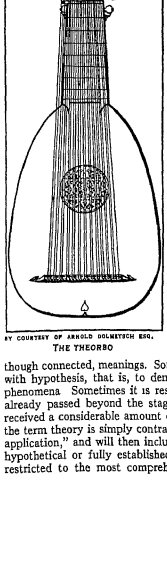
BIBLIOGRAPHY.—A good account of Theophrastus is found in E Zeller, *Aristotle and the Earlier Peripatetics* (Eng trans B. F. C Costelloe and J. H Muirhead, 1897) For his astronomical work, *see* ASTRONOMY (Historical Section) and for the botanical works, J Berendes, *Die Pharmacie bei den alten Culturvölkern* (vol 1, 1891). *See* also G. S Gordon, *Theophrastus and his Imitators* (1912).

THEOPOMPUS (380 B.C.), Greek historian and rhetorician, was born at Chios about 380 B.C. In early youth he seems to have spent some time at Athens, along with his father, who had been exiled on account of his Laconian sympathies. Here he became a pupil of Isocrates, and rapidly made great progress in rhetoric We are told that Isocrates used to say that Ephorus required the spur but Theopompus the bit (Cicero, *Brutus*, 204) At first he appears to have composed epideictic speeches, in which he attained to such proficiency that in 352–351 he gained the PRIZE of oratory given by Artemisia in honour of her husband, although Isocrates was himself among the competitors It is said to have been the advice of his teacher that finally determined his career as an historian—a career for which he was peculiarly qualified owing to his abundant patrimony and his wide knowledge of men and places. Through the influence of Alexander, he was restored to Chios about 333, and figured for some time as one of the leaders of the aristocratic party in his native town. After Alexander's death he was again expelled, and took refuge with Ptolemy in Egypt, where he appears to have met with a somewhat cold reception. The date of his death is unknown.

The works of Theopompus were chiefly historical, and are much quoted by later writers They included an *Epitome of Herodotus's History* (the genuineness of which is doubted), the *Hellenics* (Ἑλληνικά, Ἑλληνικαὶ ἱστορίαι), the *History of Philip* (Φιλιππικά), and several panegyrics and hortatory addresses, the chief of which was the *Letter to Alexander*. The *Hellenics* treated of the history of Greece, in 12 books, from 411 (where Thucydides breaks off) to 394—the date of the battle of Cnidus (*cf.* Diod. Sic., xiii. 42, with XIV 84). Of this work only a few fragments were known up till 1907. The papyrus fragment of a Greek historian of the 4th century B.C., discovered by B. P. Grenfell and A. S. Hunt, and published by them in *Oxyrhynchus Papyri*, vol. v. (1908), has been recognized by Ed. Meyer, U. von Wilamowitz-Moellendorff and G. Busolt as a portion of the *Hellenics*. This identification has been disputed, however, by F. Blass, J. B. Bury, E M Walker and others, most of whom attribute the fragment, which deals with the events of the year 395 B.C. and is of considerable extent, to Cratippus (*q.v.*) A far more elaborate work was the Φιλιππικά in 58 books In this Theopompus narrated the history of Philip's reign (360–336), with digressions on the names and customs of the various races and countries of which he had occasion to speak, which were so numerous that Philip V. of Macedon reduced the bulk of the history from 58 to 16 books by cutting out those parts which had no connection with Macedonia It was from this history that Trogus Pompeius (of whose *Historiae Philippicae* we possess the epitome by Justin) derived much of his material

BIBLIOGRAPHY.—Fragments in C. Müller, *Frag. Hist Graec*, i, monograph by A J. Pflugk (1827), and a good account in W. Mure, *Language and Literature of Ancient Greece* (1850–57), v. pp. 509–529 *See* also GREECE: *History: Ancient to 146 B.C.: General: Ancient Authorities.* A complete edition of the fragments of Theopompus and of Cratippus has been published by the Clarendon Press, Oxford (1909), containing the fragment of the new historian. For a discussion of the authorship of this fragment *see Oxyrhynchus Papyri* (1908), vol v, pp. 110–242; G Busolt, *Hermes* (1908), pp. 255–285 (*Der Neue Historiker und Xenophon*), E. M. Walker, *Klio* (1908) ("Cratippus or Theopompus"), W A Goligher, *English Historical Review*, vol. xxiii. pp 277–282 ("The New Greek Historical Fragment"); A. von Mess, *Rheinisches Museum* (1908), pp. 370–391 ("Die Hellenica von Oxyrhynchos").

(E. M. WA.)



BY COURTESY OF ARNOLD DOLMETSCH ESQ.
THE THEORBO

THEORBO, the large double-necked bass lute much used during the 16th and 17th centuries as general bass in the orchestra. The body of the theorbo was constructed on the same principles as that of the lute. The theorbo was made in two sizes, the ordinary instrument measuring about 3ft 6in., and the Paduan, also known as archlute, about 5 feet. The chitarrone, or Roman theorbo, was the largest of all, a contrabass lute in fact, and frequently stood over 6ft high. (*See* BARBITON, LUTE.)

THEOREM, a term used in mathematics to represent a proposition which is to be demonstrated. In geometry, a proposition is commonly considered as a problem (a construction to be effected) or a theorem (a statement to be proved). For example, the statement: "If two lines intersect, each pair of vertical angles are equal" is a theorem The so-called "fundamental theorem" of algebra asserts that every rational integral equation has at least one root The Greeks also recognized a proposition lying between a theorem and a problem, the porism (*q.v.*) (*See* also FERMAT'S LAST THEOREM; BINOMIAL FORMULA; REMAINDER THEOREM.)

THEORY, in logic and science, is a term used in various, though connected, meanings. Sometimes it is used as synonymous with hypothesis, that is, to denote any tentative explanation of phenomena Sometimes it is restricted to explanations that have already passed beyond the stage of mere hypotheses by having received a considerable amount of verification. Sometimes, again, the term theory is simply contrasted with "practice" or "practical application," and will then include any kind of explanation, be it hypothetical or fully established. Lastly, the term is sometimes restricted to the most comprehensive explanation (hypothetical

or verified and established) as contrasted with the less comprehensive laws or explanations comprised under them and deducible from them. In this sense we speak of the *theory* of gravitation, but of Kepler's three *laws* of planetary motion, and of Boyle's *law*, but of the dynamic *theory* of gases This last usage is perhaps the best. *See* A Wolf, *Essentials of Scientific Method* (1928).

THEOSOPHY, a term used to denote those forms of philosophic and religious thought which claim a special insight into the Divine nature and its constitutive moments or processes (from Gr. *θεός*, god and *σοφία*, wisdom) Sometimes this insight is claimed as the result of the operation of some higher faculty or some supernatural revelation to the individual; in other instances the theosophical theory is not based upon any special illumination, but is simply put forward as the deepest speculative wisdom of its author. But in any case it is characteristic of theosophy that it starts with an exploration of the Divine essence, and endeavours to deduce the phenomenal universe from the play of forces within the Divine nature itself.

General Theory.—Theosophy is thus differentiated at once from all philosophic systems which attempt to rise from an analysis of phenomena to a knowledge, more or less adequate, of the existence and nature of God. In all such systems, God is the *terminus ad quem*, a direct knowledge of whom is not claimed, but who is, as it were, the hypothesis adopted, with varying degrees of certainty in different thinkers, for the explanation of the facts before them The theosophist, on the other hand, is most at his ease when moving within the circle of the Divine essence, into which he seems to claim absolute insight. This, however, would be insufficient to distinguish theosophy from those systems of philosophy which are sometimes called "speculative" and "absolute," and which also in many cases proceed deductively from the idea of God In a wide sense the system of Hegel or the system of Spinoza may be cited as examples of what is meant. Both thinkers claim to exhibit the universe as the evolution of the Divine nature; so much is involved, indeed, in the construction of an absolute system. But in such systems the known universe—the world of experience—is nowhere transcended; God is really no more than the principle of unity immanent in the whole. Hence, while the accusation of pantheism is frequently brought against these thinkers, the term theosophical is never used in their regard A theosophical system may also be pantheistic, in tendency if not in intention; but the transcendent character of its Godhead definitely distinguishes it from the speculative philosophies which might otherwise seem to fall under the same definition. An historical survey shows, indeed, that theosophy generally arises in connection with religious needs, and is the expression of religious convictions or aspirations. Accepting the testimony of religion that the present world lies in wickedness and imperfection, theosophy faces the problem of speculatively accounting for this state of things from the nature of the Godhead itself. It is thus in some sort a mystical philosophy of the existence of evil; or at least it assumes this form in some of its most typical representatives. The term Mysticism (*q.v.*) has properly a practical rather than a speculative reference; but it is currently applied so as to include the systems of thought on which practical mysticism was based Thus, to take only one prominent example, the profound speculations of Meister Eckhart (*see* ECKHART, JOHANNES) are always treated under the head of Mysticism, but they might with equal right appear under the rubric Theosophy. In other words, while an emotional and practical mysticism may exist without attempting philosophically to explain itself, speculative mysticism is in current usage almost another name for theosophy

In the above acceptation of the term, the neoplatonic doctrine of emanations from the supra-essential One, the fanciful emanation-doctrine of some of the gnostics (the æons of the Valentinian system, for example), and the elaborate esoteric system of the Kabbalah, to which the two former in all probability largely contributed, are generally included under the head of theosophy. In the two latter instances there may be noted the allegorical interpretation of traditional doctrines and sacred writings which is a common characteristic of theosophical writers. Still more typical examples of theosophy are furnished by the mystical system of Meister Eckhart and the doctrine of Jakob Boehme (*q.v.*), who is known as "the theosophist" *par excellence* Eckhart's doctrine asserts behind God a predicateless Godhead, which, though unknowable not only to man but also to itself, is, as it were, the essence or potentiality of all things. From it proceed, and in it exist, the three persons of the Trinity, conceived as stadia of an eternal self-revealing process The eternal generation of the Son is for Eckhart equivalent to the eternal creation of the world. But the sensuous and phenomenal, as such, so far as they seem to imply independence of God, are mere privation and nothingness; things exist only through the presence of God in them, and the goal of creation, like its outset, is the repose of the Godhead. The soul of man, which as a microcosmos resumes the nature of things, strives by self-abnegation or self-annihilation to attain this unspeakable reunion (which Eckhart calls being "buried" in God) Regarding evil simply as privation, Eckhart does not make it the pivot of his thought as was afterwards done by Boehme; but his notion of the Godhead as a dark and formless essence is a favourite thesis of theosophy.

Boehme was indebted not only to mystical theology but also to the writings of Paracelsus. This circumstance is not accidental, but points to an affinity in thought The nature-philosophers of the Renaissance, such as Nicolaus Cusanus, Paracelsus, Cardan and others, curiously blend scientific ideas with speculative notions derived from scholastic theology, from neoplatonism and even from the Kabbalah. Hence it is customary to speak of their theories as a mixture of theosophy and physics, or theosophy and chemistry, as the case may be Boehme offers us a natural philosophy of the same sort. As modern theosophy has nourished itself almost in every case upon the study of his works, his dominating conceptions supply us with the best illustration of the general trend of this mode of thought. His speculation turns, as has been said, upon the necessity of reconciling the existence and the might of evil with the existence of an all-*embracing* and all-powerful God, without falling into Manichæism on the one hand, or, on the other, into a naturalistic pantheism that denies the reality of the distinction between good and evil He faces the difficulty boldly, and the eternal conflict between the two may be said to furnish him with the ground-principle of his philosophy It is in this connection that he insists on the necessity of the Nay to the Yea, of the negative to the positive. Eckhart's Godhead appears in Boehme as the abyss, the eternal nothing, the essenceless quiet (*Ungrund* and *Stille ohne Wesen* are two of Boehme's phrases). But, if this were all, the Divine Being would remain an abyss dark even to itself In God, however, as the condition of His manifestation, lies, according to Boehme, the "eternal nature" or the *mysterium magnum*, which is as anger to love, as darkness to light, and, in general, as the negative to the positive. This principle (which Boehme often calls the evil in God) illuminates both sides of the antithesis, and thus contains the possibility of their real existence. By the "Qual" or torture, as it were, of this diremption, the universe has qualitative existence, and is knowable. Even the three persons of the Trinity, though existing *idealiter* beforehand, attain reality only through this principle of nature in God, which is hence spoken of as their *matrix*. It forms also the matter, as it were, out of which the world is created; without the dark and fiery principle, we are told, there would be no creature. Hence God is sometimes spoken of as the father, and the eternal nature as the mother, of things. Creation (which is conceived as an eternal process) begins with the creation of the angels. The subsequent fall of Lucifer is explained as his surrender of himself to the principle of nature, instead of dwelling in the heart of God. He sought to make anger predominate over love; and he had his will, becoming prince of hell, the kingdom of God's anger, which still remains, however, an integral part of the Divine universe

Schelling's *Philosophical Inquiries into the Nature of Human Freedom* (1809) is almost entirely a reproduction of Boehme's ideas, and forms, along with Baader's writings, the best modern example of theosophical speculation. In his philosophy of identity Schelling (*q.v.*) had already defined the Absolute as pure indiffer-

ence, or the identity of subject and object, but without advancing further into theogony. He now proceeded to distinguish three moments in God, the first of which is the pure indifference which, in a sense, precedes all existence—the primal basis or abyss, as he calls it, in agreement with Boehme. But, as there is nothing before or besides God, God must have the ground or cause of His existence in Himself. This is the second moment, called nature in God, distinguishable from God, but inseparable from Him. It is that in God which is not God Himself, it is the yearning of the eternal One to give birth to itself. This yearning is a dumb unintelligent longing, which moves like a heaving sea in obedience to some dark and indefinite law, and is powerless to fashion anything in permanence. But in correspondence to the first stirring of the Divine existence there awakes in God Himself an inner reflective perception, by means of which—since no object is possible for it but God—God beholds Himself in His own image In this, God is for the first time as it were realized, although as yet only within Himself. This perception combines, as understanding, with the primal yearning, which becomes thereby free creative will, and works formatively in the originally lawless nature or ground. In this wise is created the world as we know it. In every natural existence there are, therefore, two principles to be distinguished—first, the dark principle, through which the being in question is separated from God, and exists, as it were, in the mere ground; and, secondly, the Divine principle of understanding. The first is the particular will of the creature, the second is the universal will. In irrational creatures the particular will or greed of the individual is controlled by external forces, and thus used as an instrument of the universal But in man the two principles are consciously present together, not, however, in inseparable union, as they are in God, but with the possibility of separation This possibility of separation is the possibility of good and evil In Boehme's spirit, Schelling defended his idea of God as the only way of vindicating for God the consciousness which naturalism denies, and which ordinary theism emptily asserts Among thinkers on the same lines, but more or less independent, Molitor is perhaps the most important. Swedenborg (*q.v.*) is usually reckoned among the theosophists.

THE THEOSOPHICAL SOCIETY

The term "theosophy" has in recent years obtained a wide currency in certain circles as denominating the beliefs and teachings of the Theosophical Society. This society was founded in the United States in 1875 by Madame H P. Blavatsky (*q.v.*), in connection with Col. H S Olcott and others Col. Olcott remained president of the original society till his death in 1907, when he was succeeded by Mrs. Annie Besant But soon after the death of Madame Blavatsky (1891) a split took place which led to the formation of a separate organization in America under the leadership of William P. Judge. The main objects of this society, as originally propounded, were:

(1) To establish a nucleus of the universal brotherhood of humanity;

(2) to promote the study of comparative religion and philosophy; and

(3) to make a systematic investigation into the mystic potencies of life and matter, or what is usually termed "occultism."

Mahatmas.—According to Madame Blavatsky's original statements this wisdom has been transmitted through the ages as a secret doctrine or esoteric teaching by a brotherhood of adepts or Mahatmas scattered through the world but in close relation with one another. With a certain group of these in Tibet she claimed to be in communication. In such adepts the spiritual nature is supposed to have been so developed that the body has become the ductile instrument of the intelligence and they have thus gained a control over natural forces which enables them to bring about results that appear to be miraculous.

Religious Aspect.—The most characteristic feature of this modern "theosophical" teaching is the belief in reincarnation, and here again the close connection with Indian thought is observable. The succession of earthly lives through which the spirit advances to its goal is interpreted in strict accordance with the Brahmanic and Buddhistic doctrine of Karma. First introduced in the Upanishads as the great secret which solves the problem of human destiny, Karma is in a sense the logical origin of all Indian thought. It expresses the inexorable law of moral causation—whatsoever a man soweth that shall he also reap—and this law is represented as fulfilling itself in the life-history of each individual agent. The consequences of a man's actions in his present life are reaped by the agent on earth in a fresh incarnation. Hence the saying, "A man is born into the world he has made." The theory of Karma is thus primarily an explanation of a man's lot in the present life as determined by his own actions in a series of previous lives If it is true that whatsoever a man soweth that shall he also reap, it must be equally true that whatsoever a man reaps that he must also have sown. The doctrine is thus in its essence a vindication of cosmic justice in face of the perplexities caused by the apparent disregard of moral considerations in the distribution of happiness and misery in the present life, and it is in this sense that it is accepted and applied by theosophists. (A. S P.-P.)

THÉOT, CATHERINE (d. 1794), French visionary, was born at Barenton (Manche). In Robespierre her followers saw the redeemer of mankind and preparations for his initiation were put in train. Catherine, with others, was arrested and imprisoned. The accused were ultimately acquitted, Catherine herself having died in prison on Sept. 7, 1794.

THEOTOCOPULI, DOMENICO (*c.* 1542–1614), known as El Greco, Spanish painter. He was born in Candia, Crete. His Greek name, Domenicos Theotocopoulos, was changed in Italy and Spain into Domenico and Dominico Theotocopuli, and he thus signed his name in Greek characters. We first hear of him in a letter written by the miniaturist, Julio Clovio, to the cardinal Alessandro Farnese, dated Rome, Nov. 16, 1570. "There has arrived in Rome a young man from Candia, a pupil of Titian, who, I think, is a painter of rare talent. . . . He has painted a portrait of himself which is admired by all the painters in Rome I should like him to be under the patronage of your reverend lordship without any other contribution towards his living than a room in the Farnese Palace." Unfortunately, the portrait here mentioned is lost. Works of this early period are: the portrait of Clovio (Naples museum), "The Healing of the Blind," of which there are two versions (Museums of Parma and Dresden) and "Christ Driving the Money Changers from the Temple," of which there are versions in the collection of Sir Herbert Cook, Richmond, in the Minneapolis museum and in the Frick collection, New York, the last of a somewhat later period. Though a pupil of Titian, he was influenced by Tintoretto and the Bassanos, and while in Rome he studied Michelangelo. In the picture at Minneapolis, Titian and Michelangelo are introduced with Clovio in the lower right hand corner.

We next hear of Theotocopuli in Toledo, at work in the church of Santo Domingo el Antiguo, rebuilt in 1575 on the outskirts of the city Here he designed the architecture and sculpture of a composite altar in Venetian style and painted the pictures for it. The centrepiece (now in the Chicago Art institute) representing "The Assumption of the Virgin," is a free adaptation to Spanish surroundings of Titian's masterpiece, in the Frari at Venice, and is painted with daring and intensity, in a rich, deep colour scheme. Flanking it, and still in their original position, are the imposing figures of St. John the Baptist and St. John the Evangelist. On the side altars are "The Adoration of the Shepherds" and "The Resurrection," while "The Trinity" with its Michelangelesque "The dead Christ in the Arms of God the Father" is now in the Prado. Toledo had never seen such art before; and in 1577, the year when "The Assumption" was completed, he was asked by the chapter of Toledo cathedral to paint the chief picture for their new sacristy. He chose as his subject "The Stripping of Christ before the Crucifixion" (El Espolio). Christ's impressive figure in the centre stands out among a crowd of executioners whose brutality contrasts with the Gentle Marys in the lower part of the picture. The whole surface of the canvas is compactly filled. As in Michelangelo's blocks of marble, there are no open views, no empty spaces. The cold tone of the painting contrasts with the glowing Venetian

colour of his earlier work, and is distinctly Spanish The picture was completed in 1579. The chapter, finding its price too high, had it valued by artists, who decided in Theotocopuli's favour. Whereupon the chapter demanded the removal from the picture of "certain impropriеties" such as the presence of the Marys below the Christ The artist, being threatened with imprisonment, at length gave in; but somehow the picture was left as it was. It constitutes the masterpiece of his early period in Spain He had lavished all his art on it in the hope that the doors of the Escorial might open to him, and he seemed to succeed, for Philip II. asked him to provide an altarpiece for his church in the spring of 1580 In "St. Maurice and his Legion," El Greco realized a new form of expression, for which he had been searching since his arrival in Spain. Withdrawn as he was from the example of the great Italian masters, he was thrown on himself. His Byzantine origin made itself felt in the swinging rhythm of his design, the fervent religiosity of 16th century Spain in the extreme expression of feeling

However, when the completed work was submitted to the king he failed to understand the strange new treatment, and though it remained at the Escorial, it was not placed over the appointed altar. His next important work was the famous "Burial of Count Orgaz" (*El Enterro*), for the church of St Tomé at Toledo It treats of a miracle Don Gonzalo Ruiz, governor of Orgaz, had, during his lifetime, professed devotion to St. Augustin and St Stephen, who descended from heaven when his body was about to be buried in the church of St. Tomé, which he had rebuilt, and laid him to rest to the wonder of the attending clergy and mourners, who are shown in a long row of vivid Spanish heads, placed like a frieze horizontally across the picture The upper portion of the painting depicts the reception of the court in heaven The supernatural world is joined to the realistic scene below by the harmonious lines of a geometric design recalling the tracery of a Gothic window. Again the price of the picture was the cause of a lawsuit El Greco henceforth seemed wholly occupied by his imaginative vision. All elements of secondary value are discarded, and everything is subordinated to the realization of a rhythmical unity. In 1590 he completed, for the church of Dona Maria de Aragon at Madrid, an altarpiece with subjects from the life of Christ. Three pictures in the Prado representing "The Crucifixion," "The Resurrection" and "The Baptism," came from this church. An "Annunciation" at Villanueve y Cetru, formerly in the Prado, probably also belonged to this group Here colour and form are used as a means of emphasizing dramatic expression, with a result that, to many, is exaggeration and distortion. The figures are elongated, the limbs twisted, and strange streaks of light flash across. The artist does not represent nature as it is, but uses it for his own ends Here is restless religious strife, tumult, agony and mystic absorption His contemporaries thought he had gone mad; others explained that he was suffering from astigmatism

In 1597 followed the works for the chapel of San José at Toledo, of which "The Coronation of the Virgin" and "The St. Joseph" are still in their original place over the high altar, and "The St Martin" and "The Virgin with Saints" are in the Widener collection at Philadelphia. Fewer figures are introduced, the colouring is silvery, the style severer and simplified. The same sober tendency is displayed in the paintings for the hospital of the Caridad at Illescas, where the "San Ildefonso" combines poetry with realism in the interpretation of a Spanish legend. Other works of this period are: "The Dream of Philip II." and the "St. Francis," "St. Peter" and "St. Eugene" in the Escorial, and the splendid portrait of the Inquisitor, Neno Guevara (Havemeyer collection, New York), which seems to anticipate Velazquez's "Innocent X."

The most representative work of the closing stage, characterized by an intensification of his imaginative qualities, is "The Assumption," in the church of San Vicente at Toledo, completed in 1613, a few months before his death It is a powerful and original composition showing the Virgin rising through the air among clouds of angels. Other important works of the late period are "The St. Bernard" (1603) and "The Plan of Toledo," in the Greco museum at Toledo; "The Pentecost," in the Prado; "The Laocoon" in Munich, and his last work, "The Baptism" at the Hospital of Tavera. El Greco anticipates imaginative landscape painting of later periods in the romantic representation of "Toledo in a Storm" (Havemeyer collection) where the old city, with its Alcázar and its cathedral is seen towering over the ravine of the Tajo against a thundery sky. Another late work is the fine portrait of Fray Hortensio Felix Paravicino at Boston The Prado possesses a number of portraits painted at various times Though few of his sitters are known to us by name, they are evidently all eminent men, of proud and distinguished race, types unchanged in Toledo to-day These austere heads, with pointed beards resting on white ruffs, emerge from a sombre background and are modelled in cool tones. The eyes are full of inward life and reserve, the hands white and sensitive As a painter of women, El Greco produced two masterpieces; "The Lady with the Flower," in the collection of Sir J. Stirling Maxwell, and "The Lady with the Mantilla" in the Johnson collection, Philadelphia The portrait of an old man in the Metropolitan Museum, New York, passes as a self-portrait of the artist Palomino states that Velazquez greatly admired El Greco's portraits, and there can be no doubt that he learned much from his predecessor.

El Greco had but few pupils, among them Maino and Tristan; they were unable to live up to his standard. Giuseppe Martinez explains: "None cared to follow his capricious and extravagant style, which was only suitable to himself." His son, Jorge Manuel, painter, sculptor and architect, born in 1578, worked with him, carrying out the paintings, which he left unfinished. The mother's name is given as Dona Jeronima de las Cuevas, but it is not stated that she was El Greco's wife. El Greco died at an advanced age, and was interred like a noble in the church of Santo Domingo el Antiguo on April 7, 1614, all Toledo mourning his death. When dangerously ill, he made his son universal heir, and gave him power to make his will He left 115 finished paintings, 15 sketches, 4 grisailles and 150 drawings. Many of the pictures were replicas; the drawings no longer exist. There is but one authentic drawing by him, in the Biblioteca Nacional (Madrid) From his will we may draw inferences about his mode of life. He occupied 24 rooms of a palace of the Marques de Villena, once situated in the Paseo del Transito, on the edge of the cliff overlooking the Jajo, near the present Greco museum. He owned a good library of Greek books, including Homer, Aristotle, Plutarch; also editions of Tasso, Petrarch and Ariosto, and numerous volumes on architecture. Pacheco, who visited the painter in 1611, says that he was a great philosopher given to witty sayings, a sculptor and architect as well as a painter. He speaks of a cupboard, in which were models in clay which he made use of in his pictures, and says he saw the originals of all that he had painted in his life, painted in oils on smaller canvases (*Arte de La Pintura*) The great orator, F. Ortensio, Paravicino, and the celebrated poet, Luis de Gongora, wrote sonnets in his memory A quotation from the writings of St. Theresa, the mystic of Spain, who was his contemporary, will help to explain the trend of El Greco's art. "I see a white and a red of a quality as one finds nowhere in nature, for they shine more brightly than the colours we perceive; and I see pictures, as no painter has yet painted, whose models one finds nowhere in nature; and yet they are nature itself, and life itself, and the most perfect beauty imaginable." Forgotten for centuries, Greco's art has only recently come into its own. It makes a strong appeal to the younger artists of the day. Manet was already a great admirer, the followers of Cézanne lay special claims on him as a forerunner, and Expressionists search for the principles, determined emphasis and distortion of form in his works.

See M. B. Cossio, *El Greco* (1908); *Lo que se sabe de la vida del Greco* (1914); *El entierro de conde de Orgaz* (1914); *Borja de San Roman, El Greco en Toledo* (1910): A. L. Mayer, *El Greco* (Munich, 1911); *Domenico Theotocopuli, El Greco*, Kritische Verzeichnis des Gesamtwerkes (Munich, 1926); J. F. Willumsen, *Le Jeunesse du Peintre El Greco* (1927); M. Barrès, *Le Greco* (1911); H. Kehner, *El Greco* (Munich, 1920); A. F. Calvert and C. G. Hartley, *El Greco* (1909); E. du Cue Trapier, *El Greco* (1925); Virginia Hensch, *The Bird of God: The Romance of El Greco* (1929). (L. A. K.)



PAINTINGS OF DOMENICO THEOTOCOPULI (EL GRECO) 1542–1614

1. "Christ Driving the Money Changers from the Temple," one of El Greco's early paintings now owned by the Minneapolis Institute of Art
2. Another painting of "Christ and the Money Changers," showing interesting contrast in style, now in the possession of Aaron Naumburg
3. "St. Peter," painted near the end of the 16th century, owned by Phillips Memorial Gallery, Washington
4. "San Ildefonso of Toledo" El Greco painted this subject twice This painting, the second, dates from his last period, 1604–1614 It is now owned by The A W Mellon Educational and Charitable Trust and is destined for the National Gallery of Art, Washington, D C
5. "St. Dominic," one of the well known paintings of El Greco, now owned by John Nicholas Brown

THERA, the southernmost island of the Sporades, now called Santorin (*q.v.*), but known as Thera until after the Fourth Crusade, when it became part of the duchy of the Archipelago.

THERALITE, in petrology, a group of plutonic rocks built up of basic plagioclase (labradorite), nepheline, and a titaniferous augite. The name is derived from *θηράν*, to pursue, as its discovery was looked forward to as completing the series of basic rocks containing nephelne as an essential constituent.

Olivine, an alkali-amphibole, biotite and orthoclase may be present as subordinate constituents With the exception of nepheline and orthoclase, the minerals of theralites are usually in well shaped crystals Nepheline itself may be largely represented by secondary zeolites Theralites are of comparatively rare occurrence. They are known from the Bohemian alkali province, as at Duppau, in association with shonkinite, at the Katzenbuckel (South-east Tirol), together with pulaskite and foyaite in the Serra de Monchique (Portugal), at Umptek (on the White sea), and among the Carboniferous intrusions of Ayrshire (Scotland).

Closely related to the theralites are the teschenites (from Teschen, Moravia). In place of nepheline these rocks contain primary analcime, but types containing both nepheline and analcime are known. In central Scotland, around Edinburgh and Glasgow, teschenites are abundant, forming thick sills intrusive into the Carboniferous rocks. Teschenites are sometimes ophitic, and show transitions to olivine-dolerites on the one hand and to picrites on the other The rock known as lugarite (from Lugar, Ayrshire) is a related type containing small amounts of plagioclase but abundant analcime, nepheline is present in subordinate amount.

Other rocks related to the theralites are the essexites and shonkinites. The former are characterized by dominant plagioclase, subordinate orthoclase, and green augite, hornblende, biotite and olivine. Nepheline also occurs by no means uncommonly. By increase in the proportion of nepheline the essexites pass into theralites. Essexites occur, together with nepheline syenite, in Essex county, Mass., at Mount Royal near Montreal, in southern Norway (Oslo district), at Rongstock, Bohemia, and among the carboniferous teschenites near Edinburgh and in the Campsie hills, Stirlingshire. The shonkinites are melanocratic rocks of much rarer occurrence. Augite and orthoclase are the prime constituents, but plagioclase, barkevikite, olivine, biotite and variable amounts of nepheline are present. At Shonkin Sag, in the Highwood mountains of Montana, shonkinite forms the greater part of a stratified laccolith passing at the border into a peculiar basic rock described as a leucite-basalt porphyry.

Shonkinites are also known from Ontario, British Columbia, and the East Indies (Celebes, Timor). (C. E. T.)

THERAMENES (d 403 B.C.), Athenian statesman, was the adopted son of Hagnon, a prominent conservative who in 430 impeached Pericles, and after the Sicilian expedition became one of the ten *probuli* (*πρόβουλοι*, commissioners) appointed to devise economies in the administration. Theramenes formulated a new party-cry, "the constitution of our fathers." It was no doubt largely due to his advocacy that the *probuli*, strengthened by further members, were commissioned to draft new measures on behalf of the public safety and to examine Cleisthenes' "ancestral code." (*See* BOULE; GREECE: *History*; *Ancient to 146 B.C. General.*) Late in 405 Theramenes went as plenipotentiary to Lysander (*q.v.*) to obtain peace terms (*see* PELOPONNESIAN WAR), after long negotiations he proceeded to Sparta and arranged a settlement which the Athenians ratified (April 404). In spite of this peace the disorder in Athens did not abate. At the instance of Critias, Theramenes was arraigned for treason and, although he successfully repelled the denunciation, he was led away by violence and forced to take poison.

See Plutarch, *Cicero*, chap. 59; Cicero, *de Oratore*, iii. 16, 59; Wilamowitz-Möllendorff, *Aristoteles und Athen* (Berlin and Leipzig, 1893), ii. p 113 *sqq.*; E. Meyer, *Forschungen zur alten Geschichte* (Halle, 1899), ii. pp. 406 *sqq.*; B. Perrin in *American Historical Review*, ix. (1904), pp. 649–69.

THERAPEUTAE, an ancient sect of ascetics believed to have lived in the vicinity of Alexandria and near Lake Mareotis. They are mentioned in Philo's *De Vita Contemplativa*, and are characterized as being unusually severe in their discipline and mode of life. Abjuring money rather than matter, the Therapeutae lived a secluded life, each member keeping to his own dwelling rather than mingling together in common fellowship

Chief among the institutions of this sect was a festival held every seven weeks and at the culmination of which, bands of women and men danced and sang throughout the night. On every Sabbath they gathered for worship jointly Their entire lives were devoted strictly to meditation and prayer. They despised all forms of avarice

As the result of Philo being the only authority regarding the life and existence of the Therapeutae, there are a number of controversial questions concerning the sect. Some authorities regard the Therapeutae as a Christian order due to the similarity between their asceticism and that of Christian monasticism, but the consensus of opinion among modern scholars is that they were a radical offshoot of pre-Christian Judaism The supposition that the Therapeutae were a branch of the Essenes is contested by Harnack. While these two ascetic sects resembled each other in many instances and especially in discipline, the Therapeutae regulations were more severe.

To the modern reader the importance of the Therapeutae, as of the Essenes, lies in the evidence they afford of the existence of the monastic system long before the Christian era. We have no clue to the origin of the Therapeutae, but it is plain that they were already ancient when Philo described them Eusebius was so much struck by the likeness of the Therapeutae to the Christian monks of his own day as to claim that they were Christians converted by the preaching of St Mark He goes so far as to say that "the writings of ancient men, who were the founders of the sect" referred to by Philo, may very well have been the Gospels and Epistles (which were not yet written). Eusebius having gone wrong on this point, others of the Fathers followed suit, so that Philo is reckoned by Jerome among the ecclesiastical writers of the Christians.

THERAPEUTICS, the name given to that branch of medicine which deals with the means employed to prevent or cure disease if possible, or to control and lessen its evil results when a cure is impossible.

Treatment may be symptomatic or radical, empirical or rational. Obviously the ideal is a radical treatment based on reasoned knowledge of the disease and of the means employed to combat it. Such a form of therapeutics is represented by the antitoxin treatment of diphtheria. But in the case of many diseases and drugs knowledge is still so imperfect that symptomatic and empirical treatment is all that can be employed at the present time. Of this form of therapeutics the use of colchicum in gout is an example. In the case of drugs the purpose to which each is usually put is contained in the article under that special heading (*e.g.*, DIGITALIS, OPIUM, QUININE, etc.); here other and more recent therapeutic methods are considered.

Prevention.—Prevention, the ideal aim of medicine, has greatly advanced in its practical application. In Great Britain this has been fostered by the establishment of a Ministry of Health in 1919 which has greatly expanded the scope of work carried on by the Local Government Board, and also by the activities of the Medical Research Council founded in 1913 as part of the National Insurance Scheme. Preventive medicine includes, in addition to improvement of environmental conditions, prophylactic treatment in the very early stages of disease, such as can be provided in antenatal, school, dental and venereal clinics and so comes within the heading of therapeutics.

A notable example of prophylactic treatment is the prevention of goitre (*see* GOITRE); this is an endemic or local disease, probably depending, as Lieut -Colonel R. McCarrison in India showed, on contamination of the water supply with micro-organisms; it is extremely prevalent in Switzerland and in North America both in men and lower animals in the neighbourhood of the Great Lakes, and has been found to be associated with a diminished content of iodine, which has a well-marked antiseptic action, in the thyroid gland. By the periodical administration of iodine to children in districts where the condition is prevalent it has been most suc-

cessfully prevented

Deficiency Diseases.—Another aspect of the same question is presented by the group of "the deficiency diseases" or the avitaminoses, which depend on the absence from the food of the vitamins or "accessory food factors" As constituents of food these vitamins (*q v*), of which there are several, are remarkable for the contrast between the extremely minute amounts present and the striking changes resulting from their absence. (*See* BERI-BERI, SCURVY, RICKETS, PELLAGRA)

Tropical Diseases.—The prevention of tropical disease, originated in Great Britain under Sir Ronald Ross's direction with the destruction of the mosquito, the carrier of the malarial parasite (*see* TROPICAL MEDICINE), has been much expanded by the Rockefeller Foundation, which has instituted many campaigns against diseases, such as malaria, yellow fever and especially a world-wide attack on ankylostomiasis (*see* HOOKWORM, MALARIA; YELLOW FEVER). Yellow fever, which formerly took such a terrible toll of life, has now been almost entirely eradicated from South America by destruction of mosquitoes, the carriers of the infection.

Inoculation.—World War I proved the enormous value of prophylactic or protective inoculations against certain diseases on the same lines as Edward Jenner's vaccination against smallpox (*q v*) Just before the South African campaign Sir Almroth Wright started the method of protection against typhoid fever (*see* IMMUNITY) by injection with a vaccine composed of killed cultures of the *Bacillus typhosus;* this inoculation sets up changes in the body which render the individual immune for a time, probably about four years, to this form of infection, in the same way as an attack of the disease. After the South African campaign cases were observed resembling typhoid fever but due to different though allied bacilli, and two additional forms, paratyphoid A and paratyphoid B., of fever became recognized, the three diseases being collectively described as enteric fever (*q.v.*). In order to protect against infection of these three forms of fever, it is necessary to inoculate the individual with the three vaccines, and soon after the outbreak of World War I paratyphoid fever attacked the troops in Flanders and did not spare those inoculated against typhoid fever only; the three vaccines, known collectively as T A.B , were then given, and the wonderful freedom of the army from enteric fever, which in past wars has killed as many as bullets, was a triumph for preventive medicine. In like manner men who were wounded and so likely to be infected with *Bacillus tetani* (*see* TETANUS), were at once injected with antitetanic serum and so protected from tetanus or lockjaw.

Dysentery (*q.v*) is another war disease, and there were many cases among the troops at Gallipoli and elsewhere in the East There is more than one kind of dysentery. One of them, amoebic dysentery, is prone to be followed by liver abscess, the amoeba passing to the liver. Before the War it was found that emetine, an alkaloid of Ipecacuanha which had been long known as an empirical remedy for dysentery, was extremely efficient in curing this form of dysentery and also the hepatitis or inflammation of the liver which precedes the formation of an abscess.

Psychotherapy.—As a result of the large numbers of officers and men who suffered from war strain and its effects, often called shell-shock, during and after the War, the psychotherapy of these nervous disorders has greatly developed (*see* PSYCHOTHERAPY).

Endocrine Therapy.—When any of the endocrine glands, the thyroid, adrenals, pituitary, which pour an internal secretion into the blood and keep the body in health, are diseased or fail to do their work properly, signs of disorder or disease result. The secretion may be suppressed or diminished, excessive or altered in character (*see* ENDOCRINOLOGY). When the secretion is diminished an attempt to provide it can be made, and in the case of thyroid, which when inadequate produces myxoedema, or in early life cretinism, brilliant results have long been obtained by this substitution therapy of giving the thyroid gland or an extract of it by the mouth. In 1914 E. C. Kendall of the Mayo Clinic, Rochester, Minnesota, obtained in a pure form the active principle—thyroxin —which is extremely effective. The parathyroid glands, small bodies close to the thyroid gland in the neck, manufacture an internal secretion which passes into the blood and exerts an action apparently opposed to that of the thyroid Whereas the thyroid is concerned with the control of iodine in the body, the parathyroids deal in a similar manner with calcium salts Deficiency in the action of the parathyroids appears to lead to a diminished quantity of calcium salts in the body and to an irritable state of the nervous system, and is thought to be responsible in children for the contracture of the hands and feet known as tetany, though on this question there is considerable discussion. Recently the extract of the parathyroid glands has been given in a number of diseases of a chronic infective nature, especially in sprue (*see* SPRUE), a tropical disease characterized by diarrhoea, want of digestion of food so that the patient wastes as if from starvation

Organotherapy.—An advance in organotherapy is the insulin treatment of diabetes mellitus (*see* DIABETES MELLITUS) In this disease the patient, who is unable to utilize sugar and starches, passes sugar in the urine, wastes and may eventually die in coma. The pancreas, or sweetbread, is a gland concerned with the digestion of food, including starches, in the alimentary canal, and at the same time that it provides this external secretion pours an internal secretion into the blood which enables the body to make use of sugar. This internal secretion is manufactured by structures in the pancreas known as the islands of Langerhans, and the extract from them is called insulin After many trials the technical difficulties in obtaining a satisfactory insulin (*see* INSULIN) were surmounted in 1922 by F. G Banting and C H Best of Toronto, and a remedy was thus made available, which though it does not cure diabetes, any more than the thyroid extract cures myxoedema, yet for some hours makes the previous diabetic practically a normal person as regards the utilization of starch and sugar. The hypodermic administration of insulin must be repeated at least once daily, but this treatment keeps the disease in abeyance and has thus prolonged and saved innumerable lives. In diabetes insipidus, a comparatively rare disease, in which large quantities of urine free from sugar are passed, relief for some hours is similarly obtained by hypodermic injection of extract of the posterior lobe of the pituitary gland. The success of thyroid and insulin treatment has stimulated research and trial in the case of other glands and numerous commercial preparations have been placed on the market; but the claims sometimes made for various forms of organotherapy have yet to be confirmed The most recent is the treatment of pernicious anaemia by feeding with liver. This method was introduced by Minot of the Rockefeller Institute and the success he claims for it has been confirmed in England.

Chemiotherapy.—Chemiotherapy, or the use of a drug which has a selective affinity for a germ and leads to its destruction without damaging the tissues of the body, was the conception of Paul Ehrlich of Frankfort-on-Main who in 1910 discovered the specific remedy "606" or salvarsan which rapidly leads to the destruction of the *Spirochaeta pallida* (*see* VENEREAL DISEASES), the protozoan responsible for syphilis It now appears that the action is not independent of the activities of the patients' bodies and that the germ is not poisoned and killed off solely by the drug, which indeed may damage the tissues of the patient very severely and even cause death, so that the ideal of chemiotherapy has not been realised. Remedies of this class are, like quinine in malaria, specific, lead to a complete cure, and are therefore of the greatest importance in opening a new vista in medicine. Since its introduction salvarsan and its modification neo-salvarsan "914" and allied organic preparations of arsenic have been increasingly used in the numerous results of syphilis with great success; but this treatment has its limitations, for when the parasite of syphilis gets inside the central nervous system and causes locomotor ataxia and general paralysis of the insane the drug cannot follow the spirochaete and the disease is little if at all influenced Recently it has been found that inoculation with the malarial organism and an attack of the disease benefits patients with general paralysis, but how far this is a permanent cure remains to be proved (*see* MALARIA). Trypanosomes, animal (or protozoan) parasites closely akin to spirochaetes are responsible for diseases, such as trypanosomiasis and African sleeping sickness (to be distinguished from quite a different disease epidemic encephalitis [*see* ENCEPHALITIS LETHARGICA] popularly called sleepy sickness) which are also curable by

the organic arsenical compounds atoxyl and arsacetin. Tartar-emetic, a salt of antimony, acts like arsenic on trypanosomes and in addition effects a cure in bilharziasis (*see* BILHARZIASIS) (a disease due to flukes), filarial disease and kala-azar, three tropical infections (*see* KALA-AZAR; PHARMACOLOGY).

Serum Therapy.—Just as in enteric fever, so in cerebro-spinal ("spotted") fever and pneumonia (*see* SPINAL MENINGITIS) bacteriology has shown the existence of several strains or types of the causal micro-organism; these though morphologically indistinguishable are so biologically different that each is most efficiently treated by an antitoxic serum, obtained from an animal injected with, and so immunised to, that particular type. Before the recognition of these types antitoxic serums were employed, but they might or might not correspond to the exact strain of the micro-organism present in an individual case. In 1913 Douchez and Gillespie, working at the Rockefeller Institute, New York, isolated four types of pneumococci, the micro-organism causing acute pneumonia; but it is only the antitoxic serum corresponding to pneumococcus type I. that is curative.

During the World War, especially in 1915, epidemic cerebro-spinal meningitis or cerebro-spinal ("spotted") fever became prevalent among the fighting forces, especially in young recruits. It is due to the *Meningococcus intracellularis* (*see* SPINAL MENINGITIS; SERUM THERAPY), and in order effectively to neutralise its effects Simon Flexner of the Rockefeller Institute prepared an antitoxic serum from animals immunised from 40 different strains (multivalent) This serum is injected by lumbar puncture into the (subdural) space around the spinal cord, so that it can come into direct contact with the meningococci which chiefly select the central nervous system. The prevalence of the disease stimulated research and strains of meningococci were isolated; Mervyn Gordon, working for the Medical Research Committee (now Council), isolated four types of meningococci and prepared four corresponding mono-type sera; when a case was bacteriologically proved to be due to infection with one of these strains, the corresponding serum was given; while waiting for the bacteriological decision as to the responsible type, a mixture of type I. and type II serum was given, as 80 to 85% of the cases were due to these strains

Tuberculosis.—The search for a specific remedy for tuberculosis, such as a new form of tuberculin, an antitoxic serum or a metallic preparation analogous to salvarsan or tartrate of antimony in protozoan diseases, has continued, but no finality has been reached (*see* TUBERCULOSIS). Spahlinger's treatment by vaccines and serums has received intermittent attention, mainly in the lay press; Dreyer in 1923, by removing the fatty material from tubercle bacilli, obtained a vaccine, called diaphyte, which has been tried on human beings, and from experiments on animals was at first thought to have an increased effect, as compared with other vaccines; later reports have not been favourable, but both experimentally and clinically it may still be premature to decide about its ultimate value Recently sanocrysin (a gold compound) has been introduced by Mollgaard of Copenhagen and is still on trial; it is a powerful remedy which kills the tubercle bacilli and, by liberating their poisons, may produce severe constitutional reactions; Knud Faber, from his clinical experience, points out that to avoid these dangerous results, the doses should be small.

In pulmonary tuberculosis a great factor in obtaining arrest and cure of the disease is rest, and in order to immobilize the lung the production of artificial pneumothorax (*q.v.*) is now widely practised. Air is introduced into the pleural cavity on the side of the affected lung which then collapses and comes to rest, all the work of respiration being carried on by the other lung. This procedure has given very good results in selected cases. Treatment in sanatoria is of great value in arresting the progress of pulmonary disease and in teaching the patient the laws of health that he must follow, but it is now becoming recognized that there is urgent need for a more prolonged protection from the strain of ordinary life in the environment of cities, and that tuberculous colonies in the country are required for this purpose, such as Papworth near Cambridge and Preston Hall near Maidstone.

The treatment of leprosy (*see* LEPROSY) by intravenous and intramuscular injections of soluble products of chaulmoogra, hydnocarpus, soya bean and cod-liver oils, as advocated by Sir Leonard Rogers, has been shown by reports from leper asylums in various parts of the world to have had beneficial effects and to have reduced the death-rate in a remarkable manner. Although there are very few lepers in Great Britain, there are 300,000 in the British Empire, and at a conservative estimate 1,700,000 in the world, so that any efficient remedy is obviously important

Protein Therapy.—By a turn of the wheel the strictly scientific employment of vaccines composed of the micro-organisms thought to be responsible for the morbid conditions has led by an empirical process to non-specific protein therapy It was found, sometimes accidentally, not only that the administration of a vaccine specific for one form of infection benefits a morbid condition due to another infection, but that intravenous injection of foreign protein, such as peptone and milk, may when they set up a reaction, namely fever, shivering and illness ("protein shock therapy"), produce a beneficial effect, just as one disease sometimes cures another. This protein shock therapy has been employed particularly in asthma and in chronic rheumatoid arthritis.

After an attack of many infective diseases there develops an immunity so that a second attack is rare; the reverse of immunity is an exaggerated susceptibility or hypersensitiveness (*see* ANAPHYLAXIS); this is what is meant by idiosyncrasies and the proverb "What is one man's meat is another man's poison." This is seen in various diseases, such as recurrent colds and asthma. A method of cure is to desensitize the subject of one of these toxic idiopathies by the administration, usually by hypodermic injection, of the substance, a bacterial or other protein, to which the individual is hypersensitive Thus a patient subject to hay fever is injected with the pollen of the plant which excites an attack; or a patient with bronchitis and asthmatic seizures is injected with an emulsion of dead bacilli (vaccine) obtained from the expectoration.

In many cases of disease and ill-health the cause is a "septic focus" or a local collection of micro-organisms, for example, in the teeth (*see* DENTISTRY), tonsils, appendix, gall bladder and intestines, which poison the body and may produce chronic painful conditions, such as chronic arthritis, sciatica, lumbago, fibrositis. The removal of such foci is therefore the important and indeed the first step in treatment; after that vaccines made from the predominant micro-organism present in the focus, and spa treatment may complete the cure.

Anaemia.—The form of anaemia (*q.v.*) called pernicious or Addisonian after its describer Thomas Addison of Guy's Hospital (*see* ANAEMIA) is apparently the result of chronic infection of the stomach and alimentary canal, which in its turn may be due to a septic focus, but the observations of Arthur F Hurst, also of Guy's Hospital, indicate that an important factor is absence of the hydrochloric acid in the gastric juice. It has, therefore, been treated by supplying the absent hydrochloric acid by its medicinal administration by the mouth, with a success which is due to investigation of the chemistry of the stomach. The manner in which liver feeding acts in pernicious anaemia (*vide supra*) is unknown.

In pernicious anaemia, as in anaemia due to haemorrhage, transfusion of blood (*see* BLOOD TRANSFUSION) has been carried out, after the blood of the donor has been compared with that of the patient to see that they are compatible and after measures have been taken to avoid transmitting diseases, such as influenza, malaria and syphilis from the donor. Transfusion of blood is a very old method of treatment and was performed as long ago as 1667, but it is only recently that the tests for the compatibility of the blood based on the existence of four blood groups in man have rendered the procedure less dangerous. Transfusion of blood with these precautions was employed on a large scale in the War for haemorrhages and severe shock, as from gunshot and shell wounds, and has also been used in conditions popularly called blood poisoning. A recent development of blood transfusion is to immunize by means of vaccines, made from the micro-organism infecting the patient, the blood of the donor, and then to transfuse his blood into the patient.

Radiotherapy.—X-rays, though mainly employed for diagnosis, have from their power of destroying the tissue cells, many

therapeutic uses Thus enlarged glands and the spleen in various diseases of the blood, and especially in lymphadenoma, are much reduced by X-ray exposure The recent Erlangen treatment of internal cancer by intensive X-rays has the grave disadvantage of making some patients extremely ill Radium bromide, the rays of which are much the same, has been much used in the treatment of inoperable carcinoma and in quite superficial growths of the skin, especially rodent ulcer on the face, which, though classed as malignant, is much less virulent. In cancer of the neck of the womb radium has proved of unquestionable value; from a combination of operation and radium good results have been obtained in cancer of the breast; in malignant growths of the tongue, mouth and throat its successful use is probably dependent upon technique. (*See* RADIOLOGY.)

The important advance in the diagnosis of disorders of the heart and the mechanism of its beat have been followed by a more accurate knowledge of how to give digitalis and by the employment of quinidine in the disorders known as auricular fibrillation and paroxysmal tachycardia. Numerous researches have been undertaken with the view of devising reliable tests for the functional activity of the liver, and it is clear that sugar is the food which most readily protects and repairs the damaged liver cells

Heliotherapy.—Recent years have shown an increasing tendency to utilize to the full the *vis medicatrix naturae* in open air treatment, improved ventilation, heliotherapy which has indeed been imitated by the use of ultra-violet rays (*see* HELIOTHERAPY), baths and waters, and exercises. The prophylactic measures based on experience and empirical use have been elaborated by the teaching of scientific research and as a result physiotherapy or physical therapeutics, which includes massage and the various forms of electrical treatment, has considerably advanced in knowledge and application. Medical hydrology has been studied and taught on these rather than on purely empirical lines, and it may be noted that spas did excellent work during and after World War I for invalid soldiers Hand in hand with open air treatment and heliotherapy has come less surgical activity in the way of operating in tuberculous disease of bones and joints. (H. R.)

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THERESA, ST. (1515–1582), or Teresa de Cepeda, Spanish nun, was born at Avila, in Old Castile, on March 28, 1515, and was educated in an Augustinian convent in the town. As a child she was interested in the stories of martyrs, and at the age of eighteen left home one morning, and applied for admission at the Carmelite convent of the Incarnation. She was disappointed at first at the slackness of discipline, but she appears afterward to have accommodated herself with tolerable success to the worldliness of her environment, though not without intervals of religious misgivings.

It was in the year 1554, when she was nearly 40, that the event known as her conversion took place, and the second part of her life began. The death of her father roused her to serious reflection, and one day, as she entered the oratory, she was struck by the image of the wounded Christ, placed there for an approaching festival She fell in tears at the feet of the figure, and felt every worldly emotion die within her. The shock threw her into a trance, and these trances, accompanied by visions, recurred frequently in the subsequent part of her life. They have since been adduced as Divine attestations of her sainthip, but the sisterhood in the convent set them down to possession by a devil; her new departure was caused in their eyes by no worthier motive than the desire to be peculiar and to be reputed better than other people. Theresa herself was very humble, and thought their explanation might be true; she took her case to her confessor and to the provincial-general of the Jesuits, who put her under a course of discipline. One day, while thus occupied, her trance came upon her, and she heard a voice say, "Thou shalt have no more converse with men, but with angels." After this the trance or fit always returned when she was at prayers, and she felt that Christ was close to her. Presently she was able to see Him, "exactly as He was painted rising from the sepulchre." Her confessor directed her to exorcise the figure, and she obeyed with pain, but, it is needless to say, in vain. The visions grew more and more vivid. The cross of her rosary was snatched from her hand one day, and when returned it was made of jewels more brilliant than diamonds, visible, however, to her alone. She often had an acute pain in her side, and fancied that an angel came to her with a lance tipped with fire, which he struck into her heart. August 27 is kept sacred in Spain to this mystery, which has also formed a favourite subject of Spanish painters. She also had visions of another description she was shown hell with its horrors, and the devil would sit upon her breviary, belabour her with blows, and fill her cell with imps. For several years these experiences continued, and the verdict as to their source still remained far from unanimous

Foundation of the Descalzos.—Meanwhile, the spread of the Reformation became the subject of much searching of hearts to pious Catholics. Theresa reflected like the rest, and her experience led her to find the real cause of the catastrophe in the relaxation of discipline within the religious orders. She formed the project of founding a house in which all the original rules of the Carmelite order would be observed. In spite of great opposition from the authorities of the order, and in particular from the prioress and sisters of the Incarnation, she persevered with her scheme, being encouraged to appeal to the pope by certain priests who saw the benefit which would accrue to the Church from her zeal.

A private house in Avila was secretly got ready to serve as a small convent, and, when the bull arrived from Rome, Theresa went out on leave from the Incarnation and installed four poor women in the new house dedicated to her patron St. Joseph. It was on Aug 24, 1562 that Mass was said in the little chapel and the new order constituted. It was to be an order of Descalzos or Barefoots, in opposition to the relaxed parent body, the Calzados. The sisters were not to be literally shoeless, but to wear sandals of rope; they were to sleep on straw, to eat no meat, to be strictly confined to the cloister, and to live on alms without regular endowment. After lodging her four sisters, Theresa returned to the Incarnation; but, when the secret was discovered, Carmelites and townspeople were alike furious. Violence, however, was prevented, and the matter was referred to the council of state at Madrid Philip II referred it again to the pope, and after six months a fresh bull arrived from Pius V. The provincial of her order now gave her leave to remove and take charge of her sisterhood. The number of 13, to which on grounds of discipline she had limited the foundation, was soon filled up, and Theresa spent here the five happiest years of her life. Her visions continued, and, by command of her ecclesiastical superiors, she wrote her autobiography containing a full account of these experiences though she was far from basing any claim to holiness upon them

The general of the order visited her at Avila, and gave her powers to found other houses of Descalzos, for men as well as women. The last 15 years of her life were spent mainly in hard journeys with this end and in the continually growing labour of organization. Convents were founded at Medina, Malaga, Valladolid, Toledo, Segovia and Salamanca, and two at Alva under the patronage of the famous duke. Then she had three years of rest, as prioress of her old convent of the Incarnation. She next went to Seville to found a house, thus overstepping for the first time the boundaries of the Castiles, to which her authorization limited her. The latent hostility of the old order was aroused; the general ordered the immediate suppression of the house at Seville, and procured a bull from Gregory XIII prohibiting the further extension of the reformed houses (1575). But the movement against her came from Italy, and was resented by Philip and the Spanish authorities as undue interference; and after a fierce struggle, during which Theresa was two years under arrest at Toledo, the Carmelites were divided into two bodies in 1580, and the Descalzos obtained the right to elect their own provincial-generals. (*See* CARMELITES) The few remaining years

of Theresa's life were spent in the old way, organizing the order she had founded, and travelling about to open new convents Sixteen convents and 14 monasteries were founded by her efforts; she wrote a history of her foundations, which forms a supplement to her autobiography. Her last journey of inspection was cut short at Alva, where she died on Sept 29, 1582.

Canonization.—A violet odour and a fragrant oil were said to distil from her tomb; and when it was opened nine months afterward the flesh was found uncorrupted A hand cut off by a fervent brother was found to work miracles, and the order became convinced that their founder had been a saint It was resolved in 1585 to remove her remains to Avila, where she was born, the sisters at Alva being consoled by permission to retain the mutilated arm.

But the family of the duke of Alva procured an order from the pope enjoining that the body should be restored to Alva, and she was accordingly laid there once more in a splendid tomb. But even then she was not allowed to rest · she was again disentombed, to be laid in a more magnificent coffin, and the greed of reverential relic-seekers made unseemly havoc of her bones

Theresa was canonized by Gregory XV in 1622 The honour was doubtless largely due to her asceticism and mystic visions She called herself Theresa de Jesus, to signify the closeness of her relation to the heavenly Bridegroom, who directed all her actions. Though she deprecated excess of ascetic severity in others, she scourged herself habitually, and wore a peculiarly painful haircloth. But her life shows her to have been, besides, a woman of strong practicality and good sense, full of natural shrewdness, and with unusual powers of organization "You deceived me in saying she was a woman," writes one of her confessors; "she is a bearded man" She was brave in the face of difficulties and dangers, pure in her motives, and her utterances, some of which have been quoted, have the true ethical ring about them Her mss. were collected by Philip II and placed in a rich case in the Escorial, the key of which the king carried about with him Besides her autobiography and the history of her foundations, her works (all written in Spanish) contain a great number of letters and various treatises of mystical religion, the chief of which are *The Way of Perfection* and *The Castle of the Soul*. Both describe the progress of the soul toward perfect union with God

Her works, edited by two Dominicans were first published in 1587, and have since appeared in various editions They were afterward translated into Italian, French (4 vols., Paris, 1840–46) and Latin, an English translation of the *Life* and works (except the letters) by A. Woodhead appeared in 1669. Other translations of the *Life* are those by John Dalton (1851), who also translated *The Way of Perfection* and the *Letters* (1902), and by David Lewis (1870), who in 1871 also translated the *Foundations* A. R Waller reprinted Woodhead's translation of *The Way of Perfection* in "The Cloister Library" (1901). Biographies appeared soon after her death by the Jesuit Ribera, who had been her confessor (1602), and by Diego de Yepez, confessor to Philip II (1599). Details are also given in Ribadeneyra's *Flos Sanctorum* and in Alban Butler's *Lives of the Saints* (rev. 1926). A separate biography, with preface by Cardinal Manning, appeared in 1865, a full and critical edition of the *Life* is that by Mrs G C Graham, 2 vols (1874) See also H Prinz v. Oettingen-Spielberg, *Geschichte d. heil Theresia* (Regensburg, 1899); A Whyte, *Santa Teresa, an Appreciation, with Some of the Best Passages of the Writings* (1897); E. Hello, *Studies in Sanctship* (1903), B. Zimmerman, *Minor Works* (1913); *The Way of Perfection* (1916); *The Interior Castle* (3rd ed. 1921). A translation of the Letters with introduction by Cardinal Gasquet appeared 1919–24 (4 vols.).

THEREZINA, Brazil· *see* TERESINA.

THERM. A name originally employed in elementary textbooks for any thermal unit but now generally restricted to the statutory unit of heat adopted for the sale of lighting gas in terms of its calorific value. For this purpose the therm has been defined as being equal to 100,000 British Thermal Units (B T U.), the unit of heat most commonly employed for measuring the calorific value of gas or other fuels throughout the British empire and the United States of America.

THERMAE, in classic architecture, originally warm baths, but then used of any large bathing establishment. (*See* BATHS.)

THERMIDOR, the name given during the French Revolution to the 11th month of the year in the Republican calendar. The month fell in the hottest season of the year, beginning on July 19 or 20 and ending on Aug 18 or 19, according to the year. As in all the other months of the Republican calendar, each of the days of Thermidor was, in accordance with the suggestion of Fabre d'Églantine, consecrated to some useful object. Thus 1 Thermidor was consecrated to spelt, 10 Thermidor to the watering pot, 15 Thermidor to sheep and 27 Thermidor to lentils The most important event that took place in this month was the revolution of 9 Thermidor, year II (July 27, 1794), the so-called Revolution of Thermidor, which resulted in the fall of Robespierre and the collapse of the Terror. The name Thermidorian (*Thermidoriens*) was given to the authors of this revolution and to the supporters of the reactionary movement of which it was the signal. The events of the revolution were subsequently dramatized by the French playwright, Victorien Sardou, in his play, *Thermidor* (1891). The name Thermidor is derived from the two Greek words θέρμη, heat, and δῶρον, gift

See C d'Héricault, *La Révolution de Thermidor* (2nd ed, Paris, 1878), E B. Courtois, *Rapport fait au nom de la commission chargée de l'examen des papiers trouvés chez Robespierre et ses complices* (1795); D A. Martin, *Papiers inédits . . . supprimés ou omis par Courtois* (3 vols, 1828), also bibliography in M. Tourneux, *Bibliog de la ville de Paris . . .* vol. i, nos. 4265–4309 (1890).

THERMIONICS. Thermionics is a branch of physics which deals with the emission of charged particles from heated solids These particles may be either electrons or positive ions. (The electron has a negative charge, of magnitude $e = 1.602 \times 10^{-19}$ absolute coulomb, and a mass, $m_0 = 9.1066 \times 10^{-28}$ g. A positive ion is an atom which has lost one or more of the outer electrons) While it had been observed for about 200 years that heated solids emit electrical charges, the observation by Thomas A Edison (1883) of the occurrence of a discharge current through the highly evacuated space in a lamp bulb between the positive and negative ends of the filament of a carbon-filament lamp (Edison effect) drew special attention to this phenomenon. Application of the effect was made by W Preece and J Fleming to the construction of a thermionic rectifier or "valve," and the phenomenon was investigated more comprehensively by J J. Thomson. He showed that the discharge observed from a heated negatively charged electrode (hot cathode) in a gas at very low pressures is caused by a transport of electrons. O. W Richardson discovered the relation between temperature of the cathode emitter and rate of emission of electrons, which is known by his name He also suggested the term "*thermionics*" to designate these phenomena, which had been previously referred to as "the emission of electrons from hot bodies."

The greatest impetus to further extension of knowledge in this field and to extensive practical applications came from development during the first two decades of the century in radio communication and long-distance telephony. The fact that electrons are emitted only from the negative electrode makes it possible to use a hot cathode device as a rectifier of alternating current. Also since the electron is a particle of infinitesimal mass and consequently possesses extremely low inertia, a hot cathode device lends itself very readily to the production of an amplifier or "repeater" (*see* ELECTRON TUBE; AMPLIFIERS) by which the intensity of a weak signal may be increased many-fold.

Still another very important application of hot cathodes has developed in the field of low-voltage gas discharges, such as fluorescent lamps and sodium vapour lamps

Richardson Equation for Electron Emission.—On the basis of the classical electronic theory of metallic conduction, O. W Richardson (1903) derived an equation for electron emission, of the form,

$$I = a\sqrt{T}\epsilon^{-b/T}, \qquad (1)$$

where I = emission in amperes per cm.^{2}, T = absolute temperature in degrees Kelvin, = temperature in degrees C.+273, ϵ = base of natural system of logarithms and a and b are constants characteristic of the emitting surface.

While Richardson had deduced from quantum theory considerations that the equation for emission might also be written in the form

$$I = AT^2\epsilon^{-b_0/T} \qquad (2)$$

where A is a universal constant, M. v. Laue (1918) and R. C. Tolman (1921) deduced from thermodynamical considerations a value for the entropy of the electron which was used by S. Dushman (1922) to derive equation (2) with the value

$$A = 2\pi m_0 e k^2 / h^3. \qquad (3)$$

In this equation, m_0 and e are the electronic constants defined previously, k is the Boltzmann constant ($=1.3805\times10^{-16}$ erg. deg^{-1}) and h is the quantum constant ($=6.624\times10^{-27}$ erg sec.). Inserting these values in the last relation, it is found that $A=60.2$ amps. cm^{-2} deg^{-2}.

In view of a subsequent conclusion, deduced from the observations on atomic spectra, that the electron has two directions of spin about an axis, it would follow that the theoretical value of A should be 2×60.2. However, observations, discussed below, on the emission from a number of pure metals, are actually in much better agreement with the value deduced from equation (3); and this has led to various explanations, based largely on the more recently developed electron theory of metallic conduction, which the reader will find discussed comprehensively in some of the references mentioned at the end of the article.

Over the range of temperatures at which emission measurements can be made, the effect of the exponential factor in equations (1) and (2) is so great that even with the most sensitive instruments it is extremely difficult to find any difference caused by a variation in the exponent of T from 1 to 2. Actually, Richardson observed that data taken over a range of temperatures in which the emission varied in the ratio 1 to 10^{10} could be represented adequately by either equation. However, there is a very much better theoretical basis for equation (2).

It will be observed that b (or b_0) has the dimensions of degrees K, and, physically, kb (or kb_0) corresponds to the *heat of evaporation* (in ergs) of a single electron. However, it is customary to express this quantity in terms of electron volts; that is, the potential in volts required to impart to an electron the kinetic energy which is equivalent to the energy of evaporation. This voltage is designated the "work function" for electron emission and is determined by means of the relation,

$$\phi_0 = (k/e)b_0 = 8.618\times10^{-5}\ b_0 \text{ volts}, \qquad (4)$$

with a similar relation between ϕ and b.

While, as shown by Richardson, the observed emission data may be represented equally well by equation (1) or (2), the latter is the one preferred on the basis of theoretical considerations.

Technique Used for Obtaining Emission Data.—In terms of logarithms to base 10, equation (2) assumes the form,

$$\log\,(I/T^2) = \log A - b_0/(2.303T) \qquad (5)$$

Hence, a plot of log (I/T^2) against $1/T$ yields a straight line, the slope of which corresponds to the value of $b_0/(2.303)$ and the intercept on the axis for $1/T=0$ ($T=\infty$) gives the value of log A.

For the accurate determination of emission data, a simple two-electrode tube (diode) may be used consisting of a filament, the cathode, located along the axis of a metal cylindrical anode. This tube is exhausted to the highest possible vacuum, and both the filament and cylinder are freed of any dissolved gases by heating to as high a temperature as practicable during evacuation. A "getter" (clean-up reagent) may be used to improve the vacuum after the tube is sealed off. (*See* VACUUM.) Since, as will be mentioned subsequently, the electron emission from a surface is decreased considerably in the presence of even slight traces of certain gases, care should be taken to clean the surface thoroughly of adsorbed gases and the pressure in the diode should be as low as possible (or the order of 10^{-7} mm. or less). The observations of dependence of emission on temperature may be made with the tube on the exhaust system or after sealing off and by the use of the "getter."

The temperature of the filamentary cathode is determined as a function of the heating current or watts by means of an optical pyrometer. Since, as is evident from the equation for emission, the emission increases very rapidly with increase in temperature, it is essential for accurate determinations of the constants A and b_0 to determine the temperature-scale with a high degree of precision. Also, corrections have to be made for the cooled ends of the filaments; or the emission may be measured from the central, uniformly heated portion of the filament by using two auxiliary anodes to cover the ends of the filament.

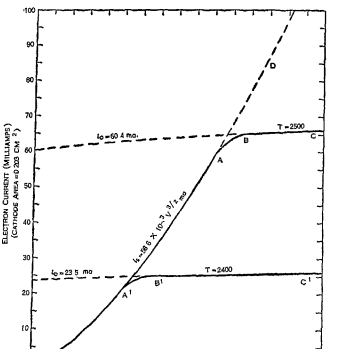


FIG 1.—ILLUSTRATING THE EFFECT OF ANODE VOLTAGE ON THE ELECTRON CURRENT IN DIODE

The observations are carried out by connecting the cathode to the negative terminal of a generator of direct current (or B-battery) while the anode or "plate" of the diode is connected through a suitable current meter to the positive terminal of the voltage source. If direct current is used to heat the filament, the negative terminal of this source is usually connected to the negative end of the generator or B-battery. In deriving true emission data from observations on the magnitude of the electron current as a function of temperature, it is necessary to take into account the manner in which this current depends on the anode voltage (V). At low voltage, the electron current is limited, as shown by C. D. Child (1911) and I. Langmuir (1913), by the repulsion between the electrons caused by their charge. This is known as the *space charge effect* (*see* ELECTRICITY, CONDUCTION OF); and theoretical considerations lead to the relation,

$$i_a = s.V^{3/2}, \qquad (6)$$

where i_a denotes the electron current between cathode and anode and s is a constant for any given geometrical arrangement of electrodes. As the voltage is increased still higher, i_a attains the value corresponding approximately to that calculated by means of equation (2) for the given area and temperature of the cathode.

At still higher voltages, there is a further slight increase in the emission current caused by the so-called *Schottky effect*. W. Schottky (1914) pointed out that such an increase in electron current with voltage is to be expected on account of the attraction between an electron just outside the surface of the cathode and its "electric image" located at the same distance from the surface inside the cathode. Because of this effect, the observed emission at V volts (i_a) is greater than the true emission at zero volts (i_0), the difference being given by the relation,

$$\log i_0 = \log i_a - \frac{4.39\sqrt{fV}}{2.303T}, \qquad (7)$$

where f is a factor, the magnitude of which depends on the geometrical arrangement of the electrodes. The value of the emis-

sion that should be used in applying equation (2) is that deduced for zero volts on the plate. In the case of pure metals, equation (7) gives the relation for deriving this value (i_0) from the observed emission (i_v) at V volts. In the case, however, of thoriated tungsten and oxide-coated cathodes (*see* below) the correction for the effect of voltage is a more complex problem which the reader will find discussed in special treatises on the subject.

These considerations are illustrated by means of the curves plotted in fig. 1, which represent observations on the variation in electron current with voltage at constant temperature for a diode having electrodes of the following dimensions The anode consists of a metal cylinder one in. in diameter and two in long, and the cathode is a 0.005-in. diameter tungsten filament located along the axis of the anode and having the same effective length. (Hence, area of cathode is 0.203 cm.^{2})

Let us assume that the filament is at a temperature of 2500° K. At $V=0$, a very small electron current is observed, because of initial velocities of the electrons. As the voltage is increased, the electron current increases as $V^{3/2}$, as shown by the curve OA^1A, for which the relation is $i=58.6\times10^{-3}V^{3/2}$ milliamps. At about 100 volts the increase in i with V becomes less rapid, and beyond 115 volts the increase follows the Schottky relation (7). In this case $4.39\sqrt{2.303}=7.55$; and at $T=2500$, $\log i_0=\log i_v-0.003\sqrt{V}$. The value of i_0 thus derived is 60.4 ma.; and, consequently, $I=i_0/(0.203)=298$ ma. per cm.^{2}

The observations at $T=2400$ would be represented by the curve $OA^2B^2C^2$, of which the initial portion at voltages below about 60 is the result of space charge effect, while the very slight increase from B^2 to C^2 is the result of Schottky effect. In this case, $i_0=23.5$ ma., and hence $I=116$ ma.cm^{-2}.

Emission Constants for Pure Elementary Substances.—From observations on the values of I for a series of temperatures, values of the constants A, b_0 and ϕ_0 may be calculated by means of equations (7), (4) and (5). The accuracy of the values of these constants as derived by different investigators varies widely. Table I gives those values (taken from reviews by A. L. Reimann and S. Dushman) which seem to be most reliable. Column 5 gives values of the emission (amps. per cm.^{2}) as derived from the emission constants, in the second and third column, for the values of T in the sixth column.

TABLE I

Emission Constants for Pure Metals and Carbon

Element	A	$10^{-6}b_0$	ϕ_0	I_T	T	ϕ_e
Carbon . .	30	5.03	4.34	1.4 x 10^{-3}	2000	
Caesium .	162	2.10	1.81	2.5 x 10^{-11}	500	1.91
Barium .	60	2.45	2.11	1.4 x 10^{-8}	1000	
Zirconium .	330	4.79	4.12	8.5 x 10^{-6}	1600	
Hafnium .	14.5	4.10	3.53	2.8 x 10^{-4}	1600	
Thorium .	60.2	3.89	3.35	4.3 x 10^{-3}	1600	
Columbium	37.2	4.66	4.01	1.10 x 10^{-2}	2000	
Tantalum	55	4.86	4.19	3.20 x 10^{-2}	2000	
Molybdenum	60.2	5.09	4.38	2.34 x 10^{-2}	2000	
Tungsten .	60.2	5.24	4.52	1.00 x 10^{-2}	2000	4.54
Rhenium . .	200	5.92	5.1	3.4 x 10^{-4}	2000	4.58
Iron (α)	26	5.20	4.48	2.7 x 10^{-13}	1280	4.77
Iron (β)	1.5	4.89	4.21	4.5 x 10^{-12}	1200	
				2.1 x 10^{-7}	1600	
Nickel .	30	5.35	4.61	5.6 x 10^{-7}	1600	5.0
Cobalt.	41	5.12	4.41	1.4 x 10^{-6}	1600	
Rhodium .		5.31	4.58			4.57
Palladium.	60	5.79	4.99	3.0 x 10^{-8}	1600	4.97
Osmium		5.45	4.7			
Platinum	17,000	7.25	6.27	9.2 x 10^{-10}	1600	6.30

Theoretically, the value of the work function for any surface can also be derived from a measurement of the *photoelectric threshold frequency*. For any given surface there exists a minimum frequency (ν_0) of radiation for the emission of electrons (*see* PHOTOELECTRICITY); and, in accordance with a relation deduced by A. Einstein, $\phi_e=h\nu_0$; that is, $\phi_0=(h/e)\nu_0=4.135\times10^{-15}\nu_0$ volts.

The last column in Table I gives, under ϕ_e the values of the work function obtained photoelectrically. (This is the significance of the subscript e.) These values should, on the basis of theoretical considerations, agree with the thermionic values given in the fourth column under ϕ_0. In accordance with equation (5) above, a plot of log (I/T^2) versus $1/T$, for emission data observed with any given surface, should yield a straight line. Fig. 2 shows a series of such plots for different types of materials that are of interest in experimental work on electron emission.

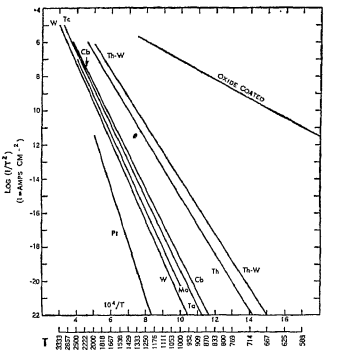


FIG. 2.—PLOTS OF LOG (I/T^2) VERSUS $1/T$ FOR EMITTERS OF ELECTRONS

Electron Emission from Monatomic Films of Thorium.—In 1913 I. Langmuir and W. Rogers discovered that by proper thermal treatment of a tungsten (W) wire containing 0.5 to 0.75% by weight of thoria (ThO_2), a very much higher electron emission could be obtained at temperatures below about 2300° K. than from pure tungsten at the same temperature. As of practice in 1945, the amount of thoria added to tungsten for emission purposes varies between 1 and 2%. As shown by Langmuir and other investigators, the high emission of thoriated tungsten (tungsten to which thoria has been added) is caused by the formation on the surface of a layer of thorium atoms one atom thick (monolayer). The procedure used in obtaining the high emission is as follows:

(a) The filament is flashed for a minute or two at temperatures above 2700° K. This causes a reduction of thoria by the tungsten, forming thorium (Th). The thorium atoms diffuse rapidly toward the surface but evaporate just as rapidly at the surface, with the result that the electron emission is that of pure tungsten.

(b) If the temperature is lowered to about 2200° K., the rate of diffusion is still sufficiently great for activation of the surface; but the rate of evaporation is considerably lower, with the result that the thorium atoms accumulate on the surface as an absorbed layer.

J. A. Becker and W. H. Brattain, as well as Langmuir, have investigated the behaviour of these monatomic films on thoriated tungsten quite extensively. A completely covered film contains one thorium atom for every two tungsten atoms, that is, 7.12×10^{14} atoms of thorium per cm.^{2} Let θ denote the fraction of the surface covered with thorium. Then, the emission at any given temperature increases very rapidly as θ increases from 0 to about 0.25 and more slowly as θ increases beyond this value. The maximum emission is obtained for $\theta=0.7$. Table II, based on the relation derived by Langmuir (*J. Franklin Inst. 217*, 543, 1934) from observations by Becker and Brattain, gives the variation in the values of the emission constants with increase in θ

TABLE II

θ	A	$10^{-4}b_0$	φ_0	$I(T=1500)$	$I(T=2000)$
0	69 2	5 200	4 48	1.38×10^{-8}	1.41×10^{-3}
0 1	42 9	4 590	3 96	$4 08 \times 10^{-6}$	1.80×10^{-3}
0.2	30 3	4 166	3 59	$5 80 \times 10^{-5}$	$1 10 \times 10^{-1}$
0 3	23 6	3 846	3 31	3.84×10^{-4}	$4 20 \times 10^{-1}$
0 4	19 7	3 620	3 12	$1 48 \times 10^{-3}$	1 09
0.5	17 3	3 461	2 98	$3 72 \times 10^{-3}$	2 11
0.6	16 1	3 367	2 90	$6 53 \times 10^{-3}$	3 16
0 7	15 5	3 320	2.86	8.55×10^{-3}	3.85
1.0	18.2	3 367	2 90	$8 51 \times 10^{-3}$	1 61

and also the emission in amps cm^{-2} at $T=1500$ and $T=2000$

As will be observed, the maximum emission at $T=2000$ for thorium on tungsten is 2,730 times that for pure tungsten, while at $T=1500$, the ratio is 619,500.

At any given temperature the actually observed emission from a thoriated tungsten filament corresponds to an equilibrium between rate of diffusion of thorium atoms to the surface and rate of evaporation at the surface. Since it has been shown that diffusion occurs to a large extent along grain boundaries, the rate of activation is affected by the grain size of the tungsten in the filament. Fig. 3 based on calculations made by Langmuir shows the emission values in the steady state for the range $T=1500°$ to $T=3000°$ for a wire of normal grain size. In the range 1500° to 2000° the emission is that of a completely covered monolayer of thorium. Above 2100°, the rate of evaporation exceeds that of diffusion; and consequently the emission decreases since θ is decreasing with increase in T. At about 2300°, the emission decreases to that of pure tungsten and follows the curve for the latter with further increase in temperature

From these data it follows that to obtain a reasonable life, a thoriated tungsten filament should not be operated above about

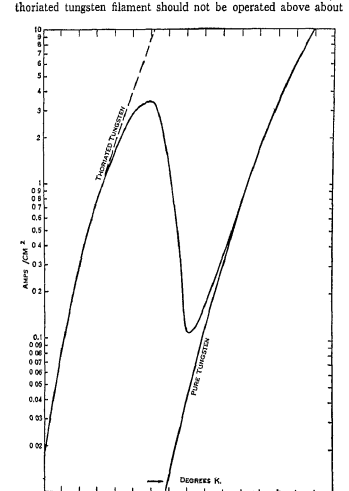
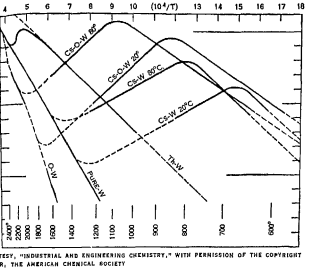


FIG. 3.—PLOT OF EMISSION VERSUS TEMPERATURE FOR ELECTRON EMISSION FROM THORIATED TUNGSTEN SURFACE



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FIG 4.—EMISSION CHARACTERISTICS FROM MONATOMIC FILMS ON TUNGSTEN

2100° K

The behaviour of thoriated molybdenum and tantalum filaments is similar to that described above Also different rare earth oxides added to tungsten have been investigated However, none of these has been found to be as satisfactory as thoriated tungsten.

Electron Emission from Monolayers of Caesium.—It was observed by I Langmuir and K H. Kingdon (1924) that caesium adsorbed from the vapour on tungsten, or on tungsten covered with a monolayer of oxygen, also exhibits very high emission, at least at temperatures below about 1500° K In a bulb containing caesium at 30° C. (vapour pressure about 2.29×10^{-6} mm. of mercury) the adsorbed layer on pure tungsten gives a maximum emission of about 10^{-4} amp.cm.$^{-2}$ at a filament temperature of 700° K. If the tungsten filament is previously heated at about 1900° K. in a very low pressure (about 0.02 mm) of oxygen and then, after removal of the gas, caesium vapour is introduced at 30° C., the electron emission is of the order of 0.35 amp cm.$^{-2}$ at 1000° K.

The electron emission is dependent, as in the case of thoriated tungsten, on the value of θ, the fraction of the surface covered with a monolayer of caesium. At any given temperature there exists an equilibrium between rate of adsorption of caesium atoms, which varies directly with the vapour pressure, and rate of evaporation of caesium atoms, which varies with the temperature and is less at any temperature for tungsten covered with oxygen than for pure tungsten.

Fig. 4, taken from a paper by Langmuir (*Industrial and Eng. Chem.*, 22 ,390, 1930) shows plots of log I (amps.cm^{-2}) versus $1/T$ for caesium on pure tungsten and on oxygen-tungsten At lower temperatures (600° K. to 1000° K) the emission caused by the monolayer of caesium increases with temperature. At higher temperatures the rate of re-evaporation of adsorbed atoms increases so rapidly that the emission decreases and finally reaches a value corresponding to that of pure tungsten or of oxygen on tungsten.

It is of interest to note that at $T=1600°$ K., the emissions from Th-W, pure W and O-W are in the ratio of $10^8 : 1 : 10^{-8}$. At low temperatures the emission from monolayers of caesium on tungsten or oxygen on tungsten is considerably greater than that observed for thoriated tungsten.

Electron Emission from Oxide-Coated Cathodes.—A. Wehnelt (1904) observed that a filament coated with a layer of an alkaline earth oxide (CaO, SrO or BaO) is a good emitter of electrons at relatively low temperatures. Since then, this type of cathode has been the subject of a large number of investigations from both the theoretical and practical points of view. As a result of this work, the electron emissivity actually obtainable has been improved considerably; and while there is not yet available a completely satisfactory understanding of the mechanism of

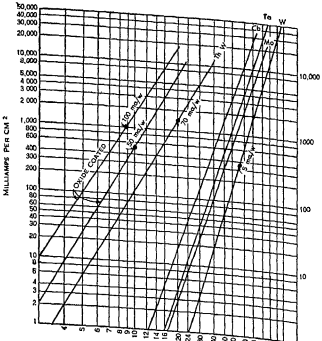


FIG. 5.—ELECTRON EMISSION FROM VARIOUS SURFACES AS A FUNCTION OF POWER INPUT

emission from this type of cathode, a great deal of progress has been made in this direction. (*See* review by J. P. Blewett listed in bibliography.)

The oxide-coated cathodes are usually prepared by coating a metallic base such as platinum, nickel or nickel alloy with a mixture of the carbonates or hydroxides of barium and strontium. The coated cathodes are "activated" on the exhaust system by heating first at a low temperature and then at about 1200° K. with simultaneous application of anode voltage to draw electron current. The thoroughly degassed and activated cathode emits about 100 ma. per cm² at 1000° K., the operating temperature for long life. While it is not possible to assign to this type of cathode definite values for the emission constants, the following range of values is given by Blewett: The work functions for the most recent types of oxide-coated cathodes "lie for the most part within about 0.3 electron volt of 1.1 ev for BaO, 1.4 ev for SrO and 1.9 ev for CaO. . . . The measured emission at 1000° K. is usually found to *lie within a factor of 10* of 10 ma. per cm.² for BaO, 1 ma. per cm.² for SrO and 0.1 ma per cm.² for CaO." The emission at any given temperature, as compared with that for tungsten and other metals, is shown in the straight-line plot in fig. 2.

It appears to be the consensus of opinion that the activation necessary for high emission produces atoms of barium (or strontium or calcium) distributed in the oxide. The mechanism by which these atoms are produced is as follows·

The carbonate or hydroxide dissociates at 800° to 900° K. with formation of the oxide. The reduction to metal then occurs at about 1100° K. by one or a combination of the following reactions: (1) reaction of the base metal with the oxide, (2) electrolytic reduction by the passage of the emission current and (3) bombardment of the oxide by positive ions obtained from residual gases.

For instance, the addition to the nickel of chemically active metals, such as titanium or silicon, has been found advantageous. On the other hand, it is very difficult to activate an oxide coating on a core of spectroscopically pure platinum or nickel.

Efficiency of Electron Emission and Life of Cathode.—Of special importance in connection with the practical application of hot cathodes are the factors of efficiency of emission and life at operating temperature.

The efficiency is defined as the ratio between electron emission per unit area and the watts radiated per unit area. Fig. 5 shows plots of the emission in ma. per cm.² versus the watts per cm.² (on special co-ordinate scales devised in the Bell Telephone laboratories) for different types of cathode surfaces. As will be observed, the actual emission as well as the efficiencies, for any given value of the watts radiated, increase as we pass from the pure metals to thoriated tungsten and to an oxide coating. Furthermore, the efficiency for any given cathode surface increases with the watts, that is, with the temperature Since the evaporation also increases rapidly with the temperature, the cathode life decreases correspondingly.

The usual operating points for a life of several thousand hours are indicated on each plot and it is thus evident that from the point of view of emission efficiency and life the oxide-coated cathode offers the greatest advantages.

Effect of Gases and Positive Ion Bombardment.—The effects of gases on the electron emission are twofold. First, the molecules of the gas may be adsorbed on the surface, like caesium or oxygen on tungsten, forming monolayers which in the case of chemically active gases like oxygen, chlorine, carbon dioxide and water vapour increase the work function and thus decrease the emission. As mentioned above, oxygen decreases the emission from tungsten to about 10^{-3} of its value for the pure metal. Similar results are obtained when oxygen molecules strike activated surfaces of thoriated tungsten or oxide-coated cathodes. Such adsorbed layers can be eliminated in the case of tungsten by flashing at high temperatures (1800° K. and higher). In the case of thoriated tungsten and oxide-coated cathodes, the "poisoned" cathode can be re-activated only by heating to a temperature above that of operation and then activating at lower temperatures. Hydrogen, in general, decreases the emission through the reduction of oxides which may be present in the vacuum tube, with formation of water vapour. However, hydrogen increases the emission from platinum and from tantalum. Hydrocarbon vapours tend to form carbides with the metals, with a resulting decrease in emission to about one-third or less

Under electron bombardment, the molecules of residual gases become ionized; and these ions, in turn, because of their positive charge, are accelerated toward the cathode. If the voltage through which these ions are accelerated exceeds a certain threshold value (20–30 volts, as determined by A. W. Hull), they will cause *sputtering* of the cathode surface. In gaseous discharges operating at a pressure of 1–10 mm. the voltage drop at a hot cathode is below the threshold value and consequently oxide-coated (and thoriated) cathodes may be operated under these conditions without harmful effects due to sputtering.

On the other hand, in low-pressure high-voltage devices, in which the cathode drop is very much higher, it is extremely difficult to operate this type of cathode without a rapid decrease in emission due to sputtering

Thermal Emission of Positive Ions.—O. W. Richardson observed that when filaments are heated for the first time, there is an emission of positive ions at temperatures below those required for electron emission. It was shown that the positive ions are in general due to atoms of the alkali or alkaline earth metals and their rate of emission decreases exponentially with time. C. H Kunsman (1926) observed that certain iron oxide crystals containing about 1% of some alkali or alkaline earth metal used as a catalyst, also provide a copious and steady source of positive ions. It was found that this emission varies with the temperature, in accordance with the Richardson equation.

A second type of positive ion emission, observed by H. B. Wahlin and L. P. Smith (1929), is that in which the ions are charged atoms of the metal itself. This occurs when refractory metals such as chromium, molybdenum, tungsten and tantalum are heated to sufficiently high temperature to cause evaporation. From the plots of $\log(I/T^2)$ vs. $1/T$ the work functions for positive ion emission are found to be 6.55 volts and 6.09 volts for tungsten and molybdenum, respectively.

Finally, a very interesting type of positive ion emission (observed by Langmuir and Kingdon) occurs when atoms of alkali metals such as caesium or rubidium, or of alkaline earth metals,

strike an incandescent filament which is charged positively. The condition for this emission is, to a first approximation, that the work function (ϕ_0) of the surface of the filament for electron emission is *greater* than the ionizing potential (V_i) of the incident vapour Thus, when caesium atoms ($V_i = 3\cdot88$ volts) strike a positively charged tungsten filament ($\phi_0 = 4\cdot52$ volts), the latter, because of its higher affinity for electrons, removes them from the atom (ionization process), and the resulting ions are emitted as a positive ion current.

Similar positive ion emission is obtained from pure tungsten in the vapours of rubidium and potassium, for which V_i has the values 4·16 and 4·32 volts, respectively. On the other hand, the vapour of calcium for which $V_i = 6\cdot09$ volts, is ionized only in presence of a tungsten filament covered with a monolayer of oxygen, since the work function for this surface exceeds 8 volts

At any given filament temperature the positive ion emission is proportional to the vapour pressure of the alkali or alkaline earth metal; and, in fact, this method has been used to determine the vapour pressures of these metals (*See* also RADIO; TELEVISION; INSTRUMENTS, ELECTRICAL; ELECTRON, THE; ELECTRICITY, CONDUCTION OF.)

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(S. DU.)

THERMIONIC VALVE or TUBE: *see* ELECTRON TUBE.

THERMIT. Thermit is a mixture of aluminum powder and iron oxide. On ignition the reaction, $8Al + 3Fe_3O_4 = 9Fe + 4Al_2O_3$ gives a temperature estimated to be between 2,300° and 2,700° Centigrade. The reaction, stated in weights, means that 217 parts of aluminum plus 732 parts magnetite (iron oxide) equals 540 parts steel plus 409 parts slag, or approximately, three parts of aluminum plus ten parts of magnetite will produce, on combustion, seven parts of steel. The steel thus produced represents about one-half of the original thermit by weight and about one-third by volume.

Thermit was discovered by Dr. Hans Goldschmidt, of Essen, Germany, in 1895, while trying to reduce chromium and manganese. Dr Goldschmidt's principal discovery related to a simple and safe method of ignition, as the action of aluminum when mixed with various oxides, sulphides and chlorides was well known. Fine aluminum will not burn below the temperature of molten cast-iron, and previous experimenters had resorted to heating their mixtures in a crucible. This made the initial temperature so high at the moment of ignition that there was an explosion. Dr Goldschmidt obtained ignition of a cold mixture by means of a barium-peroxide fuse, which was set off by a storm match. Later, magnesium powder or ribbon was used, being set off in the same way. A red-hot iron rod may also be used to set off the magnesium, which in turn ignites the thermit. Dr. Goldschmidt's original American patent No. 613700 was granted March 16, 1897, and related principally to the use of aluminum as a reducing agent for the production of carbon-free metals such as cobalt, chromium, magnesium, tungsten, etc , by what is known as the aluminothermic process.

Thermit is used considerably in the foundry for purifying iron and steel in the ladle. For this purpose the thermit is placed in a can on the end of a rod and plunged to the bottom of the molten metal. The intense heat generated tends to liberate many impurities which are carried away in the slag. The principal and better-known use for thermit, however, is in the various forms of welding.

Thermit Welding.—Two methods are used, known as the plastic and the fusion. The first is used for welding pipe and the lattice of solid or latticed sections. In the plastic method, in which the thermit is used chiefly for heating purposes, the ends of two pieces of [illegible] are obtained square and clamped in a cast-iron mould with the ends butted together. This mould is in two parts, so arranged that the pipe ends may be forced together when heated. The thermit is placed in an open top crucible lined with magnesia-tar, and ignited. After the reaction takes place, the slag, which is of course lighter in weight, rises to the top of the molten metal, and is first poured into the mould. This slag forms a protective coating on the pipe and on the inside of the mould, and keeps the thermit from melting or burning through The thermit flows into the mould and forces out the bulk of the slag, but leaves a coating as mentioned. When the pipe ends become plastic they are forced together, completing the weld. After cooling, the mould is easily knocked off, since the slag coating prevents adhesion. To weld a pipe takes from ¾ to 1½ minutes. (For a detailed description of thermit fusion welding, *see* the article WELDING) Some of the principal uses to which thermit is put are in repairing broken rudder frames, propeller shafts, locomotive frames, steel rolling-mill pinions, and other heavy sections, but it cannot be economically used for welding thin sheet metal sections Welds have been made where from 3,000 to 4,000 lb. of thermit were used. For commercial purposes there are now produced three varieties of thermit, known as plain thermit, railroad thermit and cast-iron thermit.

The plain thermit is simply a mixture of aluminum and iron oxide, as already given. Railroad thermit is plain thermit with the addition of ⅝% nickel, 1% manganese and 15% mild steel punchings Cast-iron thermit is plain thermit with the addition of 3% ferrosilicon and 20% mild steel punchings. The various names of these mixtures indicate very closely their principal uses.
(E V.)

THERMOCHEMISTRY is the name given to that branch of theoretical chemistry which seeks to trace the connection between the heat evolved or absorbed during a chemical reaction and the nature and course of the reaction. Chemical reactions which are not accompanied by a great evolution of heat are familiar; the combustion of coal or gas, the reduction of iron ores by coke in the blast furnace, and the slaking of lime are common examples. All explosives are unstable compounds or mixtures of compounds, the gaseous reaction products of which are raised to a very high temperature by the great heat evolved by the explosion; the propulsive force is due to the great pressure exerted by the gaseous products, owing to the high temperature and to the small volume they occupy before expansion. Such reactions are familiar because their effects are so obvious. They take place so rapidly that the heat evolved cannot be dissipated without raising the products of the reaction to a high temperature. It is the effects of the high temperature that are noticed, rather than the fact that large amounts of heat are evolved. In the rusting of iron we have an example of a chemical reaction which is also accompanied by the evolution of much heat; but this fact escapes ordinary notice since the rusting usually takes place so slowly that the heat has time to dissipate without perceptibly raising the temperature of the metal.

If, however, finely divided iron filings are dropped into pure oxygen, the reaction takes place so suddenly that there is no time for the heat to get away before the particles get white hot.

Confronted with so many every-day examples of chemical reactions accompanied by evolution of heat, it is natural to assume a close connection between the energy changes and the material changes. For a long time, however, the interest of chemists was mainly occupied by material changes only. Following the general recognition of the law of conservation of matter and the gradual acceptance of Dalton's atomic theory in the early part of the 19th century, there was a great development of knowledge of the properties and composition of different chemical substances and of their action on each other The real development of modern thermochemistry may be said to start from the recognition of the law of conservation of energy in the middle of the century Somewhat earlier Thomas Andrews and Hess had systematically studied the thermal effects of chemical reactions taking place in solution, and Hess, as a result of his work, had formulated a law which is one of the consequences of the conservation of energy, namely, that the thermal effect of a chemical reaction is the same however it takes place.

Law of Conservation of Energy.—According to the law of

conservation of energy, energy, though it can exist in many forms, is indestructible No method is known by which it is possible to create energy out of nothing. No system is known from which it is possible to obtain useful work without an exactly corresponding diminution in the total energy of the system. If the system is restored to its original condition by the addition of heat, then the heat absorbed is found always to be exactly proportional to the amount of work performed by the system. A few specific examples will illustrate the application of the law to chemical processes.

(*a*) Heat is necessary to convert water at its boiling point into steam at the same temperature. A small part of this heat goes to perform work through expansion against atmospheric pressure, the major part is transferred into internal energy of steam molecules The internal energy of unit mass of water vapour is therefore considerably greater than that of unit mass of liquid water at the same temperature. When steam is condensed again to water, exactly the same amount of heat is evolved as was absorbed when it was formed.

(*b*) A chemical reaction, such as the combustion of petrol, can be made to take place without performance of useful work, *e.g.*, by allowing it to take place in a closed vessel. The heat evolved by the combustion of unit weight to carbon dioxide and water vapour under these conditions can be accurately measured. When petrol is burnt in an internal combustion engine, the power output (and therefore the useful work performed by combustion of unit weight), the loss of heat to the cylinder walls and the residual heat in the exhaust gases can all be measured The sum of the heat loss to the cylinder walls, and the residual heat in the exhaust gas is always less than the total heat of combustion by an amount which is the equivalent of the work done.

(*c*) A solution of copper sulphate will react with zinc, dissolving it and depositing copper. The heat evolved by the solution of an "equivalent" of zinc can be measured. In the Daniell cell, which consists of a zinc electrode dipping into zinc sulphate solution in a porous pot, surrounded by another container where a copper electrode dips into copper sulphate solution, this chemical reaction takes place in such a way that it can yield an electric current. We can obtain work from such a cell, *e.g.*, by using it to drive a small electromotor. The work can be measured accurately. If E is the electromotive force (volts) and C the current (ampères), then work done is EC units per second. While the current is passing we can measure the heat changes in the cell itself. These are found to be small, but not zero. If we express in heat units the electrical work done by the solution of unit mass, and add (or subtract) the simultaneous evolution (or absorption) of heat in the cell, we obtain a result which is the same as that obtained when the simple reaction was allowed to take place without the production of electrical energy. Alternatively, we could join the two electrodes with a wire and measure the heat produced in the wire by the passage of the electric current and the heat produced in the cell itself at the same time The sum of these two would be the same as the heat produced by dissolving the same weight of zinc in a similar solution of copper sulphate, but by arranging the experiment in this way, most of the heat appears outside the solution instead of inside it.

It will be observed that the applications of the principle of conservation of energy depend on the assumption that a unit of one kind of energy always bears a constant relation to a unit of any other kind of energy. This is a necessary deduction from the law. If a mass of m grams is held h centimetres above the earth's surface, its *potential energy* is measured by the product mgh, where g is the constant of gravity and mg the force (in dynes) with which the earth attracts it. If it is allowed to fall freely, and we neglect the resistance of the air, it will have a velocity of v centimetres per second just before hitting the earth. Its potential energy has then been entirely converted into *kinetic energy* which is measured by the product $\frac{1}{2}mv^2$. As no energy is lost, $\frac{1}{2}mv^2 = mgh$ and $v = \sqrt{2gh}$. When it hits the earth its kinetic energy is entirely converted into heat, and the amount of heat produced is exactly proportional to $\frac{1}{2}mv^2$, or to mgh. The potential energy is so called because, if the restraining force is removed, the mass acquires kinetic energy if left to itself. The energy is originally latent and only becomes apparent when the restraining force is removed; we can speak similarly of *latent* chemical energy.

Every element and every chemical compound has a definite content of energy which varies with the temperature. We know it varies with the temperature, because if we want to raise the temperature of anything we have to put heat into it. We do not know, however, what is the total energy content of any chemical substance, nor how it is divided up within the molecules; what we can determine is the *change in total energy* content which takes place during chemical reactions, and we can express the law of conservation of energy, in its application to chemistry, in the form

$$U = A - Q,$$

where U is the diminution in total energy content accompanying a chemical reaction, A is the work done during or by means of the reaction, and Q is the actual measured absorption of heat during the reaction. In applying this equation it is necessary to express all quantities in the same units. A, the work done by a chemical reaction, is usually either mechanical work, as in the internal combustion engine, or electrical work, as in the accumulator The unit of mechanical work in the C G.S system is the *erg*, the unit of heat is the *calorie*, which is the amount of heat necessary to raise the temperature of 1 gram of water from 15° to 16° C. The expenditure of $4{\cdot}18 \times 10^7$ ergs, or 4·18 *joules* will produce 1 calorie of heat.

Determination of Total Energy Changes.—The realization that the total energy content of a chemical substance was a property of the substance as important as any other property, and that the changes in energy accompanying chemical reactions were closely connected with the nature of the reaction, led to a very large number of experimental determinations of heats of reaction by J. Thomsen and M Berthelot. Heats of reaction are determined in principle by causing the reaction to take place rapidly under such conditions that its heat is transferred to a large and well stirred volume of water, which is thereby raised a few degrees in temperature. As the specific heat of water is by definition unity at 15° C, the heat evolved can be calculated if the mass of water and its rise in temperature are accurately known. Allowance must be made for the actual heating of the containing vessels and the reacting substances, and also for the loss of heat during the time the reaction takes place. This loss of heat is kept down by keeping the rise in temperature small, which necessitates the use of very sensitive thermometers. Accurate calorimetry depends essentially on making proper allowances for this loss of heat, or alternatively on methods employed to counterbalance it. In general the data given in chemical literature cannot be relied upon to within $\frac{1}{2}\%$, and in many cases the error of determination is much greater. An experimental error of this order may be serious in certain cases, as we shall see later.

It is necessary to distinguish between heats evolved when reactions take place at constant pressure and at constant volume. Only the latter accurately correspond in all instances to the change in total energy due to the reaction. If the reaction is allowed to take place at constant (atmospheric) pressure and there is a change in volume due to the reaction, then work is done, and the measured heat of reaction will not be the same as the change in total energy. In the case of reactions taking place between solids or liquids the difference is usually negligible; in cases of gases the necessary correction can be easily applied. For instance, in the combustion of methane to carbon dioxide and liquid water, $CH_4 + 2O_2 = CO_2 + 2H_2O$, three volumes of mixture react to form one volume of carbon dioxide and a negligible volume of liquid water. This diminution of volume means that at constant pressure work is performed by the atmosphere. This work reappears as additional heat in the calorimeter. If we take the volume of one mol. of gas (22·4 litres) as the unit volume, the work done, $2PXV$, according to the gas laws $= 2RT$, where R, the gas constant, is approximately 2 when the work is expressed in heat units, and T is the absolute temperature. Thus the heat of combustion of methane, measured at 18° C (or 291° absolute), should be approximately 1,200 calories higher when the combustion takes place at constant pressure, *e.g.*, when the gas is burnt in a jet, than when the mixture is burnt in a completely closed vessel. If, however, the

combustion takes place above 100° C so that no water vapour condenses, there is no change of volume, and no difference between the heats evolved at constant volume and constant pressure

Indirect Determination.—Many heats of reaction are difficult if not impossible to measure directly. This is true of most reactions in organic chemistry which either do not take place rapidly enough to allow of accurate measurement, or yield other products besides those under investigation. But if the heats of combustion of organic compounds are known, the heat of any conceivable reaction between such compounds can be estimated by means of the first law. Take, for example, the technically important formation of methyl alcohol from carbon monoxide and hydrogen which proceeds according to the equation, $CO+2H_2=CH_3OH$ The heat of combustion of 1 mol. of carbon monoxide to carbon dioxide at constant pressure is 68,300 calories The heat of combustion of 2 mols. of hydrogen to *liquid* water at constant pressure is $2\times68,400$ calories $=136,800$ calories The heat of combustion of 1 mol. of methyl alcohol in the form of vapour to carbon dioxide and liquid water is 182,000 calories. Now the total change in energy must be the same whether the carbon monoxide and hydrogen are burnt directly to carbon dioxide and water, or whether they are first transformed into methyl alcohol and then burnt. Hence the heat evolved when carbon monoxide and hydrogen unite at constant pressure to give methyl alcohol in the form of vapour is:

$$68,300+136,800-182,000=23,100 \text{ calories.}$$

This example will serve to show the importance of accuracy in calorimeter measurements. For suppose Thomsen, whose figures have been taken, underestimated the heats of combustion of carbon monoxide and hydrogen by 1%, and overestimated that of methyl alcohol by 1%, the corrected figure for the heat of reaction to methyl alcohol would then be $69,000+138,200-180,200=27,000$ calories, which is nearly 20% higher than the estimate made on the basis of Thomsen's recorded results

Variations Due to Physical Conditions.—Since the intrinsic (total) energy of a substance varies with the conditions under which the substance exists, it is necessary in recording the mechanical data to specify the conditions of the initial and final systems. Besides change of volume, the following conditions have to be considered: (1) Dilution of solutions. (2) Physical state. (3) Temperature.

(1) *Dilution of Solutions.*—Generally speaking, there is a considerable thermal effect when a substance is dissolved in water, and this effect varies in magnitude according to the amount of water employed It is only, however, when we deal with comparatively concentrated solutions that the heat-effect of diluting the solutions is at all great, the heat-change on diluting an already dilute solution being for most practical purposes negligible. In dealing, therefore, with dilute solutions, it is only necessary to state that the solutions are dilute, the exact degree of dilution being unimportant. It occasionally happens that a change in dilution affects the chemical action that occurs. Thus, if concentrated instead of dilute sulphuric acid acts upon zinc, the action takes place to a great extent not according to the equation $Zn+H_2SO_4=ZnSO_4+H_2$, but according to the equation $Zn+2H_2SO_4=ZnSO_4+SO_2+2H_2O$, sulphur dioxide and water being produced instead of hydrogen. Here we have a different final system with a different amount of intrinsic energy, so that the thermal effect of the action is altogether different.

(2) *Physical State.*—The physical state of the reacting substances must be considered, since comparatively large amounts of heat are absorbed on fusion and vaporization. Thus the heat of fusion of ice (for 18 grams of H_2O) is 1,440 cal , and the heat of vaporization of water at 100° for the same quantity is 9,670 cal. When a substance, *e.g.*, carbon, phosphorus, sulphur, exists in allotropic forms, the particular variety employed should always be stated, as the conversion of one modification into another is frequently attended by a considerable thermal effect. Thus the conversion of white into red phosphorus evolves about one-sixth of the heat of combustion of the latter in oxygen, and so the knowledge of which variety of phosphorus has been employed is of essential importance in the thermochemistry of that element. (*See* ALLOTROPY.)

(3) *Influence of Temperature.*—The influence of temperature on the thermal effects of a chemical reaction is sometimes considerable. If we know the change in total energy associated with any reaction at one temperature, the first law enables us to calculate it for any other temperature. If, for example, the total energy content at temperature T_1 is U_{H_2} for 1 mol. of hydrogen, U_{O_2} for 1 mol. of oxygen, and U_{H_2O} for 1 mol. of water vapour, the change in total energy due to the combination of hydrogen and oxygen to form 2 mols of water vapour is, say,

$$2U_{H_2}+U_{O_2}-2U_{H_2O}=U_{T_1}.$$

If we raise the temperature of 1 mol. of hydrogen (etc.) from T_1 to T_2, its total energy is increased by $(C_v)_{H_2}(T_2-T_1)$, where $(C_v)_{H_2}$ is the mean capacity for heat of 1 mol. of hydrogen at constant volume between the temperatures T_2 and T_1. This is simply a definition of what we mean by *molecular specific heats*. Hence the total energy change at the higher temperature T_2 is:

$$2\{U_{H_2}+(C_v)_{H_2}(T_2-T_1)\}+U_{O_2}+(C_v)_{O_2}(T_2-T_1)$$
$$-2\{U_{H_2O}+(C_v)_{H_2O}(T_2-T_1)\}=U_{T_2}$$

$$\therefore\quad U_{T_2}-U_{T_1}=(T_2-T_1)\{2(C_v)_{H_2}+(C_v)_{O_2}-2(C_v)_{H_2O}\}$$

We can express this most simply by saying that the rate of change of U with the temperature (dU/dT) is equal to the sum of the heat capacities of the reacting compounds minus the sum of the heat capacities of the products of the reaction.

Thermochemical Measurements.—Some general results of thermochemical measurements applied to heats of combustion, neutralization and solution may now be considered.

(a) *Heats of Combustion.*—Experiment has shown that the heat of combustion of organic substances of various kinds varies regularly with the molecular weight. The difference between the heats of combustion of two neighbouring members in a series of homologous compounds is practically constant, and the value of the constant shows very little variation as we pass from one series to another. Thus the heat of combustion of methane, CH_4, to carbon dioxide and liquid water at constant pressure is 212,000 calories; of ethane, C_2H_6, is 370,500 calories, a difference of 158,500 calories; of propane, C_3H_8, is 529,200 calories, which is 158,700 above that of ethane; and the heat of combustion of all paraffin hydrocarbons (C_nH_{2n+2}) can be expressed by the formula $212,000+158,500\ (n-1)$ or $158,500\ n+53,500$ calories, where n is the number of carbon atoms in the molecule, and the mass to which the heat of combustion refers is the molecular weight in grams of the compound.

Similarly the heat of combustion of alcohols $C_nH_{2n+1}OH$, can be expressed by the formula:

$$183,000+158,800\ (n-1)$$

or

$$158,000n+34,200 \text{ calories.}$$

As a rule the addition of a CH_2 group to any organic molecule will increase the molecular heat of combustion by about 158,800 calories, but the rule is not exact, and the actual figure varies somewhat from series to series. In particular the heat of combustion of two isomeric substances, *i.e* , substances with the same number of carbon, hydrogen, oxygen, etc., atoms in the molecule, but differently arranged, are very nearly but not exactly the same. It follows that there are similar regularities in the *heats of formation* of organic compounds, for the heat of formation is the difference between the heat of combustion of a compound and the total heats of combustion of the carbon, hydrogen, etc., it contains.

(b) *Heats of Neutralization.*—The heats of neutralization of acids and bases in aqueous solution are additively composed of two terms, one being constant for a given base, the other constant for a given acid. In addition to this the further regularity has been observed that, when the powerful monobasic acids are neutralized by the powerful monacid bases in dilute solution, the heat of neutralization is in all cases the same. The following table gives the heats of neutralization of the commoner strong monobasic acids with soda:

	Formula	Cal.
Hydrochloric acid	HCl	137,400
Hydrobromic acid	HBr	137,500
Hydriodic acid . .	HI	136,800
Nitric acid	HNO_3	136,800
Chloric acid .	$HClO_3$	137,600
Bromic acid .	$HBrO_3$	137,800

Within the error of experiment these numbers are identical.

It was at one time thought that the greater the heat of neutralization of an acid with a given base, the greater was the strength of the acid It is now known, however, that when weak acids or bases are used, the heat of neutralization may be either greater or less than the normal value for powerful acids and bases, so that there is no proportionality, or even parallelism, between the strengths of acids and their heats of neutralization (*see* CHEMICAL ACTION).

(*c*) *Heats of Solution.*—When substances readily combine with water to form hydrates, the heat of solution in water is usually positive; when, on the other hand, they do not readily form hydrates, or when they are already hydrated, the heat of solution is usually negative The following examples show the effect of hydration on heat of solution in a large quantity of water:

I. *Sodium Carbonate*

	Heat of solution	Heat of hydration
	cal.	cal
Na_2CO_3 .	+ 5,640	.
Na_2CO_3,H_2O	+ 2,250	+ 3,390
$Na_2CO_3,2H_2O$	+ 20	+ 5,620
$Na_2CO_3,10H_2O$. .	−16,160	+21,800

II. *Sodium Sulphate*

	Heat of solution	Heat of hydration
	cal	cal.
Na_2SO_4	+ 460	..
Na_2SO_4,H_2O . .	− 1,900	+ 2,360
$Na_2SO_4,10H_2O$. .	−18,760	+19,200

First and Second Laws of Thermodynamics.—It should be clearly realized that the *law of conservation of energy*, like the law of conservation of mass, is a statement of experimental observations and in chemistry admits of no exception. All recorded observations support the law within the unavoidable errors of experiment; all deductions from the law have been amply verified. Apparent limitations of the law have been brought to light by recent physical research, and in particular through Einstein's famous theory of relativity (*q v.*), but in ordinary chemistry we do not deal with atomic or ultra-atomic changes, but with molecular rearrangements, and the laws of conservation of energy and mass, as originally conceived, still hold good.

Reversible Chemical Reactions.—As the result of the large number of experiments made by them, Thomsen and, later, Berthelot expressed the opinion that heat of reaction must be regarded as a measure of chemical affinity, and that every chemical change tended to take a course which evolved the maximum amount of heat. Berthelot in particular regarded this as a general guiding principle in chemistry, and impressed its importance so much on others that it continued to be upheld long after Berthelot himself had recognized its error. It is not easy now to realize why this "principle" commanded such universal acceptance; simple physical transformations which took place spontaneously either with absorption or evolution of heat, according to the circumstances, must have been familiar For instance, water will freeze spontaneously and in doing so will liberate thermal energy if the temperature is below 0°. Above 0° ice melts spontaneously and in doing so absorbs heat from its surroundings. Further, even at the time Berthelot put forward his theory, there was a growing recognition of the fact that many *chemical reactions are reversible, i.e.*, that they take place either in one direction (with evolution of heat) or in the opposite direction (with absorption of heat), according to the conditions of temperature and pressure and the relative masses of the reacting substances. So long ago as 1801, the great French chemist Berthollet had introduced the idea of "chemical equilibrium," and in the same year that Berthelot put forward his erroneous theory (1867) Guldberg and Waage published their famous book on chemical affinity, which dealt with reversible chemical reactions and in which they put forward the *law of chemical mass action.*

Chemical Equilibrium —This law, in so far as chemical equilibrium is concerned, may be formulated as follows. Suppose chemical substances, A_1, A_2, etc , react to form B_1, B_2, etc The reaction tends to proceed until a condition of equilibrium is set up, governed by the equation

$$\frac{[A_1]\times[A_2]\times \text{etc}}{[B_1]\times[B_2]\times \text{etc}} = K.$$

where $[A_1]$, etc., represents the concentration of the compound A_1, etc , in the equilibrium mixture. On the other hand, if the compounds B_1 and B_2 are originally brought together, then the reaction will proceed in the reverse direction with production of A_1 and A_2 until the same condition of equilibrium is set up. The value of the *equilibrium constant* K is itself independent of concentration—for example, in the case of gaseous reactions it is independent of pressure—but it varies with the temperature Clearly such constants are of great significance in the study of chemical affinities. If K is very small, then the affinity of A_1 for A_2, etc , may be said to be very great, and the affinity of B_1 for B_2, etc., small, although not zero.

The important thing to notice is that every single instance of a reversible chemical reaction really disproves the Berthelot principle. Nevertheless, the principle has this much to be said for it, that most chemical reactions which take place spontaneously at low temperatures do so with evolution of heat, and that it is only when the effects of high temperatures are studied that we become really familiar with important reactions that take place spontaneously with absorption of heat. There is one such reaction that is made use of daily on an enormous scale for the production of heat, namely, the reaction between steam and coke at a bright red heat to yield "water gas," a mixture of approximately equal volumes of hydrogen and carbon monoxide As the reaction proceeds the coke cools, and at regular intervals it is necessary to shut off the supply of steam, and to pass air over the coke in order to raise it again by combustion to a temperature sufficiently high to allow the reaction with steam to continue rapidly. It is true that the cooling of the coke during the passage of steam is not entirely due to the chemical reaction, for it is partly accounted for by the cooling effect of the steam itself, which is introduced to the retort at a lower temperature than the coke. But even if the steam were initially at the same temperature as the coke, it would be found that the mass gradually cooled The spontaneous formation of nitric oxide by the passage of air through an electric arc, a process by which nitric acid is manufactured on a large scale, is also accompanied by absorption of heat. Pure nitric oxide, on the other hand, decomposes into its elements, nitrogen and oxygen, at a somewhat lower temperature with evolution of heat Hydrogen and oxygen will combine explosively and completely at low temperatures; but steam is found to decompose spontaneously though not completely into hydrogen and oxygen if it is heated to a temperature above 2,000° C, and heat is absorbed during the decomposition. Clearly, therefore, the heat evolved during a chemical reaction cannot give a direct measure of the affinity of the reacting substances

The first big practical advance that was made in our knowledge of the relations between thermal changes and chemical affinity was due to van't Hoff's demonstration that the law of mass action was a necessary consequence of the second law of thermodynamics and of the quantitative connection between the value of the "equilibrium constant" and the change in total energy due to the reaction. The second law of thermodynamics, like the first, is a statement of experience, perhaps one might say a collection of inter-related statements of experience. The first law states that it is impossible to create energy; the second law states that it is im-

possible to convert the heat energy of our surroundings continuously into useful work. The second law deals with a question which the first law does not answer, namely, under what conditions can heat energy be converted into useful work (that is to say, mechanical energy). If heat energy passes spontaneously from one body to another, the first body is said to be at a higher temperature. It is a matter of universal experience that the reverse change, *i.e.*, the passage of heat from one body to another of higher temperature never takes place spontaneously It is also a matter of experience that any spontaneous process can be made to yield a definite amount of useful work For instance, the cooling of a furnace is a spontaneous process By the use of steam and suitably designed engines, it is possible to obtain useful work from this process

Carnot's Definition—The question how much useful work can be obtained by the spontaneous passage of heat from one temperature to another is of fundamental importance not only in mechanical engineering but in the science of chemistry. Carnot, a French engineer, actually solved this problem in 1824 before the law of conservation of energy was universally accepted. He showed that the maximum amount of work which can possibly be obtained from the "spontaneous" transference of a quantity of heat Q from a reservoir at temperature T_1 to another of the lower temperature T_2 was $Q(T_1-T_2)/T_1$. It will be noted that Carnot's result involves a quantitative definition of "absolute" temperature. The so-called "thermodynamic scale of temperatures" which is implicit in his result, is based on the behaviour of a perfect gas, the energy content of which is independent of its volume and dependent only on the temperature The absolute temperature of a perfect gas is defined by the fundamental gas law $T=PV/R$, where P is the gas pressure, V its volume, and R a constant. The value of R depends on the units in which the pressure and volume are expressed Many gases approach very nearly the properties of the imaginary "perfect" gas, particularly at low densities.

The next point of interest is that Carnot in deriving his result imagined a perfectly frictionless engine, with a perfect gas as a working fluid, taking heat from the high temperature reservoir (as steam takes heat from a furnace), converting part of the heat into work, and rejecting the rest to the low-temperature reservoir. The argument is that such an engine will always yield the maximum amount of work, because if it is reversed, the expenditure of work, only infinitesimally greater in amount than the engine yields on the direct operation, will suffice to restore the heat from the low temperature to the high temperature reservoir. For suppose it was possible to make another reversible and frictionless engine which was capable of converting a greater proportion of the transferred heat into work. Then it would be possible to use part of the work yielded by this change to reverse the first engine, and to restore the whole system to its original condition, leaving a definite amount of work over which has been created out of nothing. This is contrary to the first law. Hence we say that the work that can be done by a perfectly efficient reversible engine or process is independent of the nature of the process.

The Gibbs-Helmholtz Equation.—This conclusion leads to a mathematical expression of the first and second laws of thermodynamics in a form which can be applied to all chemical as well as other phenomena. For if, instead of having a perfect engine to transfer heat from the reservoir at $T+dT$ to another at T, we allow a chemical process to take place in the first reservoir, yielding a maximum amount of work A and absorbing heat from the reservoir equal to Q, and we then reverse this chemical process in the second reservoir by the expenditure of $A-dA$ of work, we have gained an amount of work $=dA$, and if the process is conducted reversibly this work must be equal to that gained by any other perfect process; in other words, $dA=Q.dT/T$. But Q, the heat absorbed, is equal (by the law of conservation of energy) to the maximum work A, less the diminution in total energy U, *i.e.*,

$$dA=(A-U)dT/T,$$
$$\text{or } A-U=T\cdot dA/dT.$$

This is the relation which was deduced independently by Helmholtz and Willard Gibbs. The quantity A is the maximum amount of work that can be obtained from a (reversible) chemical process taking place spontaneously and at constant volume at the temperature T; $A+dA$ is the work that would be obtained by allowing it to take place at the same volume at the higher temperature $T+dT$; and U is the diminution of total energy which corresponds to the heat evolved when the reaction takes place without the performance of any work, *e.g.*, in a closed vessel. A is often known as the *decrease in free energy*, to distinguish it from U, the *decrease in total energy*.

The most direct use of this equation is found in its application to the electric cell or battery. For the electric cell is a contrivance for converting chemical energy into useful work. If the cell is reversible, the work will be the maximum obtainable from the chemical reaction which is the source of the electric current. What we mean by a reversible cell is that, if a potential infinitesimally greater than that yielded by the cell is applied to the electrodes, the current will travel in the reverse direction in the cell and the chemical reaction will be reversed. The lead accumulator is nearly reversible in this sense; so is the Daniell cell. The electromotive force of the Daniell cell is found to be 1·1 volts For every gram-equivalent of copper deposited and zinc dissolved in the cell, an amount of work is done $=EF$, where F is the quantity of electricity (96,540 coulombs) associated with one gram-equivalent. These units can be expressed in calories; calculation shows that if E is the potential, the work done by the reaction is $23{,}050E$ calories. Hence the work done by the Daniell cell is 25,260 calories per gram-equivalent of copper deposited. The heat of the reaction, when it takes place without performance of work, is found to be 25,060 calories Hence in this case $A=U$ nearly. We should find therefore that dA/dT, or dE/dT, which is the change of electromotive force with the temperature, is very small. Measurement shows that it is only 0·000034 volt per degree.

Lord Kelvin put forward the view in 1851 that the electromotive force of a cell could always be calculated from the heat of the chemical reaction, that is to say from the decrease in total energy. This "law" involves the assumption that no chemical reaction can be made to yield electrical energy unless it is accompanied by a decrease in total energy. It holds approximately for the Daniell cell, and for others such as the standard Weston cell. The Helmholtz equation shows that it can only be true when the electromotive force does not change with the temperature. We are familiar now with cells which yield an electric current even if the chemical reaction is associated with an absorption of heat; we know of cells the voltage of which increases with temperature, and others in which it decreases. None of these cells obeys Kelvin's law, but the behaviour of all of them can be shown to be in exact accordance with the Helmholtz equation. The study of electric cells provides the most interesting and exact confirmation of the fundamental laws of thermodynamics.

The Van't Hoff Equation.—Apart from the combustion of coal and oil, most chemical reactions interest us more from the point of view of the nature of their products than from that of the work obtainable from them As all chemical reactions are in principle reversible, and as many of the more important from a practical point of view can be made to proceed in one or the other direction according to conditions of temperature and pressure, it is not only of theoretical interest but of great technical importance to get an accurate picture of the relations between chemical equilibrium and thermal changes Van't Hoff succeeded in doing this by calculating the maximum work that could be obtained from a chemical reaction taking place between gases, by the use of an imaginary "ideal" process. By the application of the second law two important results emerged:

(1) *The law of mass action*, first deduced from consideration of molecular theory, was shown to be a necessary consequence of the thermodynamical laws, that is to say, if a state of equilibrium exists between gases according to the chemical equation

$$n_1\mathrm{A}+n_2\mathrm{B}+\text{etc}=n'_1\mathrm{A}'+n'_2\mathrm{B}'+\text{etc.}+U \text{ calories,}$$

then

$$\frac{[\mathrm{A}]^{n_1}\times[\mathrm{B}]^{n_2}\times\cdots}{[\mathrm{A}']^{n'_1}\times[\mathrm{B}']^{n'_2}\times\cdots}=K.$$

(2) *The equilibrium constant* K was shown to be connected with the temperature and the decrease in total energy through the equation

$$d \log_e K/dT = U/RT^2.$$

In practical applications it is usually more convenient to express the quantities of gases present in an equilibrium mixture in terms of their partial pressures instead of their concentrations. If there are N molecules of gas present altogether in a mixture which contains n_1 molecules of one kind, n_2 of another, and so on, the partial pressures are n_1P/N, n_2P/N, etc. where P is the total pressure. It is simple to show that

$$\frac{P_A^{n_1} \times P_B^{n_2} \times}{P_A^{n_1'} \times P_B^{n_2'} \times} = K_p$$

where P_A^n represents the partial pressure of A, and the new constant $K_p = K(RT)^{\Sigma n}$, Σn being the difference between the number of the reacting molecules and the total number formed by the reaction. $d \log_e K_p/dT = Q_p/RT^2$. It can also be easily shown that where Q_p is now not necessarily the diminution in total energy, but corresponds to the heat evolved when the reaction takes place at constant pressure, without the performance of any work other than that due to the change of volume, if any, associated with the reaction. This equation is similar to that found to hold good for the change of vapour pressures of liquids (and solids) with the temperature, *viz.*, $d \log_e p/dT = \lambda/RT^2$, where λ is the latent heat of evaporation of one gram-molecule of the liquid or solid

Some Thermochemical Reactions.—The application of these equations to chemistry inaugurated a new era, and led not only to a rapid extension of our knowledge of chemical reaction, but also to the recognition of the connection between many apparently diverse phenomena. Some illustrations of the use of the equations will now be given.

Hydrogen and oxygen combine to form steam with evolution of heat according to the equation

$$2H_2 + O_2 = 2H_2O + 116{,}000 \text{ calories.}$$

If we start with 2 mols of hydrogen and 1 mol. of oxygen, then according to the law of mass action an equilibrium will be reached when $2(1-x)$ mols. of water vapour are formed, and $2x$ mols. of H_2 and x mols. of O_2 are left uncombined. Supposing the volume occupied is v, then the law states that at equilibrium

$$\frac{\text{(Concn. of } H_2)^2 \times \text{(Concn. of } O_2)}{\text{(Concn. of water vapour)}^2} = K$$

or

$$\frac{\left(\frac{2x}{v}\right)^2 \times \frac{x}{v}}{\left\{\frac{2(1-x)}{v}\right\}^2} = K \text{ or } \frac{x^3}{(1-x)^2} \times \frac{1}{v} = K.$$

Now at ordinary temperatures, the amount of hydrogen and oxygen left uncombined is very small and escapes direct measurement. As x is small, K is also small. But van't Hoff's equation shows that, as U is large and positive, log K, and therefore K, increases with the temperature. Hence x increases with the temperature. In other words, water vapour will dissociate when the temperature is raised.

This result may be generalized. All compounds which are formed with evolution of heat tend to decompose when the temperature is raised The same applies to molecules such as H_2, O_2, N_2, Cl_2, I_2, etc., which are formed from their atoms with evolution of heat. Conversely, compounds which are formed with absorption of heat become more stable at high temperatures. Nitric oxide cannot be made from nitrogen and oxygen at low temperatures, but is formed when air is blown through an electric arc. Hydrogen peroxide may be detected in an oxy-hydrogen flame. Calcium carbide is formed in an electric furnace at a very high temperature. If v in the equation given above is made smaller, then x must also diminish, because K is constant. High pressure tends, therefore, to assist combination or to prevent dissociation. This is the case whenever the reaction is accompanied by a decrease in the number of molecules. The synthesis of ammonia is an important technical example. Here one molecule of nitrogen combines with three molecules of hydrogen to form two of ammonia, $N_2 + 3H_2 = 2NH_3$. The mass action equation is

$$27x^4/4(1-x)^2v^2 = K,$$

where x is the fraction of nitrogen left over If the value of v is diminished, x must also be diminished, and the amount of ammonia formed increases. As is well known, the commercial success of the process depends on very high pressure being used. If no change in the number of molecules is caused by a reaction, v cancels out, and therefore an alteration in the pressure has no effect on the equilibrium. If the number of molecules is increased, v appears in the numerator instead of the denominator, and an increase of pressure will then have the opposite effect.

The effects of pressure and temperatures on equilibrium can be generalized in the statement that the equilibrium will always adjust itself in such a way as to oppose a change in physical conditions. If the pressure is increased, the equilibrium will shift in the direction of smaller volume. When heat is added that reaction will take place which results in an absorption of heat, thus tending to stop a rise of temperature. The same applies to physical processes. Water expands when it freezes; if we compress ice at the freezing point it will do its best to diminish its volume by melting Liquids always absorb heat when they evaporate; if heat is added to water which is boiling at atmospheric pressure, its temperature is not increased. All that happens is that it boils faster.

If a reaction between gases is studied experimentally at any one temperature and pressure, so that the equilibrium conditions are known, then the effect of a variation in pressure at that temperature can be accurately calculated provided the mixture obeys the "perfect gas" laws If the heat of reaction is also known at that temperature, then the equilibrium for any other temperature not too far removed can be calculated from van't Hoff's equation. For integration of the equation gives

$$\log_e K = -U/RT + \text{constant},$$

if U does not change much with the temperature. Hence if K_1 and K_2 are the equilibrium constants at temperatures T_1 and T_2

$$\log_e K_1/K_2 = U(1/T_2 - 1/T_1)/R.$$

Gases and Solids.—Chemical reactions in which gases and solids take part present features of special interest. To take a simple example, carbon dioxide combines with lime to form calcium carbonate with evolution of heat:

$$CaO + CO_2 = CaCO_3 + 42{,}500 \text{ calories.}$$

solid gas solid

Now the pressure of saturated vapour above any solid or liquid is independent of the amount of solid or liquid present, unless the amount is very minute. If a closed space contains carbon dioxide gas, in the presence of solid calcium oxide and carbonate, there will be an equilibrium in the gaseous phase governed by the relation

$$\frac{\text{(Concn. of CaO vapour)} \times \text{(Concn. of } CO_2)}{\text{(Concn of } CaCO_3 \text{ vapour)}} = K.$$

As the concentrations of the vapours of the two solids are constant (though extremely small) at any given temperature, it follows that the concentration of carbon dioxide must also be constant. In other words its pressure is constant. Above a mixture of calcium oxide and carbonate we have, therefore, our apparent "vapour" pressure of carbon dioxide, which varies with the temperature.

The heat of the reaction is analogous to the heat of evaporation of any solid or liquid, and if P is the "vapour" pressure, which is called the *dissociation pressure* in this and similar cases,

$$d \log_e P/dT = Q/RT^2,$$

where Q is the heat of reaction, *i.e.*, the heat absorbed on dissociation of 1 gram-molecule, and includes the work done against atmospheric pressure by the evolution of 1 gram-molecule of

carbon dioxide The dissociation pressure, like the vapour pressure of liquids, increases with the temperature. At a high temperature, about 900° C, the dissociation pressure is equal to ordinary atmospheric pressure. If the carbonate is heated above this temperature it is converted into lime and carbon dioxide is rapidly evolved

If other carbonates are examined it is found that the temperature at which they are converted into their oxides varies directly with their heat of dissociation as the following table shows:

Substance	Heat of dissociation	Temperature
	cals	°C
Silver carbonate	20,100	225
Lead carbonate	22,600	302
Manganese carbonate	23,500	*ca* 330
Calcium carbonate	42,500	900
Strontium carbonate	55,800	1,150

On similar reasoning, it may be shown generally that in all reactions in which gases and solids take part, the equilibrium conditions only take account of the gases. For instance, when carbon dioxide is passed over red-hot coke it is converted into carbon monoxide with absorption of heat, $C+CO_2=2CO-38,500$ calories. The equilibrium condition is

$$P_{co}/P_{co_2}=K \text{ or } d\log_e K_p/dT=38,500\ RT^2$$

from which it can be deduced (*a*) that the ratio CO/CO_2 in the gas mixture at equilibrium is constant if the temperature and pressure are constant; (*b*) that if the temperature is kept constant, and the pressure is increased, the proportion of carbon monoxide in the mixture goes down; (*c*) that if the temperature is increased, the proportion of carbon monoxide goes up.

In the blast furnace, air is blown through a white-hot mixture of oxides of iron and coke, and the carbon monoxide formed by the combustion of coke reduces the oxides to metallic iron. The exit gases must contain a large proportion of carbon monoxide to carbon dioxide, corresponding to the equilibrium conditions which obtain near the cooler top of the furnace It was at one time thought that by building furnaces higher, the period of contact between the gases and the ore would result in a greater measure of reduction, a diminished proportion of carbon monoxide in the exit gases, and consequently a smaller consumption of coke per ton of ore reduced Attempts to achieve these results, by building furnaces as high as 100 ft., failed. As Le Chatelier pointed out, if there had been a better acquaintance with the laws of chemical equilibrium, these experiments would have been unnecessary. It was an expensive, although no doubt an instructive, method of proving the correctness of one of the deductions from the second law.

Heat and Velocity of Reaction.—These examples will suffice to indicate how the quantitative application of simple fundamental thermodynamic principles has been successful in reducing to order an enormous range of observations on chemical reactions apparently very diverse in character It has also given the chemical engineer the power to calculate the conditions for achieving the maximum technical success in the conduct of any chemical manufacture on the large scale. Unfortunately, though the application of thermodynamics has been so successful in the study of chemical equilibrium, it has as yet taught us nothing about the rate at which equilibrium is attained, or, in other words, about the rate of chemical reaction. There seems to be no direct connection between the rate of a reaction and either the heat evolved (change in total energy), or the maximum work of the reaction (change in free energy). Hydrogen has a great affinity for oxygen, and much heat is evolved when they combine; yet a mixture of them can be kept for an indefinite period of time at the ordinary temperature without a trace of combination. Nitric oxide is an extremely unstable substance at low temperature; on thermodynamical grounds we should expect that only an infinitesimal amount of it would be in equilibrium with nitrogen and oxygen at the ordinary temperature; yet it is so difficult to decompose by heat that even at 900° C it only decomposes slowly Ammonia becomes progressively less stable as the temperature is raised. Thermodynamics indicates that in order to obtain high yields, its synthesis from nitrogen and hydrogen should be conducted at as low a temperature as possible The reaction is, however, so slow that technical manufacture only becomes possible at temperatures so high that the yield of ammonia at atmospheric pressure is extremely small The ill effects of the high temperature have to be counterbalanced by the use of high pressures Nearly all gas reactions take place extremely slowly unless the temperature is very high. Nearly all, too, take place more quickly in the presence of certain solids called catalysts. The nature of the catalyst to produce the best results varies with the nature of the reaction, and though many theories have been put forward to account for their action, there is no general theory which has been successful in predicting anything—which is the ultimate test of the real value of a theory

Free Energy.—The second law of thermodynamics deals with changes in the free energy of a system A system only possesses "free energy" when it is capable of doing work. It is only capable of doing work if it will change spontaneously into another system of greater stability. Only an unstable system has free energy A stable system can be changed into an unstable system by the performance of work, or by the transference of free energy from another system The whole of life, and of civilization as we know it, depends on thermodynamic instability; as Boltzmann (1886) put it, the struggle for existence is a struggle for free energy available for work Nearly all manufacturing processes depend essentially on using the free energy stored in coal to convert a useless stable system into a useful unstable system For instance, the synthetic manufacture of fertilizers depends essentially on the use of a small part of the free energy available when *coal is burnt*, to convert the stable system nitrogen+water, into the unstable system ammonia+oxygen. The ammonia in various forms can be made use of to fertilize plants, *i.e.*, to increase the free energy in the plant world which the animal world can convert again into useful work The enormous amount of energy which the earth continuously receives from the sun is theoretically almost completely available for useful work, for the energy leaves the sun at a temperature over 8,000° and is finally dissipated into space at a temperature of about 300° Absolute. Calculation shows that the energy so received is at least a million times greater than the energy given by the world's power plants But unfortunately we know of no means for making use of anything more than a minute fraction of the sun's energy. A very small part of it is converted into mechanical energy by water power plants; another very small part is used by the plant world to build up "unstable" organic compounds, and thus to supply the free energy available in food. One of the chief tasks of the scientist of the future will be to devise means for converting into useful work, or storing, a greater part of the energy received from the sun. The second law shows that this should be possible. If he does not succeed the advance, and even the maintenance, of civilization may be impossible when the energy stored in coal through the agency of the plant world in past ages is exhausted.

The Third Law of Thermodynamics.—It has already been pointed out that although the Gibbs–Helmholtz equation enables us to calculate from purely thermal data the change in any equilibrium with the temperature, it does not give any information on the actual value of the equilibrium constant unless this is already known from experimental observations under one set of conditions. To obtain the actual value from purely thermal data, it is necessary to integrate the fundamental equation $d\log_e K/dT=U/RT^2$, and integration introduces an unknown integration constant.

In 1901 Nernst advanced a method of evaluating this constant, and his theorem is often referred to as the "third law" of thermodynamics, although its universal applicability is still open to some doubt.

In Condensed Systems—Nernst postulates that in the case of chemical reactions in *condensed systems, i.e.*, reactions in solids or between solids and liquids, not only does A become $=U$ at

absolute zero ($T=0$), as is required by the Gibbs-Helmholtz equation, but that they both reach their final (equal) value at temperatures not far removed from the absolute zero In mathematical language, $dA/dT=dU/dT=0$ when $T=0$. Now dU/dT is equal to the difference between the sum of the molecular heat capacities (C_v) of the reacting substances and of the products. Since it is found by experiment that the specific heats of substances can be expressed with sufficient accuracy by equations of the form $C_v=a+bT+cT^2+$ etc. it follows that U can also be expressed in the form

$$U=U_0+\alpha T+\beta T^2+\gamma T^3+\ldots$$

But if $dU/dT=0$ when $T=0$, it follows that $\alpha=0$, or

$$U=U_0+\beta T^2+\gamma T^3.$$

If this expression for U is substituted in the fundamental equation $A-U=T.\,dA/dT$, it follows that

$$A=U_0+\alpha T-\beta T^2-\frac{\gamma}{2}T^3-\text{etc.}$$

where α is an unknown constant But if $dA/dT=0$ when $T=0$, as Nernst postulates, α must also be equal to zero, and therefore

$$A=U_0-\beta T^2-\frac{\gamma}{2}T^3-\text{etc}$$

Hence if the heat of reaction, and the specific heats of the substances taking part in the reaction are known, it should be possible to calculate A for any temperature.

Consider such a change as the melting point of a solid, or a transition from one modification to another such as the change from rhombic to monoclinic sulphur. Then at the temperature when the solid and liquid, or the two forms of solid, co-exist in equilibrium, A, the work obtainable from the change, is zero. If we know the heat of the reaction at this temperature (latent heat), and if we know the difference between the specific heats of the two forms over a wide range of temperature, we can express U in the form

$$U=U_0+\beta T^2+\gamma T^3+$$

and therefore T, the temperature where $A=0$ (melting point, or transition point), is given by

$$U_0=\beta T^2+\frac{\gamma}{2}T^3+\cdots$$

Nernst has shown how the transition point of sulphur can be calculated in this way from purely thermal data.

The difficulty of applying the theory to a wide range of such reactions is due to the fact that the all-important knowledge of the variation of specific heats with temperature is still lacking in the majority of cases; only in the case of regularly crystallizing elements do we now know the relation accurately. Theory is insufficiently advanced to guide us in the other cases, and accurate experimental work over a great range of temperature is extremely difficult as well as laborious. Nevertheless the application of the Nernst theorem to many different types of condensed systems has been so successful, and the theorem itself is supported in so many other indirect ways, that there is little doubt as to its essential truth.

In Gas Reactions.—It is, however, in its extension to gas reactions that the Nernst theorem has won its most significant successes. If we substitute for U in the van't Hoff equation, the expression

$$U=U_0+\alpha T+\beta T^2+\cdots$$

we get

$$\frac{d\log_e K}{dT}=\frac{U_0}{RT^2}+\frac{\alpha}{RT}+\frac{\beta}{R}+\cdots$$

Integration gives

$$\log_e K=-\frac{U_0}{RT}+\frac{\alpha}{R}\log_e T+\frac{\beta}{R}T\cdots+I,$$

where I is an unknown integration constant. Since the vapour pressure (p) of a liquid is similarly connected with the latent heat (λ) by the equation $d\log_e p/dT=\lambda/RT^2$, we can also write

$$\log_e p=-\frac{\lambda_0}{RT}+\frac{\alpha_0}{R}\log_e T+\frac{\beta_0}{R}T+\text{etc.}+i,$$

where i is the unknown integration constant of the vapour pressure curve.

Nernst shows that a consequence of his fundamental theorem is that $I=\Sigma ni$, where n is the number of molecular species taking part in the reaction; that is to say, if the reaction is

$$\text{A+B+C+ etc. = D+E+F+ etc.}$$

then $$I=i_A+i_B+i_C+\cdots-i_D-i_E-i_F\cdots\text{etc.}$$

This is a most important advance, for it means that it is possible to calculate any equilibrium between gases, provided the heat of the reaction is known, and the vapour pressure curves of the molecular species taking part in the reaction.

In the absence of sufficiently accurate data to make the strict application of the Nernst theorem possible, except in a very small number of cases, Nernst has also developed an approximation formula which is of great practical use It depends on the fact that the *vapour pressure* of most substances can be represented sufficiently accurately by the equation

$$\log_{10} p=-\frac{\lambda_0}{4{\cdot}57T}+1{\cdot}75\log_{10}T-\frac{\beta T}{4{\cdot}57}+C$$

C, the so-called *conventional chemical constant*, is itself found to be approximately $0{\cdot}14\ \lambda/T_0$, where λ is the latent heat at the boiling point T_0 For most substances which are liquid at the ordinary temperature, $\lambda/T_0=22$ approximately, and therefore $C=3{\cdot}1$ Only a few substances give values for C under 3, mainly they vary between 3 and 3·5.

On the basis of this semi-empirical vapour-pressure equation the corresponding formula for gaseous equilibria becomes:

$$\log_{10}K_p=-\frac{Q_p}{4{\cdot}57T}+\Sigma n{\cdot}1{\cdot}75\log_{10}T+\frac{\beta}{4{\cdot}57}T+\Sigma nC$$

which may as rule be further simplified by omitting the term $\frac{\beta}{4{\cdot}57}T$, thus giving:

$$\log_{10}K_p=-\frac{Q_p}{4{\cdot}57T}+\Sigma n{\cdot}1{\cdot}75\log_{10}T+\Sigma nC.$$

Now it is not pretended that an equation of this form represents actual results with accuracy. Its claim of utility is that it is based generally on correct principles, and that in actual practice it represents with considerable success the effect of temperature on chemical equilibria. A few examples will show how this claim is borne out.

(*a*) Consider the reaction:

$$2CO+O_2=2CO_2+136{,}000 \text{ calories.}$$

K_p, the equilibrium constant, is $P^2_{CO}\times P_{O_2}/P^2_{CO_2}$, where P_{CO}, etc., represents the partial pressure of CO_2 etc., in the equilibrium mixture. Q_p, the heat of reaction at constant pressure and room temperature, is 136,000 calories. Σn is the difference between the number of molecules on the left and right hand sides of the chemical equation, *i.e.*, $\Sigma n=1$; ΣnC is twice the chemical constant of CO plus the chemical constant of O_2 minus twice the chemical constant of CO_2, *i.e.*,

$$\Sigma nC=2\times 3{\cdot}5+2{\cdot}8-2\times 3{\cdot}2=3{\cdot}4.$$

$$\therefore \log K_p=-\frac{136{,}000}{4{\cdot}57T}+1{\cdot}75\log T+3{\cdot}4.$$

At 2,000° Abs. K_p calculated from this equation is 2×10^{-4} whereas the most recent results indicate that this value is reached at 2,020° Absolute. When CO_2 is half dissociated, there are 0·5 molecules of CO_2, 0·5 of CO, and 0·25 of O_2 present at equilibrium. If the total pressure is 1 atmosphere, the partial pressures of

CO and CO_2 are $\frac{0.5}{1.25}$ atmos., and of O_2, $\frac{0.25}{1.25}$ atmos.; therefore, $K_p = 0.2$. The corresponding temperature is calculated from the above equation to be 2,930° Abs., whilst the temperature actually observed is 3,100°.

(*b*) If the reaction brings about no change in the number of molecules, the second term of the equation vanishes, and the third usually becomes very small. For instance

$$2NO = N_2 + O_2 + 43{,}200 \text{ cals.}$$

and $$\log K_p = \log \frac{P^2_{NO}}{P_{N_2} \times P_{O_2}} = -\frac{43{,}200}{4.57\,T} + 1.6 = -\frac{9{,}450}{T} + 1.6.$$

This shows, in accordance with observation, that only at very high temperatures are appreciable quantities of nitric oxide formed from nitrogen and oxygen.

(*c*) If on the other hand, the change in the number of molecules is big, then the first term of the equation may be of little influence For instance, the probability of a high-boiling paraffin hydrocarbon being formed from hydrogen and carbon can be calculated:

$$n\text{C} + (n+1)\text{H}_2 = \text{C}_n\text{H}_{2n+2} + Q \text{ calories.}$$

Thomsen's experiments have shown that the heat of formation of such a hydrocarbon from its elements is given approximately by $Q_p = (7n+15)1{,}000$ As the chemical constant of H_2 is 1.6, and of C_nH_{2n+2} about 3.0 we have

$$\log K_p = \log \frac{P^{n+1}_{H_2}}{P_{C_nH_{2n+2}}} = -\frac{1000(7n+15)}{4.57\,T} + n \times 1.7 \log T + 1.6n - 1.4.$$

Suppose $T = 773°$, *i.e.*, 500° C. Then

$$\log \frac{P^{n+1}_{H_2}}{P_{C_nH_{2n+2}}} = -1.98n - 4.24 + 5.06n + 1.6n - 1.4 = 4.68n - 5.64.$$

If $n = 1$, *i.e.*, if the hydrocarbon formed is methane, CH_4, then

$$\log \frac{P^2_{H_2}}{P_{CH_4}} = -0.96 \text{ or } \frac{P^2_{H_2}}{P_{CH_4}} = 0.11$$

from which it can be calculated that if hydrogen is passed over carbon at 500° C., the issuing gas should contain about 70% of methane if equilibrium is reached. Experimental results agree quite well with this. If, however, $n = 7$, *i.e.*, if the hydrocarbon is heptane, C_7H_{16}, which boils at about 100° C., $\log \frac{P^8_{H_2}}{P_{C_7H_{16}}}$ is over 27, or $\frac{P^8_{H_2}}{P_{C_7H_{16}}}$ is over 10^{27}, which means that the amount of heptane formed at atmospheric pressure will be quite negligible. All the higher liquid hydrocarbons, such as occur in natural petroleum oil, are thermodynamically unstable at ordinary temperatures. They tend to pass into carbon and methane, but the velocity of this reaction at ordinary temperatures is very slow. If they are heated, however, they are "cracked"; hydrocarbons of lower boiling point, such as occur in petrol, are formed, and coke and gas are formed at the same time. If the cracking is continued for a long time at atmospheric pressure, the whole liquid forms into coke and gas (mainly methane). But high pressure tends to prevent the formation of gas and coke, and to give therefore a higher yield of "petrol." This is in complete general agreement with the Nernst equation, which enables us to predict approximately the conditions for the best technical success.

The further development of the third law, and its quantitative application to chemical problems depends on the provision of accurate data on the specific heats of substances over a wide range of temperature. The increase in the specific heat of gases as the temperature is raised lacks at present any sound theoretical explanation. The classical kinetic theory of gases does not account for it, and the more recent developments of the quantum theory have hitherto failed to be of assistance. But there can be little doubt that the third law provides in principle a complete explanation of the connection between chemical equilibria and the thermal changes associated with chemical reactions.

(H. T. T.)

THERMODYNAMICS. The name thermodynamics (from Gr. θερμός, hot, δύναμις, power), was originally given to the branch of science dealing with the motive power of heat, or the transformations of heat into mechanical work, or vice versa. A summary of the historical development of thermodynamics from this point of view is included in the article HEAT Further illustrations relating to heat-engines will be found in the articles INTERNAL COMBUSTION ENGINES and STEAM-ENGINE. The subject was soon extended to include other applications of the same general principles: (1) the conservation of energy, and (2) Carnot's principle of the reversible cycle, which are commonly known as the first and second laws of thermodynamics. The present article is intended to deal mainly with applications of these principles to the relations between the physical properties of a simple substance Further applications to physical chemistry, dealing with the conditions of equilibrium between different substances, are dealt with in a separate section.

THERMODYNAMICS AND HEAT ENGINES

Definitions of Symbols.—The principal physical properties of the working fluid with which we are concerned in the case of heat-engines are the specific volume V, the intrinsic energy E, the total heat H and the entropy Φ, all of which are measured per unit mass of the substance considered. The laws of thermodynamics require certain general relations between these properties and their derivatives, as affected by additions of heat Q per unit mass, or by variations in the imposed conditions of temperature T and pressure P. It should be observed that in all these relations P is the absolute pressure and not the gauge-pressure; and that T is measured on the absolute scale, as defined by Carnot's principle which differs very little from absolute temperature on the scale of a gas thermometer. Temperature measured on the same scale from 0° C. is denoted by t, so that $T = t + 273.1°$. The total heat H is defined as $E + aPV$ in thermal units, including the equivalent aPV of the work PV done by the pressure P on the volume V of unit mass. The entropy Φ of a quantity of heat Q supplied at a temperature T is defined as Q/T. The entropy of a substance per unit mass is the property which remains constant in adiabatic expansion, when no heat is supplied by friction or otherwise, as will be more fully explained in a later section, in connection with the second law of thermodynamics.

Applications of the First Law.—The intrinsic energy E denotes the quantity of energy existing in unit mass of the substance in any given state, which may in general be specified by its volume V and temperature T. We have no means of measuring the total quantity of energy contained in any body in a given state, but it suffices to be able to measure changes of E from any convenient state E_0 selected as the zero. Any such change from E_0 to E may be measured by observing the quantity of heat Q required to produce the change and the work W done by the substance per unit mass in the process. Assuming that no energy is lost, the application of the first law to this case gives the obvious relation

$$Q = E - E_0 + W/J. \qquad (1)$$

In any equation of this kind it is tacitly understood that all the terms are reckoned per unit mass of the substance, and are expressed in terms of the same units, either units of work or units of heat as desired. The general practice in dealing with heat-engines is to measure Q, E, and H in thermal units per unit mass, and to reduce W to thermal units by dividing by the appropriate value of the mechanical equivalent J. In nearly all cases W represents work done by expansion $V - V_0$ against a uniform pressure P, in which case $W = P(V - V_0)$, if P remains constant during the expansion, and equation (1) takes the form

$$Q = E - E_0 + aP(V - V) = H - H_0 \text{ at const. } P, \qquad (2)$$

where the total heat H is defined as $E + aPV$, and a is the factor required for reducing PV to heat units per unit mass. The factor

required for this purpose in practice is seldom $1/J$, because pressure-gauges are never graduated in lb/sq ft. or kg/sq mi., but often in arbitrary units such as inches of mercury.

Specific Heats.—If the heat Q is added at constant volume, $V=V_0$, and $W=0$, so that $Q=E-E_0$. If $T-T_0$ is the rise of temperature, we observe that the increase of E per degree at constant volume V_0 is equal to $Q/(T-T_0)$, which is by definition the specific heat s at constant volume. Similarly $(H-H_0)/(T-T_0)$ from (2) is equal to the specific heat S at constant pressure Thus the values of E along a line of constant volume on any diagram may be found from observations of the specific heat s at constant volume Similarly values of H along a line of constant pressure may be deduced from observations of the specific heat S at constant P.

Thus $H-H_0=S(T-T_0)$ at const. P,

and $E-E_0=s(T-T_0)$ at const V. (3)

These simple relations between H and S, and E and s, are exact for all substances at all temperatures in consequence of the definition of H, and are often very useful. But the specific heats S and s may vary widely with temperature and pressure, in which case it is usually better to measure H or E directly, in place of trying to deduce them from empirical formulae for S or s. In the case of solids or liquids, since V is small and varies little with T, the variation of E at constant *pressure*, such as atmospheric, does not differ appreciably from that of H. But the variation of H at *constant volume* may greatly exceed that of E under the same condition on account of the high pressures developed In practice it is usually preferable to measure the value of H and deduce that of E, if required, by subtracting aPV.

Application to Gases—In the case of ideal gases obeying the law $aPV=RT$, it follows directly from the general relations (3) that the difference $S-s$ is constant and equal to R. It will be shown later that the specific heats of such gases cannot vary with *pressure*, though they may vary considerably with *temperature*, while the difference $S-s$ remains constant, as in the case of hydrogen (*See* HEAT.) On the other hand, vapours, like steam, though they usually approximate closely to the law $aPV=RT$ at low pressures, show large deviations from the gas-laws at high pressures near saturation, and the value of S shows a wide range of variation with *pressure*, especially near the critical point. Fortunately these variations can be deduced from the thermodynamical relations given in a later section of this article

Cycle or Cyclical Process.—The application of the first law, as expressed in (1), to the cycle of a steam-engine, in which the working fluid is restored to its initial state of water at each repetition of the cycle, is fully considered in the articles already referred to. Briefly stated, if $E=E_0$ at the conclusion of the cycle Σ_0, it follows from (1) that the algebraic sum ΣQ of all the quantities of heat Q received and rejected by the working substance during the cycle must be equal to the net balance of work done by the engine per cycle, work done *by* the fluid in expansion being reckoned positive, and work done *on* the fluid in compression being reckoned negative. With this understanding the formula for the cycle may be expressed as follows,

$$\Sigma Q=\Sigma W=\int PdV. \qquad (4)$$

In an ideal reversible engine, in which no heat is lost and no work is wasted in friction, the area of the cycle on the PV diagram, expressed by the integral of PdV taken round the cycle, will represent the maximum work obtainable from the cycle considered. In any actual engine some of the heat received by the working fluid is lost before it has contributed its full quota of work, and some of the work done is reconverted into heat by internal friction and is rejected in the form of heat. If the properties of the working fluid are known, such losses may be estimated in the reciprocating engine by comparing the ideal diagram, as calculated, with the actual diagram as observed with the indicator. (*See* STEAM-ENGINE.) In the case of a turbine, to which the indicator method is inapplicable, it is necessary to use a different kind of diagram, or the ideal output may be calculated from the properties of the working fluid, and compared with that actually realised.

Frictionless Adiabatic Expansion.—The term "adiabatic" implies that there is no gain or loss of heat by the working fluid. Putting $Q=0$ in (1) we see that in this case $E-E_0$ must be equal to $-W/J$, or the intrinsic energy of the working fluid is *diminished* by an amount equivalent to the work done. If no work is wasted in friction, this represents the most efficient method of conversion of heat into work, which is the ultimate aim of every heat-engine. To calculate the work done from the integral of PdV under this condition, it is necessary to know the form of the expansion curve on the PV diagram, or the adiabatic equation representing the relation between P and V for the working fluid employed, which requires an appeal to experiment. Watt made the first experiments of this kind with his indicator, but found the expansion curve for a slow speed engine using wet steam to be approximately $PV=$constant, the same as Boyle's law for the expansion of a gas at constant temperature, whereas the fall of pressure in adiabatic expansion should have been more rapid than that given by Boyle's law owing to the fall of temperature. Watt was well aware that this anomaly was due to partial condensation of the steam on admission by the cool walls of the cylinder, followed by re-evaporation towards the end of the stroke, which made the conditions far from adiabatic Laplace subsequently showed (*see* HEAT) that the rate of drop of pressure dP/dV in the adiabatic expansion of a *gas* must exceed that for the same state at constant temperature, in the ratio, $S/s=\gamma$, of the specific heats. Assuming Boyle's law for a gas at constant temperature, and $\gamma=$constant in adiabatic expansion, it followed that the adiabatic equation must be of the form, $PV^\gamma=$constant for a gas

The adiabatic equation of Laplace and Poisson for a gas, was established long before the first law of thermodynamics was formulated, and has proved to be the most convenient type of equation for the purpose. But with the assistance of the laws of thermodynamics, the scope of the adiabatic equation in this form may be considerably extended. Thus with the assistance of the first law, in the form in which it is usually employed for mathematical purposes, namely

$$dQ=dE+aPdV=dH-aVdP \qquad (5)$$

the adiabatic equation, $PV^\gamma=$constant, may be shown to apply generally to any kind of substance, not necessarily a perfect gas, for which the change of intrinsic energy in any transformation is proportional to that of aPV; or more generally that it will be of the form $P(V-b)^\gamma=$constant, provided that the expression for the intrinsic energy E satisfies the condition,

$$E-B=naP(V-b) \qquad (6)$$

in which B, b, and n are constants depending on the substance, and $\gamma=1+1/n$.

To prove this relation, we put $dQ=0$ in (5) as the general condition for the adiabatic, and equate dE as obtained from (6) to $-aPdV$, which gives,

$$an(V-b)dP+a(n+1)PdV=0. \qquad (7)$$

Dividing by $aP(V-b)$ and integrating we obtain

$$n\log P+(n+1)\log(V-b)=\text{constant} \qquad (8)$$

which when put in the exponential form becomes

$$P(V-b)^{n+1/n}=\text{constant}. \qquad (9)$$

It will be observed that the value of the index γ is *constant*, and is not necessarily equal to the ratio of the specific heats, which may vary widely with pressure This is fortunate, because an equation of this type is of little practical use if the index is variable.

With the assistance of the second law of thermodynamics in addition to (5) and (6), it will be shown in a later section that the same adiabatic (9) may be put in either of the equivalent forms

$$P/T^{n+1}=\text{constant}=k_1 \text{ or } (V-b)T^n=\text{constant}=k_2 \qquad (10)$$

and that $P(V-b)/T=k_1k_2=$constant, along an adiabatic, though it is not necessarily constant under other conditions.

Experimental Verification of the Adiabatic.—The most direct way of testing the adiabatic equation is to use a cylinder containing a constant charge of gas or vapour which is alternately compressed and expanded by a reciprocating piston. Indicator cards give fairly accurate values of the actual volume and pressure, if the clearance is carefully measured, the pressure scale calibrated, and everything in perfect adjustment. But in working

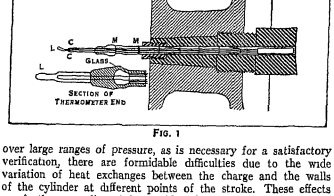


FIG. 1

over large ranges of pressure, as is necessary for a satisfactory verification, there are formidable difficulties due to the wide variation of heat exchanges between the charge and the walls of the cylinder at different points of the stroke. These effects are further complicated by accidental leakage past the piston, and, in the case of steam, by the risk of condensation, both of which affect V indirectly by reducing the apparent mass of the charge. The most complete method of eliminating these uncertain sources of error, which profoundly affect the uniformity of V throughout the cylinder, is to observe, instead of the relation between P and V, the relation between T and P, as given by the adiabatic equation in the form (10), deduced from the second law. In this case the temperature observed in the middle of the cylinder will be practically unaffected by the action of the walls, and is determined solely by the *actual* pressure as observed with the indicator. We are no longer concerned with the *theoretical* pressure, corresponding to the compression ratio by volume, which might be realized in the absence of condensation or leakage or heat-loss to the walls. These effects will still reduce the observed pressure below the theoretical value, but will not affect the relation between pressure and temperature. The success of the thermometric method depends on the construction of a thermometer sufficiently sensitive to follow the rapid variations of temperature without appreciable lag, and on obtaining simultaneous readings of the relative values of the pressure with the same order of accuracy at the maximum and minimum points of the cycle. It is easy to cover the range of temperature with a single thermometer, but, the pressure range being upwards of 10/1, it is necessary to use a separate indicator with a light spring for the low pressures. Applied in this manner the method is particularly suited to give the best average value of the index over large ranges of pressure and temperature. The procedure may be varied when it is desired to obtain the value of the index at some particular point of the scale, *e.g.*, at high or low temperatures

The annexed figure 1 shows one of the thermometers employed for this purpose, mounted on the piston of a steam-engine for observing the adiabatic relation between P and T for dry steam. The sensitive portion of the thermometer consisted of a differential loop L of fine platinum wire a thousandth of an inch in diameter and 1 inch in length. The fine wire was connected to thick platinum leads, insulated by being fused through a glass tube MM held in a gland in the centre of the piston. The platinum leads in the glass tube were connected to insulated copper leads, which were carried out to the measuring apparatus through a hole 2 ft. long bored through the piston rod. Since the ends of the fine wire, where it is attached to the thick platinum leads, cannot follow the rapid variations of temperature of the steam, it is necessary with this type of thermometer to compensate these end-effects by connecting a short loop of the same fine wire to the ends of the compensating leads CC. The quantity measured being the difference of resistance of the long and short loops, all such end-effects are automatically eliminated. Readings of temperature were taken with the aid of a periodic contact (mounted on the revolving shaft) which could be adjusted, while the engine was running, in such a way as to close the circuit of the galvanometer at any desired point of the stroke It was found possible to read the temperature to one or two tenths of 1° C at the maximum and minimum points, with the engine running at 100 rev./min. and a range of temperature of about 300° C between maximum and minimum. Readings taken at intermediate points, where the temperature was changing at the rate of more than 500° C per second, showed very good agreement, but could not be utilised in the calculation because the simultaneous values of the pressure could not be located with sufficient accuracy on the steep part of the indicator curve, whereas the maxima and minima could be measured with the greatest precision The ports of the cylinder used in these experiments were caulked with lead to prevent leakage, and the cylinder was heated by steam in the jackets and steam-chest to minimize condensation. The flywheel was belted to an electric motor and driven at a steady speed by a large storage battery. The observations covered a range of temperature from 100° to 420° C, but could not be extended beyond 150 lb. pressure by this method, owing to deficient strength of the engine and driving gear. The results obtained with several different thermometers and indicators, showed that the adiabatic index for steam must be very nearly constant over this range of pressure and temperature with a value given by $n-1=13/3$ in (10), or $\gamma=1.300$ in the relation (9) between P and V. Recent observations on the total heat H up to 4,000 lb. pressure, have shown that the same relation holds for dry steam with remarkable accuracy in the critical region, in spite of enormous variations in the ratio of the specific heats. The importance of this result in practice lies in the fact that it gives a very simple expression (6) for E or H in terms of P and V, or for V in terms of H and P, in addition to giving the simplest possible expressions for the work done in adiabatic expansion, or for the discharge through a nozzle, the utility of which can hardly be exaggerated in practical thermodynamics Similar relations, but with $\gamma=1.40$ or $n=2.5$, have long been applied to the case of atmospheric air, which forms the chief constituent of the working fluid in the internal combustion engine. But in the case of air the application is much more simple and obvious, because air obeys the gas equation $aPV=RT$ very closely, and its specific heats vary very little with pressure under ordinary conditions.

The Energy Equation in Steady Flow.—The flow of a fluid through a pipe or any closed apparatus, is said to be "steady" when the mass M per second passing any cross-section X is the same at every point, and remains constant during the flow. This implies that the fluid is supplied at a steady rate by some external agent (*e.g.*, a pump or boiler) at a constant pressure and temperature, in which case the whole apparatus traversed by the fluid will soon settle down into a steady state in which the values of P, V, and T remain constant at each point, though they will not be the same at different points, if the section X varies from point to point, or if the fluid receives heat or does work at a steady rate during its passage. It follows from the law of conservation of mass that, when the mass-flow M is constant at every point, the velocity U of the fluid at any section X is given in terms of V by the relation

$$U=kMV/X \qquad (11)$$

where k is a constant depending on the units employed.

A second relation follows from the law of conservation of energy, since the energy existing in any section must remain constant when the conditions are steady. The total energy carried into any section by the fluid per unit mass in thermal units will consist of its intrinsic energy E', together with the equivalent $aP'V'$ of the work done by the pump, and with the kinetic energy of flow, $K'=U^2/2Jg$, reduced to thermal units by the factor $1/Jg$. Thus the total energy carried in by the fluid may be represented briefly by $H'+K'$. Similarly the total energy carried out of the *same section* by the fluid may be represented by

$H''+K''$. But with the energy carried out we must include the equivalent W/J of any work done by the apparatus, and any heat Q lost by radiation or convection, both measured per unit mass of the fluid passing through. Collecting the terms, the general equation may be written

$$H'-H''=K''-K'+W/J+Q. \qquad (12)$$

The steam-turbine may be taken as a typical example. $H'-H''$ represents the drop of total heat of the fluid, or more briefly

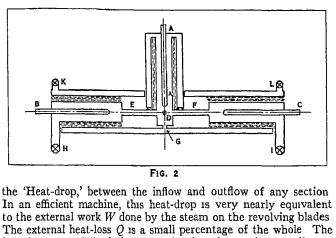


FIG. 2

the 'Heat-drop,' between the inflow and outflow of any section In an efficient machine, this heat-drop is very nearly equivalent to the external work W done by the steam on the revolving blades The external heat-loss Q is a small percentage of the whole The kinetic energy K'' of the steam leaving the section usually exceeds K', that of the steam entering and $K''-K'$ represents a similar percentage loss The greater part of the loss in a turbine is that due to internal friction, by which part of the available kinetic energy is reconverted into heat. This part of the loss is included in the total heat H' carried out by the steam If there were no friction or heat-loss, the drop of total heat, representing heat converted into kinetic energy or work, would be that obtainable in frictionless adiabatic expansion between the same limits of pressure, which may be found from the tables and compared with the actual performance to estimate the efficiency. The method of doing this will be explained later, when some of the simpler applications of equation (12) have been illustrated.

The Throttling Method.—The function of a throttle, or reducing-valve, is to regulate the flow, or change the state of the fluid, by lowering the pressure without altering the total heat. The throttle, having no moving parts, cannot do any external work, so that $W=0$ in equation (12) In this case, most of the kinetic energy is reconverted into heat by friction, so that K'' can be made nearly equal to K' under favourable conditions. The equation then reduces to the form

$$H'=H''+Q \qquad (13)$$

The chief use of the equation in this form is to find the value of the total heat H' at a high pressure by throttling to a lower pressure, such as atmospheric, and observing the temperature T'' The total heat H'' at the lower temperature and pressure may be regarded as known by equation (3) in terms of the specific heat S. Thus the required value of H' at T' and P' is given by (13) if the heat-loss Q can be determined The best way of doing this is to employ a differential calorimeter as shown in fig. 2 The high pressure steam enters the centre pocket at the back and circulates round the thermometer tube (A) for measuring the initial temperature The initial pressure is measured at the same point through the connection (D) to the high pressure gauge The main current then divides right and left through the throttle tubes (E) and (F) to the side pockets (B) and (C) where the temperature of the throttled steam is measured. These pockets are precisely similar, and are lagged and jacketed with throttled steam in order to reduce heat-loss, which would otherwise be rather large at high temperatures. The throttle tubes are fitted with a progressive series of throttles and baffles, designed to give maximum friction and reduce the kinetic energy to a negligible quantity. Using single and double dashes to distinguish the two sides, the flows M' and M'' on either side, as defined above can be adjusted in any desired ratio. The *rate* of heat-loss $M'Q'$ per second will evidently be nearly equal to the rate of heat-loss $M''Q''$ from the other side Hence Q' and Q'' (per unit mass) will be inversely as the flows, which are condensed and measured separately For instance, if $M'=2M''$, we have $Q''=2Q'$, and $Q'=H'-H''$, by taking the difference between the two equations

$$H'+Q'=H_0=H''+Q'' \qquad (14)$$

where H_0 represents the total heat in the centre pocket. Whence $H_0=2H'-H''$, both of which are known from the observed temperatures t' and t''. Since S is nearly constant for steam at atmospheric pressure, it usually suffices to correct the observed temperature t' for heat-loss by adding $(t'-t'')\ M''/(M'-M'')$, as in the following example. Starting with steam at 3,805 lb pressure and 426·6° C, the observed temperatures on either side after throttling to 16 lb were $t'=120{\cdot}3°$ C and $t''=114{\cdot}1°$ C, the ratio $M''/(M'-M'')$ being 0·97. The correction to t' for heat-loss is $0{\cdot}97\times 6{\cdot}2=6{\cdot}0°$, giving $126{\cdot}3°$ C for the corrected temperature, at which $H_0=652{\cdot}4$ cal. C, as given in the tables at 16 lb. This method is one of the simplest for measuring H at high pressures and temperatures, but cannot be applied if H is less than 640 cal, because the throttled steam would be wet. Thus in measuring H at the critical point, 374° C, and 3,222 lb, where its value is only 554·4 cal. it is necessary to use the jacketed condenser method as described in the article CALORIMETRY. This method is rather more difficult, but has the advantage of applying equally to the case of water

Discharge Through a Nozzle.—The function of a nozzle in a turbine is to convert as much as possible of the total heat of the steam into kinetic energy for turning the wheels For this reason the nozzle is formed with a bell-mouth on the high pressure side tapering smoothly to a nearly parallel throat, so as to produce a uniform jet of high velocity with the least possible friction or turbulence In this respect the nozzle is the opposite of the throttle which reconverts as much as possible of the kinetic energy into heat, leaving the total heat practically unaltered In one respect it is like the throttle, in that it has no moving parts and does no external work in itself, so that $W=0$ in equation (12), when applied to either nozzle or throttle. The heat-loss Q in the case of a nozzle is also very small compared with the heat-flow, which is usually large owing to the high velocity of flow Neglecting W and Q on this account, the heat-drop is the exact equivalent of the kinetic energy generated, thus equation (12) becomes

$$H_1-H_2=K_2-K_1=(U_2^2-U_1^2)/2J, \qquad (15)$$

in which the constant J is required for reducing $U^2/2$ to heat units. It may be observed that equation (15) remains true if any proportion of the kinetic energy generated is reconverted into heat by friction, since this has the effect of increasing H_2 exactly as much as it reduces K_2. As a rule the initial velocity is small and K_1 is almost negligible in comparison with K_2. The velocity generated may then be calculated from the heat-drop by the formula

$$U_2=(2J\mathrm{g})^{\frac{1}{2}}\ (H_1-H_2)^{\frac{1}{2}} \qquad (16)$$

If H is taken in calories C and U in feet per sec., the value of the constant is 300·2, or a heat-drop of 1 cal. C will correspond to a velocity of 300 ft/sec; or 100 cal to 3,002 ft/sec. A velocity of 100 ft/sec., or 70 miles per hour, though not unimportant in meteorology, may often be neglected in dealing with turbines, as it corresponds to only $\frac{1}{9}$th of a calorie C. Other conditions being equal, the heat-drop and velocity will evidently be greatest in the absence of friction, or in frictionless adiabatic expansion as defined by putting $dQ=0$ in equation (5). This gives the condition $dH=aVdP$ for finding the heat-drop by integrating $aVdP$ along the adiabatic (9) between the given limits of pressure P_1 to P_2. Neglecting b, this reduces to the simple form,

$$H_1-H_2=(H_1-B)(1-T_2/T_1) \qquad (17)$$

where $T_2/T_1=(P_2/P_1)^{\frac{n}{n}\mathrm{g}}$, for steam by equation (10) with $n+1=13/3$.

Having found the heat-drop, which is preferably obtained from the Tables, the velocity U_2 follows from (15), or from (16) if U_1 is small. The discharge M is easily obtained from (11) in terms of the area of the throat X, and the volume V_2 at the same point. The latter is most easily obtained from H and P by the general relation (6), which may be put in the form,

$$V=(H-B)/a(n+1)P=2{\cdot}2436(H-B)/P. \qquad (18)$$

Maximum Discharge.—It results from the form of these equations that for any given nozzle or throat area X, for a given initial state of the steam as defined by P_1 and V_1, the discharge M will at first increase as the final pressure P is lowered, but will ultimately reach a very definite maximum, when $P/P_1=0{\cdot}546$ in the case of steam Differentiating (11) to find the condition under which M is a maximum, we have $d(U/V)=0$, or $dU/dV=U/V$. Putting (15) in the form $U^2-U_2^2=2g(H_2-H_0)$, differentiating with regard to V, and remembering that U_0 and H_0 are constant, we obtain

$$-Jg(dH/dV)=U(dU/dV)=U^2/V. \qquad (19)$$

Since by (5) $dH/dV=aV(dP/dV)$ in adiabatic expansion, this may be written,

$$-aJg(dP/dV)=(U/V)^2=(kM/X)^2 \qquad (20)$$

giving the discharge M/X per unit area of throat in terms of dP/dV in the throat. Since equation (20) for $(U/V)^2$ in terms of dP/dV is the general expression for the velocity of sound U in any fluid, we infer that, when M/X is a maximum, the exit velocity of the fluid relative to the throat must be equal to the velocity of sound in the same fluid under the same conditions Thus no drop of pressure beyond the throat could travel back fast enough through the fluid to affect its state in the throat or increase the discharge In the case of any fluid like steam, having the adiabatic equation (9), $dP/dV=-\gamma P/(V-b)$, which when substituted in (20) gives the discharge in terms of P and V in the throat To find a numerical formula for the maximum discharge in the case of steam (for which $\gamma=1{\cdot}3$) in terms of the *initial* conditions, P_0, V_0, we have the approximate relations (omitting b, which is very small), which follow from (20),

$$(H_0-H)/(H_0-B)=(\gamma-1)/(\gamma+1)=3/23 \qquad (21)$$

$$P/P_0=0{\cdot}5457,\ V/V_0=1{\cdot}5934 \qquad (22)$$

which give for the discharge M/X in lb. per sec. per sq.in. of throat ($k=144$),

$$M/X=U/144V=0{\cdot}3155\ (P_0/V_0)^{1/2} \qquad (23)$$

when P is in lb. per sq.in., U in ft /sec. and V in cu ft. per lb. The correction for b is less than $\frac{1}{2}$% of 1 per cent when $P_0=300$ lb

Applications of Carnot's Principle.—The whole science of thermodynamics may be said to date from the establishment by Sadi Carnot (1824) of the principle limiting the amount of work obtainable from heat under given conditions. The reasoning by which Carnot established his principle is outlined in the article HEAT, and is justly regarded as one of the most remarkable triumphs of the deductive method, but the experimental data available at the time were far too scanty and inaccurate to supply conclusive proof. With the advance of experimental methods Carnot's predictions have been abundantly verified in every conceivable instance, and have formed the basis of the development of all kinds of heat-engines in theory and practice. The important applications to heat-engines are discussed elsewhere in their proper place. We are here concerned chiefly with the applications of the principle to the thermodynamical relations between the various properties of any substance, and to the conditions which determine the possible states of equilibrium. Carnot in applying his principle to such cases put it in the following form as being most convenient for the purpose. If a quantity of heat Q is supplied to any substance at a constant temperature t, the work dW obtainable from Q by an ideal reversible engine working in a cycle of range dt must be proportional to Qdt multiplied by some function of the temperature, $F't$, which must be the same for all substances. Putting this statement in the form of an equation, we find

$$dW/dt=QF't, \qquad (24)$$

as given by Carnot, and applied by him to the following simple cases:

Clapeyron's Equation.—In the vaporisation of unit mass of steam in a boiler, the whole work of expansion W along the isothermal at constant pressure and temperature, would evidently be equal to $p(V-v)$, the product of the vapour-pressure p by the increase of volume from that of water v to that of steam V Thus the work dW/dt obtainable in a cycle of range dt would be $(V-v)dp/dt$, where dp/dt is the rate of increase of the steam-pressure per degree rise of temperature. The heat Q absorbed in the vaporisation of unit mass is the latent heat L. Substituting these symbols in (24) we obtain the result commonly known as Clapeyron's equation,

$$(V-v)dp/dt=LF't, \qquad (25)$$

which evidently represents the condition of equilibrium between liquid and vapour at any temperature, and is applicable to any other substance with the same value of $F't$ at the same temperature, but with different values of L, V, and p, depending on the properties of the substance considered Carnot employed this relation for calculating the value of his function $F't$ at 100° C from the properties of steam, which were roughly known at this temperature. Taking $L=540$ cal. $dp/dt=27{\cdot}2$ mm. of mercury, or 370 kg./sq. metre, and $V-v=1{\cdot}670$ cb.m./kg., we find $F't=1{\cdot}135$ kilogram metres per kilocalorie for the work obtainable in a cycle of 1° range at 100° C We may remark in passing that the value found is equal to 427/373, being the mechanical equivalent of the kilocalorie in kgm. divided by the absolute temperature. This implies that the whole of the heat could be converted into work if the range of the cycle were extended to the absolute zero with the same rate of production of work per degree fall. But Carnot, who had at that time no knowledge of the value of the mechanical equivalent, naturally failed to notice this remarkable coincidence, though the result he obtained for $F't$ was correct.

Lowering of the Freezing Point of Ice by Pressure.—The application of Carnot's equation (25) to the rate of increase of vapour-pressure dp/dt with temperature, or to the rise of the boiling-point dt/dp with pressure (which are merely different ways of expressing the same property of the substance) is easily made in any case in which the latent heat L and volume V of the vapour are known, and affords in fact one of the most direct methods of verifying Carnot's principle by experiment. A more dramatic verification was that made by James Thomson (1851), who observed that equation (25) must apply just as exactly to the equilibrium between liquid and solid at the freezing-point, as to that between liquid and vapour at the boiling-point. In the case of solid and liquid, L is the latent heat of *fusion*, and $V-v$ is the increase of volume in melting, which is positive for a substance like wax which expands in melting, but negative for a substance like water which expands on freezing. Thus in the case of wax, the sign of dt/dp should be positive, or the melting point should be raised by pressure (as is always the case for the boiling-point), whereas in the case of water the sign should be negative, or the freezing-point should be lowered by pressure. Taking the known values of L and $V-v$ for water and ice, he predicted that the freezing-point of water should be lowered 0·0075° C per atmosphere of pressure, a result which was immediately verified by his brother, Lord Kelvin, and materially assisted in the final establishment of the second law of thermodynamics.

Application to Gases, Absolute Scale of T.—The application of Carnot's equation (24) to the case of a gas obeying the law $PV=RT$, is equally simple. The whole work W done in isothermal expansion, is represented by the analytical expression $RT\ln r$, where $\ln r$ denotes the natural logarithm of the ratio of expansion. It immediately follows, as Carnot remarks, that $dW/dt=Rlnr$, or is simply equal to W/T. Thus equation (24) reduces to the form,

$$W/T=QF't. \qquad (26)$$

Carnot deduced from this relation that the ratio W/Q of the work done to the heat absorbed in isothermal expansion must be the same for all gases at the same temperature, and that if equal volumes of different gases were taken at the same temperature

and pressure (or masses proportional to the molecular weights) the heat Q absorbed in isothermal expansion must be the same for all gases under similar conditions since the work W was the same for all. It followed as a special case that the *difference* of the specific heats at constant pressure and volume, being the heat absorbed in an isothermal expansion equal to V/T, must be the same for equal volumes of all gases. His endeavours to extract a value of $F't$ from this relation gave results similar to those obtained from steam and other vapours, but failed to give a decisive conclusion owing to the uncertainty of the ratios of the specific heats as deduced from the velocity of sound. At a later date when Joule (1845) proved by direct experiment that the heat absorbed by a gas in isothermal expansion was approximately *equivalent* to the work done, it became evident, by substituting $W=JQ$ in equation (26) that the value of $F't$ must be nearly equal to J/T for all substances. But since according to Regnault's experiments (1847) the temperature scales of actual gases differed quite appreciably, different gases would give different values of T at the same temperature, and it was impossible to say which should be selected. The essential point of Carnot's principle being that the value of $F't$ was *the same* for all substances at the same temperature, the most logical method was that proposed by Kelvin, to define absolute temperature T as being proportional to the reciprocal of Carnot's function. Exact consistency with Carnot's principle and with the law of conservation of energy could thus be secured, while leaving the deviation of the scale of any particular gas from the absolute scale thus defined to be determined by experiment in each case.

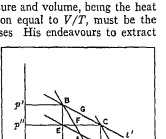


FIG. 3

Carnot Cycle of Finite Range.—If we substitute J/T for $F't$ in Carnot's equation (24) in accordance with the definition of absolute temperature T, and also write $W=JQ$ as required by the first law, the equation reduces to the form $dQ/dT=Q/T$, which tacitly involves the law of conservation of energy in addition to the adoption of Carnot's principle for the definition of the scale of temperature. The relation in this form implies that, if the range of the cycle is extended to any lower temperature, the ratio Q/T will remain constant, and the heat converted into work will increase in direct proportion to the range of temperature, since the constant ratio Q/T is equal to dQ/dT representing the heat converted into work per degree fall. Thus the formula for a Carnot cycle of finite range, in which a quantity of heat Q' is supplied to the working substance at T', and a quantity Q'' is rejected at T'', with the conversion of heat $Q'-Q''$ into work W, reduces to the simplest possible form, namely,

$$W/(T'-T'')=J(Q'-Q'')/(T'-T'')=JQ'/T'=JQ''/T'', \quad (27)$$

in which the reduction factor J may be omitted if Q is expressed in work units.

Entropy.—The quantity Q/T which remains constant in a Carnot cycle of any range bounded by two adiabatics, is called the entropy of the heat Q supplied at a temperature T. According to (27) the entropy of the heat supplied at T', is equal to the entropy of the heat rejected at T''. The entropy difference between any two adiabatics is constant, or the adiabatics are lines of constant entropy, and are often called isentropics. The thermal equivalent of the work done in any Carnot cycle is the product of the entropy supplied, namely Q'/T', by the range of temperature $T'-T''$. This relation is frequently the most convenient for calculating the work obtainable, not only in a Carnot cycle, but also in a cycle of any form.

Clapeyron's Relations.—Clapeyron (1834) observed that Carnot's principle, as represented by equation (24), implied the existence of certain general relations between the quantity of heat absorbed in isothermal expansion and the pressure and expansion coefficients of the working substance. He employed the indicator diagram, as illustrated in fig. 3, for the deduction of these relations by a method equivalent to that employed by Maxwell, *Theory of Heat* (1870). The coordinates of the point B are the pressure p', and the volume v' of unit mass of the substance at a temperature t'. Let the substance expand from B to C along the isothermal at t' absorbing a small quantity of heat dQ, while its volume increases from v' to v'', and its pressure diminishes from p' to p''. Draw the line of constant volume v' through B intersecting the line of constant pressure p'' through C in the point E. Through E draw the isothermal $E.LD$ at the temperature t''. Complete the Carnot cycle by drawing the adiabatics $B.I$ and CD through B and C. In the limit, when the difference of temperature $t'-t''$ is small, it may be represented by dt as in Carnot's equation (24), and the form of the cycle $ABCD$ will become a parallelogram as indicated in the figure. The area $ABCD$ represents the work dW done in the elementary cycle, and is equal to that of the rectangle $BE\times EC$, or to $(p'-p'')(v''-v')$. Making these substitutions in Carnot's equation (24), we obtain the general relation,

$$(p'-p'')(v''-v')/(t'-t'')=F't\times dQ. \quad (28)$$

In order to interpret this relation in terms of the pressure coefficient at constant volume, or the expansion coefficient at constant pressure, as may be desired, we may in the first place transfer $v''-v'$ to the right hand side of the equation. We then observe that $p'-p''$ is the increase of pressure BE at constant volume corresponding to the increase of temperature $t'-t''$, so that the ratio represents the familiar pressure-coefficient at constant volume, denoted by $(dp/dt)_v$ in the usual notation of partial differential coefficients. Similarly $dQ/(v''-v')$, being the ratio of the heat absorbed at constant temperature to the corresponding increase of volume, may be denoted by $(dQ/dv)_t$ in the same notation. If we also substitute J/T for $F't$ in accordance with the definition of absolute temperature, we obtain,

$$T(dp/dt)_v=J(dQ/dv)_t \quad (29)$$

which is often called the first thermodynamical relation, and was in fact employed by Kelvin as a general expression for Carnot's principle in his first exposition of the equations of thermodynamics (1851), except that he retained the symbol μ for $F't$, following Clapeyron, in place of substituting J/T, as in (29), according to modern practice.

Pressure and Expansion Coefficients.—The utility of a relation of this kind lies in the fact that small quantities of heat absorbed in expansion are very difficult to measure, but can usually be calculated with the aid of relations like (29) in terms of other coefficients, such as the pressure coefficient. Many examples of this will be given later. If the relation (29) itself is not directly applicable, it can usually be transformed by purely mathematical relations between the various coefficients into a different shape which is more convenient for the purpose required. For instance the pressure coefficient $(dp/dt)_v$ is seldom directly measurable in the case of a solid or a liquid, owing to the difficulty of keeping the volume constant while the temperature is being raised. The difficulty of measuring the pressure-coefficient may be avoided by using the familiar relation,

$$(dp/dt)_v=-(dp/dv)_t(dv/dt)_p \quad (30)$$

giving the required value in terms of the isothermal elasticity and the coefficient of expansion at constant pressure, both of which can be measured. Relation (30) is one of the commonest examples in practice of the general relation between the partial differential coefficients of any three quantities, such as x, y, z, connected by a single equation, such that any one of the three may be regarded as a function of the other two. It is most easily remembered in the cyclical form,

$$(dx/dy)_z(dy/dz)_x(dz/dx)_y=-1. \quad (31)$$

from which any required relation of this type such as (30) may be written down by replacing p, v, t, by x, y, z, or *vice versa*. But as relations of this type are usually required in the form (30), it may be as well to explain how they are deduced from first principles. The volume v of unit mass of any substance depends on the temperature t and the pressure p either of which may vary independently of the other. Any expansion due to change

of temperature alone, is found by multiplying the rise of temperature dt by the expansion per degree at constant pressure, represented by the coefficient $(dv/dt)_p$. Similarly any change of volume due to increase of pressure alone, is given by the product of the increase of pressure dp by the isothermal compressibility $(dv/dp)_t$. In the general case, when both p and t change, the whole expansion dv is the sum of the two independent effects,

$$dv=(dv/dt)_p dt+(dv/dp)_t dp. \qquad (32)$$

Similar formulae apply to all other properties of the substance depending on p and t and are frequently required in thermodynamics In the case of the volume v, it is immediately obvious from (32) that, if the compression due to increase of pressure dp is equal to the expansion due to increase of temperature dt, the volume will remain constant, or $dv=0$ The ratio of dp to dt at constant volume, or the required coefficient $(dp/dt)_v$, is obtained in terms of the other two by putting $dv=0$ in (32), dividing by dt and transposing, which gives the required relation in the form (30) if we observe that the isothermal elasticity $(dp/dv)_t$ is the reciprocal of the isothermal compressibility $(dv/dp)_t$.

Second Relation —From the first thermodynamical relation, as given in equation (29), Clapeyron deduced his second relation, for the heat evolved in isothermal compression, by substituting for $(dp/dt)_v$ the expression given in (30), which leads immediately to the corresponding expression for $(dQ/dp)_t$,

$$T(dv/dt)_p=-J(dQ/dp)_t \qquad (33)$$

in terms of the coefficient of expansion at constant pressure The negative sign in this relation indicates that heat is *evolved* by an increase of pressure, whereas heat is absorbed when the volume increases. There are several other thermodynamical relations, which are in effect equivalent to Carnot's equation (24), but the two originally given by Clapeyron are the most useful, and suffice for the majority of practical requirements. It will be observed that they are not independent relations, since one can be deduced from the other by a purely mathematical transformation, but either may be employed as required with the certainty of obtaining results consistent with the laws of thermodynamics.

Specific Heats.—The specific heats are among the most familiar and useful coefficients in practice since they are commonly required for calculating quantities of heat They are usually measured by observing the quantity of heat given up by a body in cooling through a large range of temperature, and are often treated as constants. But in addition to the variation with temperature, as illustrated in the articles Heat and Calorimetry, the results found may depend to a great extent on other conditions, such as pressure, in a manner subject to the laws of thermodynamics and amenable to calculation. In dealing with variable specific heats, the general expression for the specific heat of any substance at a temperature T is the ratio dQ/dT of the small quantity of heat dQ supplied per unit mass to the corresponding rise of temperature dT produced; but it is also necessary to specify the conditions under which the measurement is made, as these may affect the result. The two simplest cases are those in which the specific heat is measured, (a) at constant pressure, (b) at constant volume, though the latter condition can seldom be realised satisfactorily in the case of a solid or liquid For this reason it is useful to have a relation giving the specific heat at constant volume in terms of that at constant pressure. The required relation may be obtained most directly by the aid of Clapeyron's relation (33) in the following manner, which also gives incidentally the expression for any other variety of specific heat.

Difference of Specific Heats.—To find a general expression for the specific heat dQ/dT under any condition, write down the general expression for dQ in terms of dt and dp, exactly as for v in (32), by simply replacing the letter v in (32) by the letter Q, and divide each term in the expression by dt, thus we obtain,

$$dQ/dt=(dQ/dt)_p+(dQ/dp)_t dp/dt. \qquad (34)$$

The first term on the right, namely $(dQ/dt)_p$, representing the heat absorbed per unit mass per degree rise of temperature at constant pressure, is obviously the specific heat as ordinarily measured at constant pressure, which may be denoted by S_p. The next coefficient, $(dQ/dp)_t$, represents the heat evolved per unit mass per unit increase of p in isothermal compression. The value of this is given by Clapeyron's second relation (33) in terms of the coefficient $(dv/dt)_p$. Since the specific heat is usually required in thermal units, it is best to retain the reduction factor $1/J$, explicitly in equations expressed in thermal units, in which it is usually represented by the single letter a for convenience in writing or printing. The last factor dp/dt must be taken to correspond with the condition under which the specific heat dQ/dt is desired Thus if we require the specific heat at constant volume $(dQ/dt)_v$, or S_v, we must also append the suffix v to dp/dt implying that it must be taken at constant volume. Making these substitutions in (34) we obtain the required expression for S_v,

$$S_v=(dQ/dt)_v=S_p-aT(dv/dt)_p(dp/dt)_v \qquad (35)$$

Saturation Specific Heat —As a further illustration of the same method, if we require the specific heat S_s of a wet vapour maintained in the state of saturation, implied by the suffix s, we have merely to replace the suffix v in (35) by the suffix s, thus,

$$S_s=(dQ/dt)_s=S_p-aT(dv/dt)_p(dp/dt)_s \qquad (36)$$

in which $(dp/dt)_s$ represents the rate of increase of saturation pressure p with temperature, which is usually much larger than $(dp/dt)_v$ for the *dry* vapour. For this reason S_s is often negative, whereas S_v though smaller than S_p, is always positive. Thus, in the case of wet steam at 100° C, $S_s=-1\cdot04$.

By means of these and similar relations the variation of any specific heat can be calculated if one specific heat, such as S_p or S_v is known by experiment at the required temperature In some cases these variations may be considerable, especially near the critical point of any substance In general, if the path on the indicator diagram along which the specific heat is to be measured approaches the isothermal, the specific heat will become very large. If the path coincides with the isothermal, the specific heat becomes infinite, because there is finite absorption of heat while $dt=0$ When the path on the diagram is a little steeper than the isothermal the specific heat becomes *negative*, changing from positive to negative infinity in crossing the line. For any path between the isothermal and the adiabatic the specific heat is negative, falling to zero when the path coincides with the adiabatic ($dQ=0$), and changing to positive again on the other side. Such changes would be very troublesome to deal with in experimental work, if the thermodynamic relations did not afford a complete method of taking them into account.

Cooling Effect in Adiabatic Expansion.—The efficiency of any heat engine depends primarily on the range of temperature through which the working fluid can be cooled while converting its heat energy into work done in adiabatic expansion. It is important for this reason to be able to observe and calculate the cooling effect, which is most conveniently defined as the ratio of the drop of temperature dt to the drop of pressure dp under the condition that no heat is supplied to the working fluid, and that the expansion is frictionless and reversible. The heating effect in compression is the same coefficient with the signs of both dp and dt reversed, so that its value is the same as that of the cooling effect in expansion To find a thermodynamic expression for the cooling effect under the condition $dQ=0$, we may put $dQ/dt=0$ in the general expression (34) for the specific heat; in which case we must also take dp/dt in (34) under the same condition at constant Q, *i.e.*, we must write $(dp/dt)_Q$, which is the reciprocal of the required cooling effect $(dt/dp)_Q$. Substituting as before from Clapeyron's relation (33), we obtain immediately,

$$S_p(dt/dp)_Q=+aT(dv/dt)_p \qquad (37)$$

which gives a general expression for the cooling effect, in terms of the specific heat and the coefficient of expansion, both at constant pressure, and comparatively easy to determine by experiment.

Thus if the specific heat of a *liquid* and its coefficient of expansion are known, as is the case for most liquids, it is easy to calculate the heating effect of a sudden compression. The effect is zero for water at its point of maximum density, but increases rapidly with the coefficient of expansion, since S is nearly constant.

In the case of a *gas or vapour*, which approximates to the equation $aPV = RT$ at low pressures, since (dV/dt) approaches the limit R/aP, the expression for the cooling effect becomes RT/SP, corresponding to the adiabatic equation in the form (10), with $S/R = n+1$. This shows that, if a vapour, like steam, obeys an adiabatic equation of this type with n constant, the limiting value S_0 of its specific heat at zero pressure must be constant, *i.e.*, independent of the temperature. Conversely in the case of a gas, such as hydrogen, which follows the law $aPV = RT$ very accurately, there will be no variation of S with pressure, but any variation of S with temperature requires a corresponding variation in the index $n+1$, and in the cooling effect, which is equal to $T/(n+1)P$. In such a case, it is often much easier to measure the cooling effect directly with a thermometer of a well adapted type, than it is to measure the specific heat itself at high or low temperatures. The variation of the specific heat with temperature may then be deduced from observations of the cooling effect. This method was applied by Makower (*Phil Mag.*, Feb 1903) to verify the constancy of S in the case of steam by observing the cooling effect in a jacketed vessel, at 110° C. By allowing the steam to expand suddenly from a pressure of 81 cm to atmospheric and observing the corresponding drop of temperature, he found a value of the index $\gamma = 1{\cdot}304$, agreeing closely with that deduced from the engine experiments at much higher temperatures and pressures, as previously described. Brinkworth (*Proc Roy. Soc*, 1925) employed a similar method for verifying the variation of the specific heat of hydrogen at low temperatures. It will readily be understood that it is most important in all such cases to have an exact thermodynamical relation such as (37) between the coefficients to be measured. Otherwise the interpretation of the results is apt to be uncertain. Thus it is usually possible to allow for the small variations of dv/dt in reducing the results, and similarly for the variations of S with pressure.

The Joule-Thomson Cooling-effect.—This is the most important coefficient of its type, and is most easily measured in steady flow. It was first measured by Joule and Thomson (1852), and was defined by them as the ratio of the drop of temperature to the drop of pressure in a pure throttling process, in which the kinetic energy generated by the pressure-drop is completely reconverted into heat without any external heat-loss. Under these conditions, as explained previously, the value of H is the same after passing the throttle as in the initial state, except that in any actual experiment at high temperatures it is necessary to make a small correction for heat-loss. Since H remains constant in a pure throttling process, the cooling-effect in throttling may be defined as the ratio of dT to dP at constant H and may be denoted by $(dT/dP)_H$ provided that we are dealing with small changes of temperature. In the example previously cited we were concerned only with the fact that the value of H at the high initial pressure and temperature must be the same as that observed at atmospheric pressure after throttling when corrected for heat-loss. The drop of temperature amounted to upwards of 300° C, but the cooling effect represented by the ratio, $300{\cdot}3°/3789$ lb., or $0{\cdot}07925°$ per lb., does not enter explicitly into the calculation though it might be described as the *mean* cooling effect over the given range. To find the limiting value of the cooling-effect at a particular temperature and pressure, it is of course necessary to make measurements over much smaller ranges of temperature.

Variation of H with P.—The cooling-effect C at constant H as thus defined, is the ratio of the two partial differential coefficients of H with respect to P and T, thus,

$$C = (dT/dP)_H = -(dH/dP)_T/(dH/dT)_P. \qquad (38)$$

This does not involve thermodynamics, but is merely a special case of the formal relation (30), as is easily verified by writing H in place of V in (30). Putting S for $(dH/dT)_P$, the specific heat at constant pressure, we have the useful relation $(dH/dP)_T = -SC$, giving the variation of H with P at constant T in terms of the specific heat S and the cooling effect C, which are the most easily measured of all coefficients. Another expression for the same coefficient may be obtained by applying the two laws of thermodynamics. From the first law in the form $dH = dQ + aV\,dP$, as given in (5), dividing by dP at constant T, we find,

$$(dH/dP)_T = (dQ/dP)_T + aV = -aT(dV/dT)_P + aV \qquad (39)$$

in which the second law is involved in the substitution for (dQ/dP) from Clapeyron's second thermodynamical relation (33).

Joule-Thomson Equation.—The utility of relation (39) lies in the fact that it supplies the necessary and sufficient condition which must be satisfied by any expressions selected to represent H and V (the two most important thermodynamical properties of any substance) in order to render such expressions consistent with the laws of thermodynamics. Joule and Thomson made use of (39) in the form

$$SC = aT^2(d(V/T)/dT)_P \qquad (40)$$

in order to deduce an expression for V consistent with their observations on the cooling-effect. Their experiments showed that C was approximately independent of the pressure, but varied as $1/T^2$ with temperature for air and CO_2 over the range 0° to 100° C. Integrating (40) at constant P, with S constant, and $C = K/T^2$, they obtained the solution:

$$-SK/3T^3 = aV/T - R/P \qquad (41)$$

in which the constant of integration R/P was determined by the condition that the equation must approximate to the form $aPV = RT$ when T is very large. The small term $SK/3T^3$, which may be written $SC/3T$, represents the deviations of the actual gas, air or CO_2, from the ideal state, in terms of the observed values of S and C for the gas employed. Thus equation (41) makes it possible to deduce the absolute temperature T from the observed temperature by air thermometer as defined in terms of P and V, but the process of reduction (for which *see* the article THERMOMETRY), is far from being as simple as it might appear to be at first sight. Moreover the original Joule-Thomson equation as given in (41), though it showed that the deviations of air from the ideal state must be very small, was somewhat unsatisfactory in other respects. It failed to explain the heating-effect observed in the case of hydrogen, and made no allowance for the known variation of specific heat in the case of CO_2. These difficulties may be avoided in practice by reversing the procedure. Assume a convenient type of equation for V, differentiate to find the expression for SC as in (39), and determine the constants by comparison with experimental results for S and C.

Modified Equation.—A suitable equation of a type similar to (41), is the following,

$$V - b = RT/aP - c, \text{ where } c = c_1(T/T)^n \qquad (42)$$

The small constant b, called the covolume, may be regarded as representing the limiting volume of the molecules at high temperatures and pressures. The small correction term c, called the coaggregation volume, represents the defect from the ideal volume caused by coaggregation or pairing of molecules. This is assumed to vary inversely as the nth power of T, and c_1 is the value of c at any convenient temperature T such as 0° C. On this assumption c is a function of the temperature only, and $dc/dt = -nc/T$. Differentiating equation (42) in order to find SC as given by (39) or (40), we obtain,

$$SC = aT(dV/dT)_P - aV = a(n+1)c - ab \qquad (43)$$

from which the values of the constants c, n, and b, may be deduced, when the values of S and C are known by observations taken over a sufficient range. It is easy in this way to take account of any variations of S with temperature or pressure. The slope of the isothermals on the Amagat diagram, in which PV is plotted against P, is represented by $d(PV)/dP = -c + b$, and is *positive* in the case of hydrogen (for which PV increases with P) because b is so much larger than c at ordinary temperatures. For the same reason the cooling effect C is *negative*, as found by Joule and Thomson, who observed a *rise* of temperature with *drop* of pressure in throttling. This result is explained by (42), if b exceeds $(n+1)c$, as is actually the case with hydrogen.

Expression for the Total Heat H.—The same equation (42) may be employed as a simple illustration of the general method of deducing consistent expressions for the total heat and the entropy of a substance when an equation for V in terms of P and T has

been obtained by the above method To find an expression for H we start with the general formula for dH in terms of S and C, thus,

$$dH = SdT - SCdP. \qquad (44)$$

Since the value of H depends only on the state, we may perform the integration along any convenient path, starting from any convenient zero. The simplest method is to integrate the first term from o to T at zero pressure, since the value of S at zero pressure, denoted by S_o, is a function of the temperature only. We may denote this integral by $S_m T$ where S_m is the mean value of S_o from o to T. We then have to add the integral of the second term at constant T from $P=$o to P. In the present case, since SC is a function of T only, as given by (43), the integral of $SCdP$ is simply SCP. Adding the two terms, we obtain the general expression for H at T and P,

$$H - B = S_m T - SCP \qquad (45)$$

in which the constant of integration B is determined by reference to any known value of H at some definite point, such as 100° C and atmospheric pressure. In the case of steam, S_m may be taken as constant and equal to S_o.

Variation of the Specific Heat S with Pressure.—According to (43) the specific heat S at constant pressure will be a function of both temperature and pressure The required expression for S is easily obtained by differentiating (45) at constant pressure, thus,

$$S = (dH/dT)_P = S_o + an(n+1)cP/T \qquad (46)$$

This shows that, with an equation of the type (41) or (42), S cannot be constant, as assumed by Joule and Thomson in the integration of (40), and invalidates their method of deducing (41), but the same objection does not apply to the reverse procedure employed in deducing (42) The variation of S with pressure at constant temperature for any equation of this type can also be obtained from the consideration that H is a definite function of P and T depending only on the state, so that if we differentiate S as found in (46) with regard to P at constant T, we must obtain identically the same result, namely $d^2H/dPdT$, as by differentiating $(dH/dP)_T$ (or $-SC$) with regard to T at constant P. Using the general expression for SC given in (39), we obtain,

$$(dS/dP)_T = -(dSC/dT)_P = -aT(d^2V/dT^2)_P \qquad (47)$$

which shows that S cannot be independent of the pressure, if SC is a function of the temperature. From another point of view (47) represents the condition that dH as given in (44) should be the exact differential of a definite function of P and T, as must be the case if H is a property of the substance depending only on the state as defined by P and T. On the other hand if we apply the same condition to the general expression for dQ, namely,

$$dQ = SdT - aT(dV/dT)_P dP \qquad (48)$$

we observe that (47) cannot be satisfied in the case of dQ consistently with the second law of thermodynamics, because the heat added in any transformation is not simply a property of the substance depending on the initial and final states, but depends essentially on the process by which the transformation is effected. In other words, dQ is not the exact differential of any function of P and T, and cannot be integrated without knowing the relation between P and T defining the process But if the path is given, Q can always be found from (48). Thus if the path on the indicator diagram is a straight line defined by $dP = kdT$, $dQ/dT = S - akT(dV/dT)_P$, and the required value of Q can be found for any substance for which the specific heat and the coefficient of expansion are known. The heat required for any transformation is often required in practice, and may always be obtained in this way, if the path is given.

Expression for the Entropy Φ.—If a small quantity of heat dQ per unit mass is supplied to any substance at a temperature T, the corresponding increase of entropy $d\Phi$ is dQ/T. Thus we obtain immediately from (48),

$$d\Phi = dQ/T = (S/T)dT - a(dV/dT)_P dP. \qquad (49)$$

If we apply the mathematical test for an exact differential, as in (47), we find,

$$(d[S/T]/dP)_T = (1/T)(dS/dP)_T = -a(d^2V/dT^2)_P \qquad (50)$$

which, it will be observed, is precisely the same as that found for dH. We conclude that Φ like H may be regarded as a property of the substance depending only on the state, and capable of tabulation in terms of P and T.

Since Φ itself cannot be measured in practice in any convenient manner, it is usually deduced for any substance from the expression found by experiment for H Since $dQ = dH - aVdP$, by (5), taking dH from (44), we obtain,

$$d\Phi = dQ/T = (S/T)dT - (SC/T + aV/T)dP \qquad (51)$$

which is seen to be identical with (49) if we substitute for SC from (39). This may be integrated, as in the case of H, from o to T at zero pressure, with $S = S_m$ and from o to P at constant T. Taking as an example the simple equation (42) for V, with SC from (43), we find the expression,

$$\Phi - A = \int (S_o/T)dT - \int (R/P + anc/T)dP$$
$$= S_m \ln T - R \ln P - ancP/T \qquad (\ln = \text{rat. log}) \qquad (52)$$

in which A is the constant of integration determined in the usual manner.

Use of the Entropy.—It should be observed that the entropy is not an independent property of the substance, since it can be deduced from H and V, but it is most useful in practice for defining the process of frictionless adiabatic expansion, and for deducing the maximum work obtainable from a quantity of heat supplied to the working substance under specified conditions. As a simple example we may take the case of the steam-turbine. Any part of the heat received (e g., in the superheater) at the constant initial pressure P' is represented in virtue of relation (3) by the increase DH of the total heat of the steam over the range considered Let $D\Phi$ represent the increase of entropy taken from the tables over the same range of temperature In the ideal cycle after adiabatic expansion the corresponding part of the heat rejected at the constant temperature T'' of the condenser will be $T''D\Phi$. The difference $DH - T''D\Phi$ represents the work obtainable from this part DH of the heat supplied, and the ideal efficiency is given by $1 - T''D\Phi/DH$. Thus it becomes possible to estimate the thermal efficiencies of different stages of the heating system, as depending on the temperature T' of heat reception by the working fluid.

The equivalent of the work theoretically obtainable in any part of an ideal cycle included between two adiabatics may also be found by subtracting the heat-drop along the lower adiabatic from that along the higher adiabatic. This gives the same result as subtracting the heat rejected from the heat received, but saves trouble in calculation if tables of adiabatic heat-drop are available

If the "mean effective temperature" T_m of heat reception DH at constant pressure P is defined as being equal to $DH/D\Phi$, the expression for the ideal efficiency of the cycle between the two adiabatics differing in entropy by $D\Phi$ reduces to the form $1 - T''/T_m$, the same as that of a Carnot cycle in which all the heat is received at one temperature T_m. As G. M. Clarke has pointed out, the mean effective temperature thus defined affords a convenient method of expression for the ideal efficiency of any cycle as compared with the Carnot cycle. But it does not supersede the use of the entropy, which is required in order to be able to calculate T_m.

Efficiency of Expansion in a Turbine—The foregoing method of finding the efficiency of *an ideal cycle*, or part of a cycle, between two adiabatics, depends on assuming that the useful work done is equal to the excess of the heat received over that rejected by the working fluid, and is restricted to the case in which no losses are incurred in expansion, and all the heat is rejected at one temperature T'', as in the condenser of a steam-engine or turbine. The method gives the fraction of the heat received in any part of *the heating system* which could be converted into work by a *perfect* engine under the conditions imposed. On the other hand, in analysing the performance of an actual engine or turbine, it is necessary to take account of losses incurred *in the engine* during the expansion, and to compare the actual performance with that obtainable in adiabatic expansion under ideal conditions over the same range. The general principle of the method by which this may be accomplished in the case of a

turbine is as follows:

The Case of Dry Steam.—As explained previously, and implied by equation (12), the drop of H in expansion through a turbine, when corrected for the minor losses Q and K, is the equivalent of the useful work done by the steam So long as the steam is *dry*, the value of H at any point of the expansion can be determined by observing the pressure and temperature, and the actual drop of H, denoted by DH, between any two points can be deduced. The work theoretically obtainable in frictionless expansion can also be found from the adiabatic equation as shown in (17). The ratio of the actual heat-drop DH, as corrected, to the adiabatic heat-drop for the same drop of pressure, gives the efficiency of any stage or section of the turbine This simple method fails when the steam is *wet*, as usually happens towards the end of the expansion, because there is no satisfactory means of measuring the degree of wetness under these conditions at low pressures. But if the initial value Φ of the entropy is known, the adiabatic heat drop can still be found from the final temperature T'', with the aid of the tables giving H_s'' and Φ_s'' for *dry saturated* steam, since for *wet* steam in the state H'', Φ'', at any temperature T'' we have the simple relation,

$$H_s''-H''=T''(\Phi_s''-\Phi''). \qquad (53)$$

Heat-Drop for Wet Steam.—Putting $\Phi''=\Phi'$ in (53) the final H'' for wet steam at T'', in adiabatic expansion, is obtained in terms of the tabulated values H_s and Φ_s. Thus we obtain for the adiabatic heat-drop from the initial state H', Φ'.

$$H'-H''=H'-H_s''+T''(\Phi_s''-\Phi'). \qquad (54)$$

Equation (54) is also the appropriate equation to employ for finding the adiabatic heat-drop over the whole range of expansion in the turbine, from admission to exhaust, when the final state of the steam is wet, as is usually the case with a condensing engine It is equally applicable to the case of a reciprocating engine, since the discontinuities involved in the operation of this type of engine are supposed to be absent from the ideal cycle. The heat-drop thus found may be compared with the work actually done per lb. of steam, as deduced from measurements of the feed and the power, for which *see* STEAM-ENGINE.

Equation (53), with Φ'' constant and equal to Φ' may be regarded as the simplest and most useful form of the adiabatic giving the final value H'' of the total heat for a wet vapour, when tables of Φ and H are available. It may be expressed if desired in terms of H and T only, but cannot be put in the usual form (9) or (10) (as is often attempted), because the value of the index γ varies so much with temperature and wetness as to make the equation difficult to use and less accurate in practice than measurements on a diagram.

Types of Characteristic Equation.—The general relation between P, V, and T, which exists for any substance in various states is commonly called the characteristic equation, or equation of state, of the substance. It has often been thought possible to include both liquid and vapour states in a single equation, such as that of van der Waals, since the properties of the two states approximate to each other in the critical region, and show a continuous transition above the critical pressure. This will be further discussed in the article VAPORIZATION dealing with the relations between the two states. For the present purpose we may confine our attention to a few simple types of equation for the gas or vapour state, which is of primary importance in practice in relation to heat engines. It appears that all simple substances with stable molecules tend to approximate in the vapour state at low pressures to the ideal gas equation $PV=RT$, in which the value of the constant R varies inversely as the molecular weight (if V is the volume of unit mass) and is equal to the difference of the specific heats in work units. An equation of this type receives a satisfactory physical explanation on the kinetic theory of gases, but it is the province of thermodynamics to indicate how the simple gas equation must be modified to take account of deviations from the ideal state, and to interpret the results of various experimental methods as applied to the problem.

One of the commonest methods of measuring these deviations is to observe the variation of the volume with pressure at constant temperature The values of the product PV should then be constant if Boyle's law is obeyed, and should give a horizontal line on the PV—P diagram As a rule the isothermal lines thus plotted from observations at various constant temperatures, are nearly straight for a moderate range of pressure at each temperature, but have a downward slope, represented by $d(PV)/dP=-c$, where c diminishes with rise of temperature as the vapour approximates more closely to the ideal state Observations of this kind could be represented by an equation of the type (42) by assuming PV to be proportional to T at low pressures, and choosing c, or $c-b$, to be a suitable function of the temperature. But even if all the isothermals were found to be horizontal, this method by itself would not prove that PV was proportional to the absolute temperature, as in $PV=RT$, since Boyle's law would be perfectly satisfied by an equation of the type, $PV=F(T)$, with $F(T)$ any arbitrary function of the temperature

Fortunately the Joule-Thomson method, as described on page 98, affords an independent means of verifying the form of the characteristic equation It has the additional advantages of being easy to apply and of measuring the small deviation itself, without requiring any absolute measurements of volume, which are essential to the Boyle's law method, and very exacting. As shown by the thermodynamic expression (40) for the cooling effect, any substance for which $C=0$ must have a characteristic equation of the general type $V/T=F(P)$, in which $F(P)$ represents any arbitrary function of the pressure. The ideal gas, $PV=RT$ is a special case for which $F(P)=R/P$. The condition $C=0$ by itself leaves the form of $F(P)$ indeterminate But when the same gas also satisfies Boyle's law, which requires a characteristic equation of the form $PV=F(T)$, the two conditions can be simultaneously satisfied only by the ideal gas equation $PV=RT$. Joule and Thomson were therefore justified in their choice of the constant of integration R/P in equation (41), since the gases they employed also satisfied Boyle's law at low pressures.

Type of Equation Required by Condition (6).—Another case of practical interest is to find the general form of characteristic equation compatible with condition (6), and with the simple form of adiabatic equation (9), which follows by the first law of thermodynamics from the assumption that the change of intrinsic energy is proportional to that of aPV as expressed in (6) Equations (6) and (9) make no mention of temperature, and it is obvious that the deduction of the relation between PV and T must essentially involve an appeal to the second law with its implicit definition of T. The most direct way of doing this is to find the two specific heats, S_p and S_v, from H and E as given by (6), and to equate the difference, S_p-S_v, thus found to the expression (35) for the difference of the specific heats as given by the second law. Thus by differentiating (6) at constant volume we obtain for the specific heat S_v,

$$S_v=(dE/dT)_v=an(V-b)(dP/dT)_v. \qquad (55)$$

Similarly by adding aPV to (6) to give $H-B$ instead of $E-B$, and differentiating H at constant pressure, we obtain for the specific heat S_p,

$$S_p=(dH/T)_p=a(n+1)P(dV/dT)_p. \qquad (56)$$

Substituting the difference of these two expressions for S_p-S_v in (35), and dividing by $a(dP/dT)_v(dV/dT)_p$, we obtain the required expression for T in terms of P and V in the form of a differential equation, namely,

$$T=(n+1)P(dT/dP)_v-n(V-b)(dT/dV)_p \qquad (57)$$

which is a special case of Lagrange's linear equation, and is easily solved as follows.

(a) Write down the corresponding subsidiary equations of Lagrange, namely,

$$dT/T=dP/(n+1)P=-dV/n(V-b) \qquad (58)$$

(b) Find any two independent solutions of these equations The two simplest and most obvious solutions of (58) are those given in (10) above, which are alternative forms of the adiabatic equation, and are also solutions of (57). (c) To find the most general solution, including all other possible solutions, make one of these ex-

pressions an arbitrary function of the other. This will be the most general form of characteristic equation consistent with (6) and (9) The most convenient form for most practical purposes, giving V explicitly as a function of P and T, is as follows,

$$P(V-b)/T=F(P/T^{n+1}) \qquad (59)$$

which is expressed in words by stating that $P(V-b)/T$ must be constant along any adiabatic represented by $P/T^{n+1}=$constant Thus (59) includes all possible forms of characteristic equation consistent with the adiabatic found experimentally for steam, and with the expression (6) for the intrinsic energy, which was assumed as the basis of the equations first proposed for steam by the writer (*Proc R S* 1900, p. 269) At that time none of the experimental evidence available, except that for the adiabatic, extended much beyond 200 lb. pressure and 200° C, and the state of knowledge did not justify going further than the first approximation represented by equation (42), in which the arbitrary function F was assumed to be of the simple form $R/a-cP/T$ This proved to be a very good approximation and amply sufficient at moderate pressures or high superheats, but it appeared that higher powers of cP/T would be required at higher pressures, and that no equation of this type could represent the accepted theory of the critical state, as represented by the van der Waals equation

While retaining the fundamental assumption (6) it would evidently be possible to construct an equation of the van der Waals type, giving P as a cubic function of $1/(V-b)$, by replacing P/T^{n+1} in (59) by $1/(V-b)T^n$, as follows,

$$aP(V-b)/RT=1-c/(V-b)+c^2/3(V-b)^2 \qquad (60)$$

which would give a critical point of the usual type defined by the conditions,

$$V-b=c=RT/3aP, \qquad (61)$$

but in the absence of accurate experimental data it was impossible to predict that this would be more satisfactory than (59) in terms of P, whereas it would certainly be much less convenient for practical calculations.

It has recently been found possible (*Proc. R S.* Sept. 1928), to extend the experimental range for water and steam to 400° C and 4,000 lb pressure, including the whole of the critical region Results obtained for water, by the steady flow method described in the article CALORIMETRY, verify the thermodynamic equation there given for the total heat with extreme accuracy up to the critical point. Those for steam disagree materially on several fundamental points with the accepted theory of the critical state, and appear to show that an equation of the type (59) is capable of representing the critical phenomena with much greater accuracy than any equation of the van der Waals type. Since the points in question are of primary importance with respect to the relations between the liquid and vapour states, they are further discussed in the article VAPORIZATION, though they also afford a good illustration of the application of the laws of thermodynamics to experimental research

As it would be impossible within the limits of this article to illustrate or explain adequately the applications which have been made of the principles of thermodynamics, it has been necessary to select such illustrations only as are required for reference in other articles, or could not be found elsewhere. For fuller details and explanations of the elements of the subject, the reader must refer to general treatises, such as Ewing's *Thermodynamics for Engineers* (Cambridge, 1920), Birtwistle's *The Principles of Thermodynamics* (2nd ed., Cambridge, 1927) or Preston's *Theory of Heat* (5th ed., 1928). One or two chapters on the subject are also generally included in treatises on the steam engine or other heat engines, such as those of Rankine, Ewing, or Perry. Of greater interest, especially from a historical point of view, are the original papers of Joule, Kelvin and Rankine A more elaborate treatment of the subject will be found in many foreign treatises, such as those of Clausius, Zeuner, Duhem, Bertrand, Planck and others. (H L C.)

THERMODYNAMICS AND PHYSICAL CHEMISTRY

Introductory.—The principles of thermodynamics (introduced in their modern form by Clausius in 1850) are the basis of a method of dealing with mechanical problems in which heat exchanges take place, without the necessity arising of considering the detailed mechanical structure of a system. The system may consist of an assemblage of an enormous number of molecules in agitated movement and exerting attractions and repulsions upon one another. Very little can be found out about the individual motions and positions of these particles. Thermodynamics provides a means of examining certain properties of matter in bulk. The principles that are discovered form the basis of the preceding article and reference must be made to that article for their description and proof They are applied there mainly to the properties of steam and its applications to steam-engines In the present article which deals with the application to bodies in general we must be content with summarizing the fundamental facts which will be utilized.

i. The intrinsic or internal energy of a body can change by the entry of heat (by conduction or radiation) and by the performance of external work, i e , $dE=dQ-dW$ provided the system remains sensibly in equilibrium *(Conservation of energy)*.

ii. A body may get hotter even if no heat flows in. The energy depends on the temperature and this is increased if work is done upon the system even when dQ is zero *(Adiabatic changes)*

iii The energy, E, depends only upon the state; so that, in whatever way the system is changed, if the original state is returned to, the initial value, E, is recovered.

iv The work done depends in general not only upon the initial and final states but also upon the path of transformation.

This results from the fact that three variables at least are necessary to specify the state, viz , pressure, volume and temperature, and they are connected by only one equation (the equation of state). The work done is in each case $\int pdV$. In a complete cycle the work done is equal to the area enclosed by the cycle on a p, V diagram For any given value of V, T and therefore p may have different values on the return and forward paths and the cycle encloses an area It follows that for an *isothermal* reversible cycle the pressure for any given volume is fixed and the work done must be zero for the path then returns on itself

v. The energy E depends on both the temperature and the volume: for internal work can be done against molecular attractions when the volume changes.

When the system is subjected to a uniform pressure the fundamental equation becomes $dH=CdT+ldv$

We select unit mass for consideration. In this case C is the specific heat at constant volume and $l\left(=\frac{\Delta H}{\Delta v}\right)$ is the latent heat of expansion. In the case of a perfect gas, for which the characteristic equation is $pv=RT$ and for which no internal attractions exist, so that the internal work is zero

$$dH=C_vdT+pdv$$

which can be put in the alternative forms (by using the characteristic equation)

$$dH=C_pdT-vdp=\frac{1}{R}(C_ppdv+C_vvdp)$$

where C_v and C_p are the specific heats at constant volume and at constant pressure.

From these for adiabatic changes ($dH=0$)

$$C_vdT+\frac{RT}{v}dv=0 \quad \text{or} \quad vT^{C_v/R}=\text{const.}$$

$$C_pdT-\frac{RT}{p}dp=0 \quad \text{or} \quad \frac{T^{C_p/R}}{p}=\text{const.}$$

and $$C_ppdv+C_vvdp=0 \quad \text{or} \quad pv^{C_p/C_v}=\text{const.}$$

The work done is $\int pdv=-C_v\int dT=C_v(T_1-T_2)$.

It is presumed that the changes are reversible throughout. A very quick change is always irreversible owing to the rushes of material that take place. The only way to bring about approximate reversibility is to keep the heat from getting in or out as well as possible by means of non-conducting boundaries.

vi. The second law of thermodynamics enables relations to be found between the several quantities (or their derived quantities) According to this law the work that can be done in a reversible Carnot cycle is the maximum possible for the two extreme temperatures concerned, and, *independently of the working substance*, the work done divided by the heat taken in at the higher temperature is equal to $(T_1-T_2)/T_1$: where T_1 and T_2 are absolute temperatures on the perfect gas scale. This ratio is called the efficiency.

[This law is derived from the fact that heat can only flow *down* a gradient of temperature. Clausius showed that if a more efficient performance were obtainable it would be possible to make a hot body hotter while simultaneously a cold one became colder without any performance of work This would entail that heat flowed *up* the temperature gradient.]

vii. Since the efficiency is also given by $\frac{W}{Q_1}=\frac{Q_1-Q_2}{Q_1}$ we deduce that $\frac{Q_1}{T_1}=\frac{Q_2}{T_2}$.

Now in a Carnot cycle Q_1 and Q_2 are the only transfers of heat (each at constant temperature); if therefore we define a quantity ϕ such that $Td\phi=dQ$ this quantity ϕ undergoes zero change in any complete reversible cycle. It is called the entropy of the system per unit mass.

For irreversible changes this definition is not complete. In such changes there is kinetic energy of matter in bulk, and friction which is always present is continually frittering the motion down into heat. If we regard the system as an assemblage of small elements rubbing against one another the heat produced flows across the boundaries of these elements. In doing so some has entered each element and produces the same changes of p, v, T and entropy as any heat entry would do. When this heat production and corresponding entropy change is summed up for the whole system we hav

$$Td\phi=d(Q+q)$$

where q is the heat produced by friction inside the walls of the complete system. Since friction never produces "cold," dq is always positive and consequently for any change

$$Td\phi\geqq dQ.$$

Cases in which the equality sign holds are ideal cases only; but they are approximated to more nearly the nearer a system keeps in equilibrium states throughout.

The quantity T, is, as we have said, the absolute temperature according to a perfect gas scale. We could have defined it alternatively in terms of the efficiency equation and it is therefore called the *thermodynamic* temperature It would have been necessary then to show that it is identical with the ideal gas scale

The advantage gained by introducing the conception of entropy is that it provides us with a function of Q which depends (unlike Q itself) only upon the state of the system, provided that we measure it for reversible changes only.

viii. When any property of the state of a system (say E) is defined completely by two independent variables (say x and y) so that we can write

$$dE=adx+bdy$$

where $$a=\left(\frac{\partial E}{\partial x}\right)_y \quad \text{and} \quad b=\left(\frac{\partial E}{\partial y}\right)_x$$

the following mathematical relation must be valid, viz.:

$$\left(\frac{\partial a}{\partial y}\right)_x=\left(\frac{\partial b}{\partial x}\right)_y$$

the suffixes denoting quantities which remain constant during the partial differentiations to which they are appended.

This mathematical relation can be applied in the case of reversible changes to E and ϕ which depend only on the state but it cannot be applied to Q or to W, which depend upon the path taken between the extreme states. In consequence some writers prefer not to use the expressions dQ and dW for small changes in Q and W because, for example, these may each acquire different values whether the "co-ordinates" of the system (e.g., v, T) have changed *on the whole* or not. Small changes in quantities which depend only upon the state are said to be perfect differentials

When there are more than two independent variables we can apply the same theorem to any two of them in turn. For example, adding a third term cdz, we have the additional relations

$$\left(\frac{\partial a}{\partial z}\right)_{x,y}=\left(\frac{\partial c}{\partial x}\right)_{y,z} \quad \text{and} \quad \left(\frac{\partial b}{\partial z}\right)_{y,x}=\left(\frac{\partial c}{\partial y}\right)_{x,z}$$

where two of the independent variables are kept constant in each differentiation.

The employment of thermodynamics in the study of various systems consists very largely of the application of this important mathematical theorem. We shall apply it first to homogeneous systems in equilibrium.

Homogeneous Systems.—A homogeneous system is alike in all its parts. Its state can be defined in terms of its pressure, volume and temperature. Any one of these three may be eliminated by means of the so-called characteristic equation when it is known; so that Q, ϕ, E may be taken as functions of T and v, of T and p, or of p and v. Since each portion is the same as any other we can deal with unit mass. Since equilibrium exists the temperature and pressure will be uniform throughout No assumption will be made as to the molecular constitution of the system; nor, until applications are considered will any assumption be made as to the form of the characteristic equation.

For such a system we can write:

$$dQ=dE+pdv=C_vdT+ldv$$

also $$d\phi=(dQ)/T$$

so that $$dE=C_vdT+(l-p)dv$$

and $$d\phi=\frac{C_vdT}{T}+\frac{l}{T}dv.$$

It follows that (a) $$\left(\frac{\partial C_v}{\partial v}\right)_T=\frac{\partial}{\partial T}(l-p),$$

(b) $$\frac{1}{T}\left(\frac{\partial C_v}{\partial v}\right)_T=\left(\frac{\partial}{\partial T}\frac{l}{T}\right)_v.$$

The latter (b) multiplied by T gives

$$\left(\frac{\partial C_v}{\partial v}\right)_T=\frac{\partial l}{\partial T}-\frac{l}{T}$$

which, comparing with (a), gives $l=T\left(\frac{\partial p}{\partial T}\right)_v$

and $$\left(\frac{\partial C_v}{\partial v}\right)_T=T\left(\frac{\partial^2 p}{\partial T^2}\right)_v.$$

For a perfect gas $pv=RT$, whence $T\left(\frac{\partial p}{\partial T}\right)_v=p$ and $\left(\frac{\partial C_v}{\partial v}\right)_T=0$.

For a van der Waals gas $\left(p+\frac{a}{v^2}\right)(v-b)=RT$, so that

$$T\left(\frac{\partial p}{\partial T}\right)_v=p+\frac{a}{v^2} \quad \text{and} \quad \left(\frac{\partial C_v}{\partial v}\right)_T=0;$$

whence $dQ=C_vdT+\frac{adv}{v^2}+pdv$; the term $\frac{a}{v^2}dv$ shows how the energy depends upon the volume.

It will be noticed that these are all cross-relations between different terms. There is no thermodynamical relation giving $\frac{\partial C_v}{\partial T}$ because C_v and T both refer to the same term. We know nothing about C_v as a function of T except from experiment and from tentative mechanical theory.

In a similar way if $dQ=C_pdT+l'dp$ (T and p being taken as independent variables) we have

(a) $$dE=C_pdT+l'dp-pdv$$

and (b) $$d\phi=\frac{C_pdT}{T}+\frac{l'dp}{T}.$$

Now $d(pv)=pdv+vdp$; and if this be added to both sides of (a) we have $d(E+pv)=C_pdT+(l'+v)dp$. Since, the product pv

returns to a fixed value whenever p and v do therefore $E+pv$ also depends on the state alone and its change is defined here in terms of dT and dp. Hence

$$\left(\frac{\partial C_p}{\partial p}\right)_T = \left[\frac{\partial}{\partial T}(l'+v)\right]_p$$

and

$$\left[\frac{\partial}{\partial p}\left(\frac{C_p}{T}\right)\right]_T = \left[\frac{\partial}{\partial T}\left(\frac{l'}{T}\right)\right]_p$$

which yield finally $l' = -T\left(\frac{\partial v}{\partial T}\right)_p$ and $\left(\frac{\partial C_p}{\partial p}\right)_T = -T\left(\frac{\partial^2 v}{\partial T^2}\right)_p$

It is to be noted that these equations in reality express the connections that must exist between the properties of a substance in order to bring about the universality of the value of the efficiency if the substances were employed as the working substances in reversible engines working between two given temperatures A high vapour pressure or a low boiling point does not lead to higher efficiency, the variables being so interconnected that this is impossible

The above equations hold for any homogeneous systems. The equation

$$dQ = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dv$$

is exceedingly important, embodying all that can be learned from the two thermodynamical principles, and serving as a secondary starting point from which other relations may be obtained without further reference to the two principles For example if λ is any other variable we can write

$$\left(\frac{dQ}{dT}\right)_x = C_v + T\left(\frac{\partial p}{\partial T}\right)_x \left(\frac{dv}{dT}\right)_x$$

the suffix x indicating that x is to be kept constant during the differentiation. For example, if $v = p$ (the pressure), $\left(\frac{dQ}{dT}\right)_x = C_p$ (the specific heat at constant pressure) and we have

$$C_p = C_v + T\left(\frac{\partial p}{\partial T}\right)_v \left(\frac{\partial v}{\partial T}\right)_p$$

which is an expression for the difference between the two principal specific heats For a perfect gas the right hand side equals R, the gas constant. For a van der Waals fluid it equals

$$R \Big/ \left(1 - \frac{2a}{v^3}\cdot\frac{(v-b)^2}{RT}\right).$$

Berthelot's equation of state is very widely used in calculating the difference of the specific heats. The equation is

$$\left(\alpha + \frac{16}{3\gamma\beta^3}\right)\left(\beta - \frac{1}{4}\right) = \frac{32}{9}\gamma.$$

It is given here in its "reduced" form, *i.e.*, the actual pressures, volumes and temperatures are given as the fractions α, β, γ of their respective critical values Calculating in the same way, this equation leads to

$$C_p - C_v = \frac{32}{9}\frac{p_c v_c}{T_c}\left(1 + \frac{6}{\gamma^2\beta}\right) \text{ approximately}$$

when β is large compared with unity. This can be written

$$C_p - C_v = R\left(1 + \frac{6}{\gamma^2\beta}\right) = R\left(1 + \frac{27}{16}\frac{\alpha}{\gamma^4}\right)$$

where R is the characteristic constant of the gas.

Callendar's simplified equation, $v - b = RT/p - c/T^n$ leads to

$$C_p - C_v = R\left(1 + \frac{nc\,p}{RT^{n+1}}\right)^2.$$

The last two equations are only applicable when the density is moderate.

Saturation Values.—As a second application, let x denote a change along the line of saturated vapour; then $\left(\frac{dQ}{dT}\right)_x$ becomes σ, the specific heat of saturated vapour, and

$$\sigma = C_v + T\left(\frac{\partial p}{\partial T}\right)_v \left(\frac{\partial v}{\partial T}\right)_{\text{sat}}$$

Now $\left(\frac{\partial p}{\partial T}\right)_v$ is always positive and $\left(\frac{\partial v}{\partial T}\right)_{\text{sat}}$ is always negative so that σ is always less than C_v and it may even be negative This latter is the case for steam at all temperatures. The values for sulphur dioxide have also been studied in detail experimentally by Mathias (*Comptes Rendus*, t. cxix p 840). The importance of this substance in mechanical refrigeration warrants quoting the values in some detail:

t° C	0	20	40	60	80	100	110
σ	−0·410	−0·357	−0·300	−0·235	−0·165	+0·027	+0·062

t° C	120	125	130	140	150	155	
σ	−0·078	−0·176	−0·306	−0·620	−1·253	−3·850	

It appears that for this substance σ is negative except between the temperatures 97·5° C and 114° C. When plotted against temperature the curve is an inverted unsymmetrical U. This is so for all substances but in many cases it lies wholly in the negative region The value of σ for the liquid along the saturation line has also been studied by Mathias It is positive (because for the liquid $\left(\frac{\partial v}{\partial T}\right)_{\text{sat}}$ is positive) and changes from 0·315 at −20° C to 1·800 at 155° C.

We can start equally well from the equation

$$dQ = C_p dT - T\left(\frac{\partial v}{\partial T}\right)_p dp$$

and find

$$\sigma = C_p - T\left(\frac{\partial v}{\partial T}\right)_p \left(\frac{dp}{dT}\right)_{\text{sat}}$$

The thermodynamic equations employed above are exact. It should be noted, however, that the characteristic equations are only approximate at best. The underlying assumption that is made in deriving them is that the system consists of molecules alike in all respects. Even in such a case it is not to be expected that the p, v, T, equation should be of a simple form. It is much simplified by the fact that we are only concerned with average values. No instrument is capable of measuring either the pressure or temperature at a single point and a single moment of time Each quantity measured is an average value over such a volume or area or time as to maintain a constant value in the equilibrium state. For real fluids molecules may be of different kinds and may be associated with one another in different ways which change with the volume and temperature. In such cases the connection between p, v and T is bound to be of a more elaborate character. The only assumption that has been made is that for a definite p, v, T, the constitution is the same whenever these return, after changes, to their original values.

Entropy.—Since $dQ = C_v dT + p dv$ for a perfect gas the entropy change is

$$d\phi = \frac{dQ}{T} = C_v\frac{dT}{T} + \frac{R}{v}dv;$$

whence

$$\phi_2 - \phi_1 = C_v \log_e \frac{T_2}{T_1} + R \log_e \frac{v_2}{v_1}$$

$$= C_p \log_e \frac{T_2}{T_1} - R \log_e \frac{p_2}{p_1}.$$

For a van der Waals fluid

$$dQ = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dv$$

$$= C_v dT + \frac{RT}{v-b}\,dv$$

and

$$\frac{dQ}{T} = C_v\frac{dT}{T} + \frac{R}{v-b}\,dv.$$

Now C_v for such a fluid may be a function of T but not of v, and

experiment shows that, for many gases, it is very nearly a linear function of T through a range of seven or eight hundred degrees centigrade. If we write $C_v = c + gT$

$$\phi_1 - \phi_1 = c \log \frac{T_2}{T_1} + g(T_2 - T_1) + R \log \frac{v_2 - b}{v_1 - b}.$$

Thermodynamic Potentials.—It has been explained that, when the possibility of irreversible changes is taken into account the increase in entropy is always greater than that calculated from the heat entry from outside the system, *i.e.*, we may write

$$Td\phi = dQ + Pos.$$

where $Pos.$ is a positive quantity In the ideal case of a reversible change this positive quantity becomes zero. For any change therefore

$$dE = dQ - pdV$$
$$= Td\phi - pdv - Pos.$$

If we subtract $d(T\phi)$ from both sides

$$d(E - T\phi) = -\phi dT - pdv - Pos.$$

If the change is at constant temperature $\phi dT = 0$

To the quantity brackets on the left Helmholtz gave the name *free energy*. Representing it by F we write, at constant temperature

$$-dF = +pdv + Pos,$$

i.e., the isothermal decrease of free energy is equal to the work done by the system plus a positive quantity. Since, for a reversible change, $Pos =$ zero, the work done is then a maximum *for a given isothermal diminution of free energy.* This is known as the principle of maximum work.

The isothermal change of free energy may be greater or less than the change of energy, E, because nothing is specified as to whether heat enters or leaves the system during the isothermal change. For in such a change

$$dE = dF - Td\phi \quad (dT = 0)$$

and $Td\phi (= dQ)$ may be positive or negative.

If the change is made at constant temperature and constant volume $-dF = Pos.$ Hence in any such change the free energy can only decrease.

If the free energy reaches a minimum value in such a change no further decrease can occur. The system (at constant temperature and volume) *must then be in equilibrium.*

In ordinary mechanics a system is in equilibrium when its potential energy is a minimum. In this more general problem where thermal changes must be allowed for this property belongs to the free energy The theorem is general; no assumption has been made in regard to the constitution of the system. Unfortunately difficulties arise in attempting to apply it excepting in the case of an *ideal gas* mixture

For such an ideal mixture the various components of the system are independent of one another. The total pressure, energy, entropy, and free energy are given by the sums of the values for the separate components.

Let the constant volume and temperature be V and T, and let the contents consist of a number of gases capable of reacting according to the general law of chemical combination

$$\nu_1 A_1 + \nu_2 A_2 + \cdots = \nu_a A_a + \nu_i A_i + \cdots$$

and let them be present when in equilibrium in the proportions

$$N_1 N_2 \cdots N_a N_i \cdots$$

where the values of N are the numbers of molecules of the various kinds present. It is necessary, in the first case, to calculate the free energy *per molecule* of each component.

Now reckoning from any arbitrary temperature T_0 we may write

$$E = C_v(T - T_0)$$

$$\phi = C_v \log \frac{T}{T_0} + R(\log v - \log v_0)$$

$$= C_v \log T + R \log \frac{V}{N} + k$$

where k is a constant and the other quantities are the values per molecule. Hence

$$F = C_v T + TC_v \log T + RT \log \frac{V}{N} + kT - C_v T_0.$$

Since the temperature is to be treated as constant we may conveniently divide by it and write

$$F/T = C_v + C_v \log T + R \log \frac{V}{N} + k - \frac{C_v T_0}{T}$$

and for N molecules of any one kind this must be multiplied by N. Now the total value of the free energy is $\sum(NF)$ and this, or its value divided by the constant T, is to be a minimum for equilibrium, *i.e.*,

$$\sum \frac{1}{T}\left(F + \frac{dF}{dN}\right) dN$$

must equal zero. But owing to the laws of chemical combination any changes of the quantities must satisfy the equations

$$\frac{dN_1}{\nu_1} = \frac{dN_2}{\nu_2} = \cdots = -\frac{dN_a}{\nu_a} = -\frac{dN_i}{\nu_i}.$$

Hence $$\sum_{1,2\ etc}\left(F + \frac{dF}{dN}\right)\nu = \sum_{a,i,etc}\left(F + \frac{dF}{dN}\right)\nu.$$

Performing the operations after dividing by T it follows that

$$\sum_{1,2,etc}\left(C_v + C_v \log T + R \log \frac{V}{N} + k - \frac{C_v T_0}{T} - \frac{RN}{N}\right)\nu = \sum_{a,i,etc}(\ )\nu;$$

or $$\sum_{1,2,etc} R\nu \log \frac{V}{N} = \sum_{a,i,etc} R\nu \log \frac{V}{N} + \text{function of } T \text{ alone},$$

or $$\log \frac{V^{\nu_1+\nu_2+\cdots-\nu_a-\nu_i}}{N_1^{\nu_1} N_2^{\nu_2} \cdots N_a^{-\nu_a} N_i^{-\nu_i}} = \text{function of } T.$$

This is the equation of chemical equilibrium at constant volume and temperature If we write $\frac{N_1}{V} = n_1$, $\frac{N_2}{V} = n_2$ etc., it becomes

$$\log \frac{n_a^{\nu_a} n_i^{\nu_i} \cdots}{n_1^{\nu_1} n_2^{\nu_2} \cdots} = \text{function of } T$$

The quantity under the logarithm sign is the equilibrium constant for constant temperature and volume. If the equation in terms of N_1, N_2 etc is examined it will be seen that when

$$\nu_1 + \nu_2 + \cdots = \nu_a + \nu_i \cdots$$

a change of volume will not disturb the equilibrium. On the other hand if $\nu_1 + \nu_2 + \cdots$ is the greater sum then an increase of V will increase the values of N_1, N_2, etc. and diminish those of N_a, N_i, etc.

The former case would be illustrated by a reaction such as

$$H_2 + Cl_2 \rightleftarrows 2HCl$$
$$N_1 \quad N_2 \quad N_3$$

where $\nu_1 = 1$, $\nu_2 = 1$ and $\nu_3 = 2$, and the latter case by

$$2H_2 + O_2 \rightleftarrows 2H_2O$$

in which the $\sum(\nu)$ on the left is one greater than of the one on the right This is stated without prejudice to the question as to whether the above reactions usually occur or not.

The function of temperature involves the specific heats (or molecular heats), which depend upon the temperature in a way undeterminable by thermodynamics, as well as the constants of integration. The values of the specific heats can however be ascertained by experiment and thus the value of the equilibrium constant at any temperature can be calculated within a constant.

Any deviation that is found from these conclusions may leave it a moot point whether the reactions are not of the specified type or whether the deviations are due to departures from the ideal gas law.

The equilibrium constant was first given by Guldberg and Waage. They based it on the laws of probability of encounters between the reacting molecules. Taking the probability of an encounter of any molecule of the first with one of another kind as proportional to N_1, the probability that ν_1 of them will simultaneously collide is $N_1 N_1 N_1 N_1 \cdots$ to ν_1 terms; that is, it is $N_1^{\nu_1}$. Similarly for N_2 the required probability is $N_2^{\nu_2}$. Further the

probability that the two groups shall collide simultaneously is $N_1^{r_1} N_2^{r_2}$, and so on Some slight departure from the gas law is needed in order that collisions may occur at all, for if the molecules had no volume there would be nothing to collide against But if the volume occupies a sensible proportion of the total system, corrections are required to Guldberg and Waage's law; and any attractions between the molecules, which will necessarily increase the number of collisions, necessitates still further corrections, so that this method of attacking the problem lands us in difficulties The same is true of the thermodynamic method which has been given in detail, when other characteristic equations are employed, even the total pressure is not the sum of the "partial" pressures as it would be according to Dalton's law The additive law breaks down also for all the other functions (E, ϕ, etc). We shall return to the problem after dealing with heterogeneous equilibria.

But first some of the other properties of the free energy must be stated Since for reversible changes $dF = -\phi dT - p dv$ it follows that

$$\left(\frac{\partial F}{\partial T}\right)_v = -\phi \text{ and } \left(\frac{\partial F}{\partial v}\right)_T = -p.$$

But $$F = E - T\phi = E + T\left(\frac{\partial F}{\partial T}\right)_v.$$

Therefore $$T\left(\frac{\partial F}{\partial T}\right)_v - F = -E$$

or $$\frac{\partial}{\partial T}\left(\frac{F}{T}\right)_v = -\frac{E}{T^2}.$$

It should be noted that the *decrease* of F in a reaction is often represented by A and the corresponding *evolution* of energy (*i.e.*, the heat of reaction at constant volume) by U. In terms of these quantities the equation becomes

$$T\frac{\partial A}{\partial T} - A = -U$$

which is of the same form as before.

Again, since F depends, in reversible changes, only upon the state (because E, T, and ϕ so depend) it follows that

$$\frac{\partial^2 F}{\partial v \partial T} = \frac{\partial^2 F}{\partial T \partial v}$$

and therefore $$-\left(\frac{\partial \phi}{\partial v}\right)_T = -\left(\frac{\partial p}{\partial T}\right)_v.$$

Since, we can write $Td\phi = dQ$ this is identical with the equation already found, viz :

$$\left(\frac{\partial H}{\partial v}\right)_T = l = T\left(\frac{\partial p}{\partial T}\right)_v.$$

Heterogeneous Systems.—A heterogeneous system is one in which the whole system can be divided into discrete parts each of which is homogeneous but differs from its neighbours. Each is called a "phase". Without at first considering such systems in general we may take the familiar case of a vessel containing a liquid and its vapour or a solid and a liquid. These can at certain temperatures be in equilibrium with one another. Putting aside the effects of gravity and other body forces, when equilibrium exists the pressure must be uniform throughout the system for mechanical reasons, provided there is no curved interface between the phases; and the temperature must be uniform throughout for reasons depending upon conduction and radiation The values of these variables are independent of the relative amounts of liquid and vapour Let $1-m$ and m be the masses of the two phases in a system of unit mass; and let v_1 and v_2 be their specific volumes (*i.e.*, volumes per unit mass) then the total volume is $(1-m)v_1 + mv_2$. The uniform pressure is the saturation pressure; we denote it by the symbol π the value of which experiment shows to be independent of the volume but dependent upon the temperature. The total energy is $E = (1-m)E_1 + mE_2$ where E_1 and E_2 are the energies per unit mass of the respective phases. The entropy is $\phi = (1-m)\phi_1 + m\phi_2$. Any heat that enters may be divided into two parts corresponding to the phases it passes into Since the law of summation obviously applies throughout we can write

$$dQ = CdT + ldV \text{ as before}$$
$$= \{(1-m)\sigma_1 + m\sigma_2\}\, dT + ld\,\{(1-m)v_1 + mv_2\}$$

provided, at least, that neither of the phases vanishes Now the same considerations as before give

$$l = T\left(\frac{\partial \pi}{\partial T}\right)_v = T\frac{\partial \pi}{\partial T}$$

since π is independent of V. The change of volume is $(v_2 - v_1)dm$ so that the equation becomes

$$dQ = \{(1-m)\sigma_1 + m\sigma_2\}\, dT + T(v_2 - v_1)\frac{d\pi}{dT}\, dm$$

The heat taken in when unit mass evaporates at constant temperature is called the latent heat of evaporation, it is equal to the coefficient of dm and is therefore

$$L = T(v_2 - v_1)\frac{d\pi}{dT}.$$

This is the equation of latent heat for a change of phase first given in the present form in 1850 by Clausius but actually found to be verified by experiments made in the case of the change of ice into water by Lord Kelvin in 1850 before he had accepted the law of the conservation of energy. These experiments were first interpreted in terms of a calculation made by his brother James Thomson in 1849 based upon Carnot's theory of the conservation of *heat* (not energy)—the effect to be expected from lowering a quantity of heat through one degree being determined, *not by theory*, but by comparison with results obtained from Regnault's experiments on steam. The lowering caused by an increase of the equilibrium pressure π by 140 atmospheres is about one degree centigrade. It is a lowering in the case of ice-water because $v_{ice} > v_{water}$, it is a rise in the transition temperature (*i.e.*, the boiling point) in the case of water-steam because $v_{steam} > v_{water}$. We can conveniently take the equation in the form

$$dQ = \{(1-m)\sigma_1 + m\sigma_2\}\, dT + Ldm$$

so that the independent variables become T and m. Consider now an adiabatic change, $dQ = 0$; then

$$\frac{dm}{dT} = -\frac{(1-m)\sigma_1 + m\sigma_2}{L}.$$

Since the symbols σ_1, σ_2 stand for saturation values, σ_1 is positive but σ_2 *may* be negative. If we write $(-\sigma_2)$ in such case for its positive numerical value we find that dm will be negative when dT is negative provided that $(1-m)\sigma_1$ is numerically less than $m(-\sigma_2)$, *i.e.*, that liquid will form in the case of water-steam when the temperature lowers. Since the water deposits most readily on particles of dust, etc., in the vessel a cloud will appear. This is obviously most likely to happen when the amount of water initially present $(1-m)$ is small compared with the amount of vapour (m). In the case of a positive value for σ_2 no cloud can form.

A reversible *isothermal* expansion of a mixture of water and steam always causes evaporation.

Phase Rule.—We have considered the co-existence of water and steam and of ice and water in separate phases. The possibility of this co-existence is determined by the *phase rule* due to Willard Gibbs The dividing surfaces between the phases are presumed to be plane so as to exclude effects arising from surface tension. The phase rule asserts that the number of independent variations of which a system of co-existent phases is capable is $C + 2 - P$ where C is the number of independently variable *components* in the whole system. The term *component* must be carefully distinguished from *constituent* Thus in dealing with water and steam, hydrogen and oxygen are constituents of each phase, but since they can only vary in chemically combining proportions it would be sufficient to specify *either* of them or even the amount of water present. Thus there is only one component in this case. If free hydrogen (or oxygen) were present as well in excess there would be an additional

component and there is again an arbitrary choice as to the two components to be selected. The proof of the rule is that the system of phases is completely specified by the temperature, pressure and the data for the C components and between these $C+2$ quantities there are P independent relations (one for each phase), which characterize the system of phases.

For example, in the case of water which can exist (not necessarily co-exist) as ice, water or steam there is one component and three possible phases so that if all are present $C+2-P=0$ and there is no disposable relation—their states (defined by v and T) are absolutely fixed If only two of the phases are present $C+2-P=1$; there is therefore one relation between various values of p and T for equilibrium. This relation gives the vapour pressure line or, in the case of ice and water, the connection between pressure and freezing-point Again if there is only one phase present, there are two disposable relations; in other words the pressure and temperature can vary independently of each other. The number of disposable relations is known as the number of degrees of freedom (F) so that

$$C+2-P=F$$

When the number of phases that co-exist is the greatest possible the value of F is zero Of these phases not more than one can be gaseous because the components mix in such a phase in all proportions, so that two gaseous phases would interminglе and reduce to a single phase

In considering the equilibrium of such a system it is necessary to introduce a new function of the variables; this is done in such a way that the independent variables become T and p. As before we have

$$Td\phi=dQ+Pos.$$

where *Pos.* stands for a positive quantity. Hence

$$dE=dQ-pdv=Td\phi-pdv-Pos.$$

Adding to both sides $d(pv-T\phi)$

$$d(E-T\phi+pv)=-\phi dT+vdp-Pos.$$

It follows that if the quantity in brackets on the left is calculated for the whole system its value can only decrease in any change of the system that takes place at constant pressure and temperature. Or again, if an infinitesimal change, in which p' and T are kept constant, is made about a state of equilibrium, the change on the left hand side is zero. It is sometimes called the *thermodynamic potential at constant pressure and temperature* (Duhem); or since it is concerned with the equilibrium of co-existent phases it may be called the *paraphase potential* and will be denoted by ζ.

One Component System.—Let there be one component only ($C=1$). Then if there are two phases there is one degree of freedom. There must therefore be a connection between p and T; this connection is the vapour pressure curve if the two phases are liquid and vapour. Let the values of ζ per unit mass be ζ_1 for liquid and ζ_2 for the vapour. The total potential is therefore

$$\zeta=(1-m)\zeta_1+m\zeta_2.$$

Now for equilibrium

$$d\zeta=-\zeta_1 dm+\zeta_2 dm=0.$$

Therefore $\zeta_1=\zeta_2$

that is the potentials per unit mass are the same for the two phases Similarly for solid and liquid

$$\zeta_0=\zeta_1$$

and for solid and vapour.

$$\zeta_0=\zeta_2.$$

These three equations specify three curves on a pT diagram. The first two curves intersect at a point given by $\zeta_2=\zeta_1=\zeta_0$. This point also satisfies all three curves. Thus the three equilibrium curves must intersect at one point. This point is called the *triple point*. Further they cannot all intersect at any other common point for according to the phase rule there are no degrees of freedom when the three phases meet—the point of meeting is absolutely determinate.

Now the equations for these potentials are:

$$d\zeta_2=-\phi_2 dT+v_2 dp,$$

$$d\zeta_1=-\phi_1 dT+v_1 dp,$$

$$d\zeta_0=-\phi_0 dT+v_0 dp$$

Whence $d(\zeta_2-\zeta_1)=-(\phi_2-\phi_1)dT+(v_2-v_1)dp=0$

for all points on the curve connecting p and T which are common to both vapour and liquid. Hence this curve is also defined by

$$\phi_2-\phi_1=(v_2-v_1)\frac{dp}{dT}.$$

The left hand side is $\frac{latent\ heat}{T}=\frac{L_{12}}{T}$.

Therefore $L_{12}=T(v_2-v_1)\frac{dp_{12}}{dT}$; Liquid→Vapour.

Similarly for the two other curves,

$$L_{01}=T(v_1-v_0)\frac{dp_{01}}{dT}\text{; Solid→Liquid,}$$

and $$L_{02}=T(v_2-v_0)\frac{dp_{02}}{dT}\text{; Solid→ Vapour.}$$

These are simply Clausius equations for the three possible changes of phase.

The trigonometric tangent to the slope of any one of the p, T, curves is given by the value of $\frac{dp}{dT}$ for the curve, i.e.,

$$\frac{dp_{12}}{dT}=\frac{\phi_2-\phi_1}{v_2-v_1};\ \frac{dp_{01}}{dT}=\frac{\phi_1-\phi_0}{v_1-v_0}\text{ and }\frac{dp_{02}}{dT}=\frac{\phi_2-\phi_0}{v_2-v_0}.$$

Hence at the triple point these are obviously connected by the relation

$$(v_2-v_1)\frac{dp_{12}}{dT}+(v_1-v_0)\frac{dp_{01}}{dT}+(v_0-v_2)\frac{dp_{02}}{dT}=0$$

and therefore, at the triple point,

$$L_{02}=L_{01}+L_{12}.$$

This relation does not hold at any other point.

It must be emphasized that in the above no assumption is made as to whether the single component is associated or not, nor whether it is equally associated in the several phases nor that the degree of association remains unchanged when the temperature changes, nor even that the matter in the phase consists of molecules. The decision in regard to such questions has no bearing on the investigations of this part of the subject. What we do assume is that each of the homogeneous phases is quite definite when the temperature and the specific volume are definitely given.

Many Components.—When there are many components in each phase the subject becomes too complicated to be dealt with in this short article. The thermodynamics potential ζ for each phase will depend upon the masses of the components as well as upon T and p. When its value is differentiated at constant temperature and pressure and equated to zero an equation is obtained of the form $\mu_1 dm_1+\mu_2 dm_2+\cdots=0$. The coefficients μ_1, μ_2, etc., are called the chemical potentials of the several components in the particular phase The final result is that the chemical potential of any one component must be the same for all the phases that are coexistent. The problem of heterogeneous equilibrium in the general case would therefore be solved if only it were possible to obtain ζ as an explicit function of all the masses. This is not possible unless the ideal gas laws are assumed.

OSMOTIC PHENOMENA

When a tube has its lower end stopped by a suitable membrane and is partly full of a solution; and the lower end is dipped in pure solvent, a difference of level is often maintained in the final state of equilibrium. It is necessary that the membrane shall be permeable to the solvent but not to the solute—it shall be only *semi-permeable* in fact. If it is permeable to both, equilibrium can only be attained when the concentration on both sides has come to the same value by diffusion. Semi-permeable membranes are easily obtained that will act for months with hundreds of atmospheres difference of pressure between the two sides.

Unglazed earthenware impregnated with colloidal ferrocyanide of copper by an electrolytic method constitutes such a membrane, impermeable to sugar and many salts but permeable to water. It is only the final state of equilibrium that will be considered in this place. When all flow is over, there is a difference of pressure between the two sides of the membrane: this difference of pressure is called the *osmotic pressure* It is, in general, a property not of the solution alone but involves the solvent also. Loose definitions based upon the properties of dilute solutions should be carefully avoided. The thermodynamical study of osmotic pressure is based upon the impossibility of obtaining external work from an isothermal reversible cycle. (The efficiency of such a cycle is zero) It is possible to evaporate a unit mass of the solvent from the solute, to change its pressure so that it can then be passed *reversibly* into the liquid solvent, and finally to pass it back into the solution through the osmotic membrane. This cyclic series of operations can all be conducted isothermally and reversibly In order that the concentration shall keep constant during the changes it is necessary that the mass of the solution shall be practically infinite or that the unit mass be infinitesimal. The algebra can be much simplified if a modification is made in the process. Any term, representing external work done is an expression of the type $\int_1^2 p dv$. Now, integrating by parts, $\int_1^2 p dv = p_2v_2 - p_1v_1 - \int_1^2 v dp$, and for a complete cycle of changes $\sum(p_2v_2 - p_1v_1)$ must equal zero and consequently adding expressions such as pdv comes, for the whole cycle, to the same thing as adding expressions such as $\int vdp$ for the several stages. The imagined process can be supposed carried out in an arrangement such as is shown in fig. 1 (called by van't Hoff an equilibrium box and used by him for dilute solutions only) The solution and solvent are on opposite sides of a semi-permeable membrane C and enclosed by means of ordinary pistons A and B. Lateral cylinders are also provided with pistons; these cylinders are connected with the main cylinders by means of membranes permeable to *the vapour alone* The solution is at a hydrostatic pressure p and any vapour in its lateral cylinder at a pressure π_p which corresponds to the particular pressure of the solution; similarly for the solvent and its vapour we have the pressures π_o and $\pi_{o_{p_o}}$. In making these provisions it is being definitely recognized that the vapour pressure depends, not only upon the temperature but also upon the pressure of the solution or solvent (an example of this will be dealt with in connection with interfacial effects)

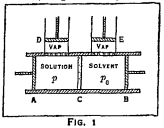


FIG. 1

The cyclic series of operations and the values of vdp corresponding to them are as follows:—(The value of $\int vdp$ in each stage is denoted by S).

i. Remove unit mass (supposed infinitesimal compared with the total mass so as not sensibly to alter the concentration) of solvent from the solution by means of the lateral cylinder. Piston A requires to be moved to the right to effect this transfer. Since the pressures keep constant, $S_1 = 0$.

ii. Change the pressure of the vapour removed, from π_p to $\pi_{o_{p_o}}$: then $S_2 = \int_{\pi_p}^{\pi_{o_{p_o}}} v d\pi$ where v is the specific volume of the vapour.

iii. Pass the vapour into the solvent reversibly at constant pressure:

$$S_3 = 0.$$

iv. Pass unit mass of solvent into solution through C at constant pressures (by moving A and B suitably):

$$S_4 = 0.$$

Adding all the values of S we obtain

$$\int_{\pi_p}^{\pi_{o_{p_o}}} v d\pi = 0 \quad \text{whence} \quad \pi_{o_{p_o}} = \pi_p.$$

Thus it appears that the vapour pressure of the solution when the latter is at the pressure p must equal that of the solvent when at a pressure p_o where $p - p_o$ is the osmotic pressure It must be remembered that the standard vapour pressures as usually measured are for the cases when the liquids are at the pressures of their vapours alone.

It can easily be seen that this must be the case. For if, otherwise, π_p is greater than $\pi_{o_{p_o}}$ it would only be necessary to put the lateral cylinders into communication for a flow of vapour to take place from left to right. This would cause fresh evaporation from the solution (to maintain the equilibrium value of vapour pressure) and (for a similar reason) condensation of vapour into the solvent. Since the evaporation from the solution would increase the concentration a flow through C from the solvent would take place to maintain the equilibrium This action would go on unceasingly and a particular kind of perpetual motion would be obtained. Unless we are prepared to admit the possibility of this type of perpetual motion, we must deny the assumption of any difference between the vapour pressures of the solvent and solution when measured under equilibrium conditions for the two *liquids*. That the vapour pressure of a pure liquid must depend upon the hydrostatic pressure was first shown by Sir William Thomson (Lord Kelvin). If a vertical capillary tube be placed in water, *e.g.*, under the bell jar of an air pump so that the air can be removed, the water stands in the tube at a higher level than outside by the amount h where $gph = 2\sigma/r$, ρ = density of the liquid, σ the surface tension and r the radius of the tube. (*See* SURFACE TENSION.) Now the vapour constitutes an atmosphere and between the inside and outside levels there is a difference of vapour pressure of $gp'h$ approximately where p' is the density of the vapour. Now the essential difference between the liquid inside and out is that at the upper level inside it is at a less hydrostatic pressure than outside (equilibrium being maintained by the effects of the curvature of the surface).

Hence
$$\frac{d\pi}{dp} = \frac{gp'h}{gph} = \frac{\rho'}{\rho} \text{ approximately.}$$

It is easy to show that this is not approximate merely but exact for a pure liquid. In the case of a solution however it requires modification (Porter, *Roy. Soc. Proc* A 79, p. 519 [1907]). To examine the case of a solution enclose a large volume V of solution in a cylinder, under pressure, fitted with a lateral chamber such as on the left of fig. 1 replacing the membrane C by a solid base. Conduct a cyclic series of operation as follows.—

i. Remove unit mass of vapour at constant pressure by means of the lateral cylinder: the volume of the solution diminishes by s (say) and the vapour increases by v:

$$S_1 = 0.$$

ii. Compress the vapour removed and the solution to new *equilibrium* values:

$$S_2 = \int_p^{p'} (V - s)\, dp + \int_{\pi_p}^{\pi_{p'}} v d\pi.$$

iii Pass the removed vapour back into the solution at constant pressure for each:

$$S_3 = 0.$$

iv. Compress solution by restoring the original pressure:

$$S_4 = \int_{p'}^{p} V dp$$

If these changes are conducted isothermally and reversibly they must add to zero Hence

$$\int_{\pi_{p'}}^{\pi_p} v d\pi = \int_{p'}^{p} s dp \text{ exactly.}$$

Since this is true, however small the change of pressure, we can write it in the differential form

$$d\pi/d\rho = \frac{s}{v}$$

or more precisely (owing to the fact that all the quantities depend upon the pressures)

$$\frac{d\pi_p}{d\rho} = \frac{s_p}{v_\pi}.$$

The quantity s stands for the shrinkage of the volume of the solution when unit mass of solvent is removed from it, the unit mass being so small (or the volume so large) that no sensible change of concentration occurs Combining this result with the proved fact that in the state of equilibrium $\pi_p = \pi_{o_{p_0}}$ we can obtain an expression for the osmotic pressure, $p - p_0$. For, employing the integral form, the limits being from the standard values of the vapour pressures to the equilibrium values of the pressures

$$\int_{\pi_\pi}^{p} s d\rho = \int_{\pi_\pi}^{\pi_p} v d\pi \quad \text{and} \quad \int_{\pi_{o\pi_0}}^{p_0} u d\rho_0 = \int_{\pi_{o\pi_0}}^{\pi_{o_{p_0}}} v d\pi,$$

where π_π and $\pi_{o_{\pi_0}}$ are the standard vapour pressures Subtracting these, we obtain an exact equation for the osmotic pressure

$$\int_{\pi_\pi}^{p} s d\rho - \int_{\pi_{o\pi_0}}^{p_0} u d\rho_0 = \int_{\pi_\pi}^{\pi_p} v d\pi + \int_{\pi_{o_{p_0}}}^{\pi_{o\pi_0}} v d\pi = \int_{\pi_\pi}^{\pi_{o\pi_0}} v d\rho$$

because $\pi_p = \pi_{o_{p_0}}$.

From this equation simpler approximate equations can be deduced to fit particular cases

The equality in the equilibrium vapour pressures may be shown in another way. In fig. 2 is represented a domed chamber separated into two portions by the lower part, by a membrane semi-permeable to solvent *liquid;* in the upper part, by one semi-permeable to solvent vapour. The lower part contains solution and solvent on the opposite sides of the membrane, the upper part contains, besides the vapour, sufficient air on each side to make up the total pressures to p and p_0 respectively If the pressures due to the vapours are not equal it is easily seen as before that a *perpetuum mobile* will be set up

It ought to be added that, in the exact equation for the osmotic pressure, there is no assumption as to the molecular state in either the liquid or vapour phases. Any influence that the degree of association or dissociation may have is all taken into account by the numerical values that can be found by direct experiment for u, s, and the standard vapour pressures. When the approximate equation is used, the values of R and u (or s) both refer to unit mass and there is no reference to molecules If we consider (so-called) molecular values by multiplying u, s, and R by such a factor that R becomes the universal value of the gas constant it may be presumed that this multiplier is at least an approximation to the molecular weight of the vapour in *the vapour state* but still no information is obtained as to the molecular state of either solvent or solute in the liquids. Such information as we have concerning molecular states is obtained by the aid of gas theory as distinct from thermodynamics.

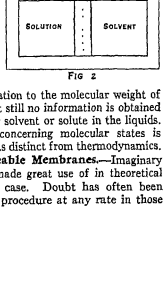


FIG 2

General Use of Semi-permeable Membranes.—Imaginary semi-permeable membranes are made great use of in theoretical investigations, as in the above case. Doubt has often been raised as to the validity of this procedure at any rate in those cases for which no real membrane of the kind has been manufactured. We know that such membranes are obtainable in certain cases; *e g.*, hot silica ("fused quartz") transmits helium and not nitrogen; hot cast iron transmits hydrogen; indiarubber is permeable to carbon dioxide The curved surface to a liquid maintains a difference of pressure between the interior and exterior and thereby acts as a membrane semi-permeable to the *vapour;* and between a solution and the liquid solvent, as it has been already stated, very perfect membranes can be obtained. In reality, in order to employ the thermodynamical argument, it is unnecessary that it should be possible to make any such membrane. Clerk Maxwell introduced the idea of "*demons*" instructed to let very fast molecules pass through an opening and stop the slow ones, thereby increasing the effective temperature on one side of a partition and diminishing that on the other. In this way he was able to show that the second law of thermodynamics does not hold for individual molecules but only for matter in the bulk. In like manner we may suppose a row of good demons turning back all the sugar molecules and letting the water molecules through in such a way that the average distribution of the water molecules in the solvent region is maintained in equilibrium. Such a row of demons will be doing precisely what our *semi-permeable* membrane is supposed to do and the average force per unit area they exert (viz: $p - p_0$) corresponds exactly to the osmotic pressure. It should be noted that it is not exactly equal to the pressure the sugar molecules would exert if they were a gas with its molecules equally

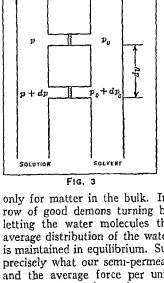


FIG. 3

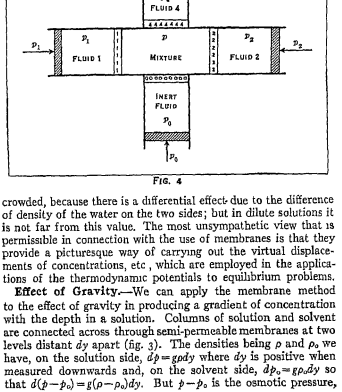


FIG. 4

crowded, because there is a differential effect due to the difference of density of the water on the two sides; but in dilute solutions it is not far from this value. The most unsympathetic view that is permissible in connection with the use of membranes is that they provide a picturesque way of carrying out the virtual displacements of concentrations, etc , which are employed in the applications of the thermodynamic potentials to equilibrium problems.

Effect of Gravity.—We can apply the membrane method to the effect of gravity in producing a gradient of concentration with the depth in a solution. Columns of solution and solvent are connected across through semi-permeable membranes at two levels distant dy apart (fig. 3). The densities being ρ and ρ_0 we have, on the solution side, $dp = g\rho dy$ where dy is positive when measured downwards and, on the solvent side, $dp_0 = g\rho_0 dy$ so that $d(p - p_0) = g(\rho - \rho_0)dy$. But $p - p_0$ is the osmotic pressure, P, so the equation gives $dP/dy = g(\rho - \rho_0)$ or $dP/dp = \frac{\rho - \rho_0}{\rho}$.

If we differentiate, with respect to p, the exact equation for the osmotic pressure the result is $sdp = udp_0$

or
$$\frac{d(p-p_0)}{dp} = \frac{u-s}{s}$$

This differs from the above value, but the value just given is the variation when the concentration is kept constant, the other is the total variation. In fact we can write

$$\frac{dP}{dp} = \frac{\partial P}{\partial p} + \frac{\partial P}{\partial c} \cdot \frac{dc}{dy}$$

where c is the concentration (measured in any convenient way); i.e,

$$\frac{p-p_0}{p} = \frac{u-s}{s} + \frac{\partial P}{\partial c} \cdot \frac{dc}{dy}.$$

For dilute solutions $\frac{\partial p}{\partial c}$ follows nearly the gas law. **If its exact** value is known, either in consequence of this law or from experiment, the value of dc/dy can be determined. This result is of wide application. There is no assumption that it is limited to true solutions. Applied to a gamboge suspension it gives Perrin's Law of the distribution with depth when the concentration is small, and allows also a calculation to be made of the very great deviations from Perrin's Law of distribution when the concentration is great. (*Trans. Far. Soc* XVIII. [1922]; XIX. [1923], XXI., 63, 66 [1925]).

Application of Membranes to Homogeneous Equilibrium.—An interesting application can be made of semi-permeable membranes to determine the equilibrium constant for homogeneous equilibrium. Fig 4 indicates the kind of equilibrium box required. The equilibrium which is taken as the type is that for which the chemical equation is

$$\nu_1 A_1 + \nu_2 A_2 \rightleftharpoons \nu_3 A_3 + \nu_4 A_4;$$

and in addition an inert gas is supposed to be present, indicated by A_0, this takes no part in the reaction but modifies the total pressure of the mixture. By appropriate movement of the semi-permeable membranes a cycle of changes is carried on leading eventually to the equation

$$\nu_1 \int^{p_1} u_1 dp_1 + \nu_2 \int^{p_2} u_2 dp_2 - \nu_3 \int^{p_3} u_3 dp_3 - \nu_4 \int^{p_4} u_4 dp_4$$
$$= \text{function of the temperature alone}$$

This reduces to the mass action law when gas values are inserted. For detailed information in regard to its derivation reference must be made to the original paper (*Trans. Far. Society*, 1919). Since the membranes may be made permeable to the *vapours* of the respective components the values of u and p may be taken to stand for the specific volumes (or molecular volumes) and pressures of these vapours

Duhem-Margules Equation.—This information is in part supplied for condensed systems by a theorem put forward by Duhem in 1887 and subsequently interpreted by Margules (1895). By means of an equilibrium box similar to that in fig. 4 we can produce the series of changes indicated in fig. 5 The case of a homogeneous mixture of two components will be considered so that only two lateral cylinders are needed Fig 5 consists of three diagrams, one for each separated vapour and one for the liquid mixture. It should be mentioned that from a theoretical

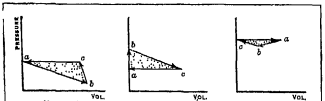


FIG. 5

point of view (thermodynamically) there is no difference between a solution and a mixture, at least, a mixture of molecular type (coarse emulsions must be excluded). Again, the operations must be isothermal and reversible. **The presence of each** component in the mixture lowers the vapour pressure of the other component. Throughout each change the pressure in the lateral chambers must be perpetually maintained in equilibrium with the mixture by suitably moving the pistons. The detailed changes are as follows:

1. Remove a definite fraction, say fn_1 of the molecules n_1 in the mixture. The pressure in A cylinder goes down along ab, that of B goes up—in both cases because the relative concentration of B is increased—along ab (on the B diagram). The mixture also changes along ab.

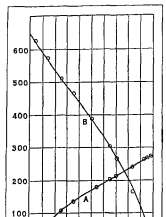


FIG. 6

ii. Remove the *same fraction* fn_2 of the molecules of B. The pressure in B goes down along bc (on B diagram) and that of A goes up along bc (on A diagram); and that of the mixture changes along bc (on the third diagram). The solution is now of the same concentration as at first and consequently the pressures at c must in each chamber be the same as at first, *i.e.*, as at a

iii. Lastly return the vapours in A and B to the mixture adjusting the rates of transfer so that the concentration of the mixture remains constant The changes in the three diagrams are in each case along ca and the original state is restored.

We will neglect the changes of volume of the solution because, for usual cases they are exceedingly small compared with the vapour changes. The total work done is the difference of the areas of the triangles on A and B; or

$$fn_1 v_1 \frac{\partial \pi_1}{\partial n_1} + fn_2 v_2 \frac{\partial \pi_2}{\partial n_1}$$

and this sum must equal zero. So far we might have considered masses instead of numbers of molecules (for the problem has nothing essential to do with molecules) We can now put $\pi v_1 = n_1 RT$ and $\pi_2 v_2 = n_2 RT$, where R is the same for both. The values of n_1 must now mean the numbers of molecules in the mixture reckoned as of the same constitution (*i.e.*, either single or double molecules, etc.) as in the *vapour* state; and similarly for n_2. So that

$$\frac{n_1}{\pi_1}\frac{\partial \pi_1}{\partial n_1} + \frac{n_2}{\pi_2}\frac{\partial \pi_2}{\partial n_1} = 0.$$

The differential coefficients are partials, the value of n_2 being constant during the change represented. We can usefully represent the concentrations by molar fractions, that is, $\mu_1 = n_1/(n_1+n_2)$ and $\mu_2 = n_2/(n_1+n_2)$ so that $\mu_1 + \mu_2 = 1$.
When this is done the equation becomes

$$\frac{\mu_1}{\pi_1}\frac{d\pi_1}{d\mu_1} + \frac{\mu_2}{\pi_1}\frac{d\pi_2}{d\mu_1} = 0$$

or
$$\mu_1 \frac{d}{d\mu_1} \log \pi_1 = \mu_2 \frac{d}{d\mu_2} \log \pi_2$$

since $d\mu_2 = -d\mu_1$. The advantage of the transformation to molar fractions is that the equation has been reduced to a symmetrical form the right hand being the same function of μ_2 that the left is of μ_1. This is the Margules-Duhem equation. It is not quite exact because the *vapours* have been treated as ideal gases and the changes of the volume of the mixture have been neglected. For practical purposes, however, it is probably very much more accurate than experiments require. The implication of the equation is that each side of it *must be the same symmetrical* function of μ_1 and μ_2; *i.e.*, it must be of the form $f(\mu_1\mu_2)$ and this must be the *same* for both vapours. Unfortunately the law imposes no further restriction upon this function so that an endless number

of cases can arise. Suitable simple values for the functions are 1, $\mu_1\mu_2$, $\mu_1^2\mu_2^2$, etc., each of which may be multiplied by an arbitrary constant and any number of terms may be taken simultaneously. For any such function the equation can be integrated and it takes the form

$$\log\frac{\pi_1}{\Pi_1} = \alpha\log\mu_1+\beta\mu_2{}^2+\gamma\mu_2{}^2(1+3\mu_1) \text{ etc.}$$

and

$$\log\frac{\pi_2}{\Pi_2} = \alpha\log\mu_1+\beta\mu_1{}^2+\gamma\mu_1{}^2(1+3\mu_2) \text{ etc.}$$

where Π_1 and Π_2 are the vapour pressures of the pure components and the constants α, β, γ, etc. must be the same for both. If the first term on the right is sufficient we have

$$\frac{\pi_1}{\Pi_1} = \mu^{\alpha} = \left(\frac{n_1}{n_1+n_2}\right)^{\alpha} = \left(1-\frac{n_2}{n_1+n_2}\right)^{\alpha} \doteq 1-\frac{\alpha n_2}{n_1+n_2}$$

when n_2 is small.

This is practically Raoult's law when allowance is made for dissociation. In very many cases two terms are necessary and α is often unity. The equation then becomes

$$\log\frac{\pi_1}{\Pi_1\mu_1} = \beta\mu_2{}^2.$$

In fig. 6 the curves for a mixture of acetone and ether are given. The value of β was determined from one point on the acetone curve but it fits equally well the curve for either. The base line gives the molar % of acetone when read from left to right but it equally well gives the percentage of ether when read from right to left. The experimental points were determined by J. Sameshima (*Amer. J. of Sc.* XL., 1482, 1918) Examination of the equation shows that in this group of examples there is only one parameter, viz.: β. In fig. 7 the shapes of the curves are shown for different values of β, the ordinates being π/Π. Examples can be found for many values of β For sulphuric acid and water $\beta = -0.6$ except for dilute solutions, when a more complicated formula is necessary Fig. 8 gives the case of gold in mercury. In this example four terms are required. If the base line is read from left to right the curve is the vapour pressure for mercury, if the base line is read from right to left the curve gives the vapour pressure (though exceedingly small) of gold in mercury. In both cases these are the values of π_1, π_2 which require to be inserted in the equations for the constant of homogeneous equilibrium The central part of the curve, which slopes downward, is easily shown to be in an unstable region. Where the curve is horizontal (towards the right of the figure) is the concentration at which the equilibrium becomes unstable; in other words it represents the *saturation* concentration of the solution of gold. The vapour pressure of the *gold* should at that point be the same as that of pure gold and that is seen to be the case by examining the curve reversed Calcium chloride in water also requires four terms, curves are shown on fig. 9 for this case at two temperatures.

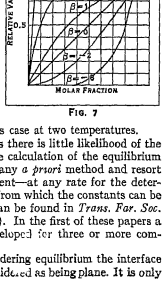


FIG. 7

Taking these cases as examples there is little likelihood of the vapour pressures required for the calculation of the equilibrium constant being determinable by any *a priori* method and resort must be made to direct experiment—at any rate for the determination of a few typical values from which the constants can be deduced. Further information can be found in *Trans. Far. Soc.* 15, 1920; 24, 344, 405, 543 (1928). In the first of these papers a general form of equation is developed for three or more components.

Interfacial Effects.—In considering equilibrium the interface between any two phases was considered as being plane. It is only if it is plane that the pressure is uniform over the whole system. There is a change of pressure on crossing the boundary equal to $\sigma\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$ where σ is the surface tension and R_1 and R_2 are the radii of curvature in any two mutually rectangular planes. (*See* SURFACE TENSION.) The pressure is greater on the concave side (as in a soap bubble.) We have seen that it increases the vapour

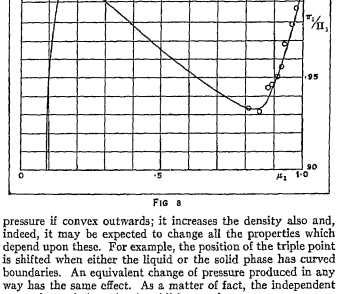


FIG 8

pressure if convex outwards; it increases the density also and, indeed, it may be expected to change all the properties which depend upon these. For example, the position of the triple point is shifted when either the liquid or the solid phase has curved boundaries. An equivalent change of pressure produced in any way has the same effect. As a matter of fact, the independent atmosphere of air acting in addition to the vapour pressure on ice and water shifts the triple point from ·0075° C to exactly zero. It clearly must do so because the ice water line under the pressure

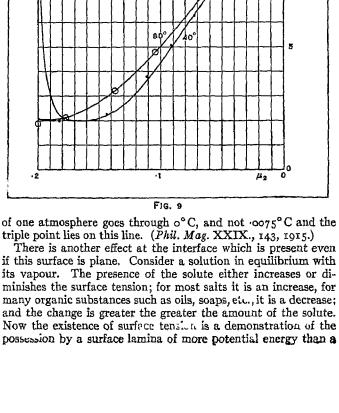


FIG. 9

of one atmosphere goes through 0° C, and not ·0075° C and the triple point lies on this line. (*Phil. Mag.* XXIX., 143, 1915.)

There is another effect at the interface which is present even if this surface is plane. Consider a solution in equilibrium with its vapour. The presence of the solute either increases or diminishes the surface tension; for most salts it is an increase, for many organic substances such as oils, soaps, etc., it is a decrease; and the change is greater the greater the amount of the solute. Now the existence of surface tension is a demonstration of the possession by a surface lamina of more potential energy than a

lamina in the body of the phase. The tendency being for the potential energy to take the lowest possible value, solute (being free to be displaced) will move toward the surface lamina or away from it according to which change will diminish the surface tension. In strictness therefore, the two phases are not delimited by mathematically sharp boundaries: there is an intervening lamina whose structure depends upon both phases and is different from that in the body of either. This subject was first studied in detail by Willard Gibbs. Following him, we replace the actual distribution of material by a *uniform* distribution in each phase and superimpose upon this an *extra* distribution (which may be negative) representing the excess per unit area of any component in this superficial lamina. This excess is called the surface concentration and is usually denoted by σ. When a surface tension is measured experimentally it is the value as modified by the surface layer which is actually determined. One effect of this non-uniform distribution of the solute is that when the solute tends to lower the surface considerably, small traces of it added to the pure solvent are sufficient to produce very considerable lowering. In fig. 10, the curve shows the change of surface tension with the amount of soap added to the solute. An amount of soap equal to a concentration of 0·2% produces a lowering to practically the same value as for a concentrated solution and a great part of this reduction is produced by the first traces of soap that are added and go almost completely to the surface layer.

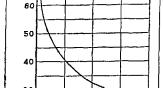


FIG. 10

Willard Gibbs investigated thermodynamically the "surface-concentration" to be expected. External work is done not only in expansion of volume (pdv) but also in the extension of the surface area ($-\sigma dA$). Hence $dE = Td\phi - \pi dV + \sigma dA$ for reversible changes or $d(E - T\phi + \pi V) = -\phi dT + V d\pi + \sigma dA$.

Since $E - T\phi + \pi V$ depends only upon the state

$$\left(\frac{\partial V}{\partial A}\right)_\pi = \left(\frac{\partial \sigma}{\partial \pi}\right)_A$$

Representing quantities for the liquid and vapour phases with suffixes 1 and 2 respectively, we have $dV_2 = \frac{RT}{\pi} dN_2$ where V_2 is the volume of the vapour, π the vapour pressure and N_2 the number of molecules in the vapour. In the liquid let n_1 equal *total* number of molecules of the solute and N_1 those of the solvent in the solution. Imagine a virtual displacement from the liquid to vapour phase at constant temperature and concentration produced by an extension of the area. For unit increase of area n_1 changes by $-\frac{dn_1}{dA}$; and for the concentration to keep constant $\frac{dn_1}{n_1} = \frac{dN_1}{N_1}$ so that dN_1 molecules of solvent evaporate.

But $dN_2 = -dN_1 = -\frac{N_1}{n_1} dn_1$. The change of volume dV is practically dV_2 (*i.e.*, neglecting change of volume of the liquid).

Hence $$\left(\frac{\partial V}{\partial A}\right)_\pi = -\left(\frac{RTN_1 dn_1}{n\pi\, dA}\right)_T.$$

Again $$\left(\frac{\partial \sigma}{\partial \pi}\right)_A = \left(\frac{\partial \sigma}{\partial n} \cdot \frac{dn}{d\pi}\right)_A = -\frac{N_1}{\pi}\left(\frac{\partial \sigma}{\partial n}\right)_A$$

in which an approximate value of the change of π with n has been inserted. Hence finally

$$\frac{dn_A}{d\,A} = \Gamma = -\frac{n}{RT}\frac{d\sigma}{dn}$$

where n_A are the *excess* molecules of solute in unit surface layer. This is a maximum value for Γ, since more exact expressions for the vapour pressure tend to reduce it. For strong solutions of sugar the simple expression goes up to four times the more exact value; but for dilute solutions it must be very near the truth.

THERMAL EFFECTS

The thermal changes that take place in the case of dilution of solutions can be examined in a similar way to other latent heats. If we enclose a solution and the solvent on opposite sides of an osmotic membrane in an "equilibrium box" it is easy to carry out a Carnot cycle of changes for which the efficiency is $\frac{dT}{T}$.

We deduce, for the reversible latent heat of dilution corresponding to unit mass of solvent entering, the expression,

$$H_{\text{reversible}} = T\left(s\,\frac{d\rho}{dT} - u\,\frac{dp_0}{dT}\right) \text{ exactly.}$$

For the corresponding change of energy we must subtract the external work done, viz: $sd\rho - ud p_0$, whence

$$\Delta E = s\left(T\frac{d\rho}{dT} - p\right) - u\left(T\frac{dp_0}{dT} - p_0\right)$$

This latter must be very nearly the irreversible heat absorbed on stirring solvent into the solution instead of through an osmotic membrane, because in the stirring process, the whole being at ordinary pressure, there is very little external work done and the latent heat is practically the energy change. When p_0 is small throughout,

$$H_{\text{reversible}} \text{ is practically } Ts\frac{dP}{dT}$$

and $$\Delta E \text{ is practically } s\left(T\frac{dP}{dT} - P\right)$$

where P is the osmotic pressure. Connecting P with the vapour pressure by the usual substitution $Ps = RT\log\frac{\pi_0}{\pi_\pi}$,

$$\Delta E = T^2 s\,\frac{\partial}{\partial T}\left(\frac{R}{s}\log\frac{\pi_0}{\pi_\pi}\right)$$

and, if s and R are independent of temperature, this becomes the same as an approximate equation given by Kirchhoff. If this irreversible heat of dilution is zero, $\log\frac{\pi_0}{\pi_\pi}$ must be independent of temperature.

This approximate law is known as von Babo's law.

Freezing Points.—When a solution is in equilibrium with the solid phase of the solvent it is at its freezing point, and must have the same vapour pressure as the solid. Different solutions in the same solvent must have the same freezing points if their vapour pressures (and therefore their osmotic pressures) are the same.

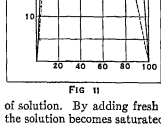


FIG. 11

Cryohydric Points.—If, at the freezing point, the solution of one is saturated it is then at a cryohydric point. A solution of common salt is at the point at about $-22°$ C.

Freezing mixtures depend upon the fact that if salt be added to ice it will dissolve and cool the system owing to the latent heat of solution. By adding fresh salt further cooling goes on until the solution becomes saturated at the final temperature reached. The effect of adding various quantities is shown in fig. 11. The experimental curve (dotted) differs from the curve, calculated from an approximate theory, mainly owing to the thermal capacity of the containing vessel. It will be seen that the relative proportions of ice and salt may be varied within wide limits and the cryohydric temperature will be approached. When the material cooled by the mixture has considerable thermal capacity the greatest chance of producing the lowest temperature is when

the amount of salt is about 30 per cent.

Irreversible Processes.—Owing to the universality of frictional forces every process that we can conduct is in reality irreversible. Trains require to be driven even on the level, ocean waves subside and winds cease soon after the cause producing them has ceased to be effective. The motion of the piston of an engine allows the steam to be set in motion and the kinetic energy that corresponds is ultimately transformed into molecular energy and is mainly unavailable for doing useful work It is true that so far as a difference of temperature is set up by friction *some* of the temperature energy may be transferred into work but the amount is incommensurable with the loss.

The most typically irreversible process is that in which a fluid is forced through a nozzle or a porous plug Considering the steady state of adiabatic flow only, we have (i.) an equality of the mass leaving and entering the plug, (ii.) an equality of the energy leaving and entering. The energy is in part the intrinsic energy E (per unit mass) and in part energy of motion in bulk, $\frac{1}{2}$ velocity squared (per unit mass) Further the incoming fluid does work p_1v_1 in forcing the fluid through and the outgoing fluid does work p_2v_2 in forcing out the fluid in front of it; the gain of energy on this account is $p_1v_1-p_2v_2$. Hence the total gain of energy inside the plug is

$$E_1+p_1v_1+\tfrac{1}{2}V_1^2-(E_2+p_2v_2+\tfrac{1}{2}V_2^2)$$

and in the steady adiabatic state of flow this is zero. We assume that the two positions at which the energies are reckoned are well outside the plug so that we can consider the velocity, etc., as uniformly distributed across the cross section. When the 'narrows' inside the throttle or plug are reached the velocity attains a high value and a high viscous resistance is met with so that even V_1 may be small in spite of the great difference of pressure on the two sides and further dissipation of energy takes place in the eddies that form on emergence. The result is that the fluid is much hotter on emergence than if it had expanded between the same extreme pressures reversibly and adiabatically in a cylinder. We suppose for simplicity only a small difference of pressure, etc., so that

$$d(E+pv)=-d(\tfrac{1}{2}V^2).$$

If the motion has been *linear* and *without friction* it is known from hydrodynamics that

$$d(\tfrac{1}{2}V^2)=-vdp$$

so that the equation would reduce to

$$dE+pdv=0,$$

which as we know represents the heat entry in a reversible process. To consider such a process would be equivalent, for example, to discussing the oscillation of a frictionless pendulum. Such a pendulum would go on vibrating without loss of amplitude for ever and every half period it would perfectly reverse its path. The lack of reversibility of a real pendulum is entirely due to its meeting with frictional resistance to its motion. The loss of kinetic energy on the average is represented by the extra temperature of the bob and air, together with the energy which is radiated out. This 'loss' of energy of visible motion corresponds to an increase in the internal energy of the system such as would be caused by an entry of heat from outside and it produces the same effects. Similarly in the problem of the flow of fluid if we add the frictional heat dq to the actual value of $d(\frac{1}{2}V^2)$ it may be expected by the law of conservation to give $-vdp$. Hence

$$d(E+pv)=-d(\tfrac{1}{2}V^2)=-vdp+dq$$

or

$$dE+pdv=dq.$$

Hence the actual value of the change on the left side is precisely the same as it would be if heat dq had entered *reversibly from outside the system*. In reality no heat has entered from outside but the frictional heat produces precisely the same effect as if it had done so. The essential difference between the two cases is that if we were to reverse the reversible system the corresponding heat would be *given out;* but the frictional heat is always positive in whichever sense the transformation proceeds. Since dq produces the same effects as if it had come from outside reversibly it must increase the entropy by the amount dq/T although the change is really adiabatic so far as the whole system is concerned. This can be illustrated by supposing the fluid to be an ideal gas.

In such a case the increase of entropy is $C_v\log\frac{T_2}{T_1}+R\log\frac{v_2}{v_1}$. But

$$dE=C_vdT \text{ and } pv=RT;$$

hence

$$d(E+pv)=(C_v+R)\,dT.$$

Neglecting $d(\frac{1}{2}V^2)$, as we can do when the flow is slow (because it depends upon the square of V and the other changes are of the first order of small quantities), this must be zero, i.e., $dT=0$; so that no change of temperature occurs Hence $T_2=T_1$ and $\phi_2-\phi_1=R\log\frac{v_2}{v_1}$. Further $v_2>v_1$ because $p_1>p_2$. So there is a positive increase of entropy, and its value is $R\log\frac{v_2}{v_1}=-\frac{1}{T}\int vdp$ as we inferred it to be. Since $E+pv$ (which is called the *enthalpy*) is a quantity which depends only upon the state we can calculate it for *any* change (adiabatic or otherwise) between the extreme states. It is most convenient to calculate it for a reversible change (which may not be adiabatic). Starting from

$$dq=dE+pdv$$

$$d(E+pv)=dq+vdp$$

$$=C_vdT-T\left(\frac{\partial v}{\partial T}\right)_p dp+vdp.$$

Hence if $E+pv$ has the same value as at first the right hand must also be zero or

$$\left(\frac{dT}{dp}\right)_{E+pv}=\frac{T\left(\partial v/\partial T\right)_p-v}{C_p}.$$

The left hand side is the amount the temperature falls in the plug experiment for unit fall of pressure It will be zero (as it is for a perfect gas) provided that

$$T\left(\frac{\partial v}{\partial T}\right)_p-v=0$$

or (by integration)

$$v=Tf(p),$$

where $f(p)$ stands for *any* function of the pressure. Kelvin and Joule found experimentally that at moderate pressures air and carbon dioxide cool in the process while hydrogen warms. In reality all fluids (gaseous or liquid) at certain temperatures and pressures undergo neither warming nor cooling in the process. At sufficiently high or sufficiently low temperatures all get hotter, in an intermediate region of temperatures they *may* get cooler but they fail to do so if the pressure is above a certain limit which appears to be at about 15 times the critical pressure (*Trans. Far. Soc., Discussion on the production and utilization of cold:* President's opening remarks, 1922).

General.—The conclusions drawn from thermodynamics can be confirmed and extended by the aid of the principles generalized in mechanics which enable problems to be approached from a different aspect. The two fields of enquiry overlap. The thermodynamical way ignores the precise mechanism of the various transformations: making use of principles which are independent of the particular mechanism. This does not exclude the possibility of information being obtained in other ways which are not as independent of it and by which it may ultimately be possible to formulate with some degree of precision the nature of that mechanism. Such methods are of course less abstract in the picture with which they present us but enormous difficulties are met with in dealing even with the simpler phenomena.

It is possible to examine the movements of the hands of a watch and to detect and discuss certain regularities of their movement; but it is another matter to predict (without taking the watch to pieces) what the precise mechanism inside may be. The problems that are met with in chemical and other reactions are much more complicated than the movements of the hands of the watch. It is only very gradually that an imperfect picture is being created. Such help as is being given it by statistical me-

chanics is exceedingly valuable; but it is outside the scope of this article.

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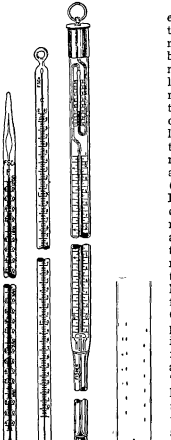
(A. W. Po.)

THERMOMETRY, the art of measuring temperature. Temperature may be defined as the thermal state of a body considered with reference to its ability to communicate heat to other bodies Instruments used for this purpose are known as thermometers, or sometimes, when they are used to measure temperatures above a red heat, as pyrometers.

EARLY DEVELOPMENT

Thermometry.—Of the two commonly practised basic methods of measurement, namely, by contact and by radiation, only the first was known for more than two centuries following the invention of the faulty air-thermoscope of Galileo Galilei, and the hermetically sealed Florentine thermometers first developed in the middle of the 17th century H. L. Callendar, in the article on HEAT states that "the type of thermometer familiar at the present time, containing a liquid hermetically sealed in a glass bulb with a fine tube attached, was first brought into general use by the Grand Duke Ferdinand II of Tuscany, and he is said to have possessed such instruments as early as 1654 . . . Alcohol was the liquid first employed, and the degrees, intended to represent thousandths of the volume of the bulb, were marked with small beads of enamel fused on the stem. . . ."

Gabriel Daniel Fahrenheit (1686–1736), a modest German instrument maker, native of Danzig and long a resident of Holland, is said to have invented in 1714, the mercury-in-glass thermometer and the scale of temperature by which his name is daily remembered in English-speaking countries. In devising a scale for his thermometer, Fahrenheit chose as the zero the lowest temperature obtainable with a mixture of ice and common salt, and first proposed to divide the interval between this temperature and that of the limit of the heat which is found in the blood of a healthy man, into 12 divisions, subsequently increasing the number to 96, purely as an arbitrary measure of convenience. Fahrenheit had previously shown that pure water while freezing in the presence of pure ice, always gave the same reading on his thermometer, and he invented the mercury thermometer so that he could observe the constancy of the boiling point of water, a report of which he had read in the *History of the Sciences* issued by the Royal Academy of Paris. These two points on his thermometer, which were later to become fully recognized as fixed points, were observed at the 32nd and 212th divisions, respectively. His thermometer must perhaps have had a rather uniform bore for him to have observed 212° as the boiling point of water, but not precisely so, because the blood temperature of a healthy man was observed as 96°, and is now known to be 2° to 3° higher. The so-called Fahrenheit scale, having an interval of 180° between the freezing and boiling points of water, went rapidly into general use, and is still retained in most English-speaking countries as the most convenient, particularly for meteorological work, because of its small degrees. R. A. F. de Réaumur, French naturalist (1683–1757), proposed in 1730 to divide the interval into 80°, and his scale is still (1947) used in many countries. Anders Celsius (1701–1744), Swedish astronomer at Upsala is credited with first proposing to make the interval 100°, as we now find it on the centigrade scale.



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FIG. 1.—MERCURY-IN-GLASS THERMOMETERS

1. Extra hard glass for 1,200° F. (649° C.) in 2° divisions
2. Precision type for 200° C. in 0.2° divisions
3. Beckmann differential, 6° range in 0.01° divisions
4. Common household type for indoor or outdoor use

During the century after Fahrenheit, the mercury-in-glass thermometer became an instrument of useful precision and the basis of all temperature measurements, the thermal expansion of liquids being the only recognized means for measuring temperatures. The principles of thermodynamics were not well established nor did the knowledge of the behaviour of gases extend much beyond the information afforded by the laws of Boyle (Mariotte) and Charles (Gay-Lussac) (1802). No material success was attained in the experimental use of a gas thermometer, and measurements were limited to the range of the mercury thermometer graduated from −40° to 300° centigrade. The lower limit was determined by the freezing of mercury at −39.87° C. (modern value), and the upper range was roughly limited by its high vapour pressure, which reaches atmospheric pressure at approximately 357° C (675° F.). The thermometers of that period had to be kept well below this temperature because within the thermometer in the capillary space above the mercury there was no gas under pressure, as usually found in thermometers many years later, to prevent the mercury from boiling and from distilling into the capillary. The upper limit was not affected by the softening of the glass which would probably have withstood a temperature above 400° C.

Pyrometry.—In order to measure higher temperatures than these early thermometers could withstand, James Prinsep (1828), interested in alloys of gold, silver and platinum, and wanting to measure their melting points, made a large bulb of gold connected with a sensitive manometer with which to maintain the gas (air) at constant pressure within, and connected also with a reservoir of olive oil Temperatures were measured by weighing the oil that had to be removed from the manometer, as the air expanded, in order to maintain the level constant. Prinsep's measurements were limited in the upper range by the melting point of gold, found to be 1,063° C. near the close of the century. Others, including Sir Humphry Davy, used the Prinsep method without much improvement, until Claude Servais Mathias Pouillet (1836) made a bulb of platinum and improved the experimental procedure, which was further improved in 1847 by Henri Victor Regnault, and in the 1880s by H. L. Callendar and his associates. The high melting point (1,773° C.) of platinum extended the upper limit of measurement many hundreds of degrees Pouillet tried a thermocouple made of a platinum wire inside an iron gun barrel, and also studied the relation between temperature and radiation from glowing solids. Thomas Johann Seebeck had discovered in 1821 that an electric current flows in a closed circuit of two dissimilar metals when the junctions of the metals are maintained at different temperatures, and Henri Becquerel had tried a platinum-palladium couple in 1830.

The methods of gas thermometry continued to be improved throughout the 19th century, although they were in serious

disrepute in the third quarter as methods of precision at higher temperatures. For example, Étienne Henri St.-Claire Deville and Louis J Troost (1857) found the boiling point of zinc to be 1,040° C , using iodine gas in a bulb of porcelain, and in 1863, E. Becquerel found this point to be 932° C Many years later the former experimenters reported 942° C as the mean of 27 determinations, using nitrogen, after Victor Meyer had discovered in 1879 that iodine dissociates at high temperatures. All of these values are considerably higher than that finally accepted, 906° C During these developments of methods for high temperatures, Regnault had shown in 1847 that the gas thermometer could afford precision in the range 0° to 100° C He attained a precision sufficient to detect differences in the expansion coefficients of some of the more readily condensible gases, but not of hydrogen and nitrogen, which were found to expand one part in approximately 273 per °C at 0° C. During this period, the mercury thermometer remained the primary and most reliable means for measuring temperatures in practical applications.

In order to understand the trends of subsequent developments, it will be necessary to review briefly some of the scientific progress of the times (*See* HEAT; THERMODYNAMICS) N. L S Carnot, a French physicist, had described in 1824 his ideal reversible heat engine, and had endeavoured to prove on theoretical

Degrees centigrade (°C.) versus degrees Fahrenheit (°F)

°C.	°F	°C.	°F
5,000	9,032	100	212
2,000	3,632	0	32
1,500	2,732	−40	−40
1,000	1,832	−100	−148
500	932	−273 16	−459 69

To convert degrees Fahrenheit into degrees centigrade, first subtract 32, then take 5/9 of the remainder. To convert degrees centigrade into degrees Fahrenheit, first multiply by 9/5, then add 32.

grounds that the efficiency of his ideal engine was the maximum possible and dependent only on the limits of temperature between which it works. Neither Carnot's proof nor that of many others appeared to be fully satisfactory for many years. The mechanical theory of heat, that is, its identification as a form of energy subject to the law of conservation, was slowly displacing the older theory that heat is an imponderable fluid with the power of penetrating all substances. Quoting Callendar, "The honour of placing the mechanical theory of heat on a sound experimental basis belongs almost exclusively to J. P. Joule, who showed by direct experiment that in all the most important cases in which heat was generated by the expenditure of mechanical work, or mechanical work was produced at the expense of heat, there was a constant ratio of equivalence between the heat generated and the work expended and vice versa." Joule reported his long series of brilliant experiments in a series of papers from 1840–43 and in 1848 he wrote to William Thomson (Lord Kelvin) to point out that according to his experiments, the efficiency of Carnot's engine must be proportional to $1/T$, the absolute temperature appearing in the equation $pv=RT$, representing the combined laws of Charles and Boyle for the expansion of gases. This equation was known to be a good approximation for the air thermometer between 0° and 100° C. if T be put equal to t(°C.) plus 273. At this time, thermodynamics was making rapid strides and the experimental work was all based on the centigrade scale as defined by the mercury thermometer and the value 273 for T-t. In 1852 Thomson gave as the expression for the efficiency of the Carnot cycle on the evidence of Joule's experiment:

$$W/Q=(t_1-t_0)/(t_1+273)=(T_1-T_0)/T_1$$

and had realized that in the ideal heat engine lay a means for measuring temperature independently of the property of any substance. Four years earlier he had proposed for this purpose to write W/Q equal to a constant, but as the experimental evidence accumulated he proposed in 1854 to *define* the thermodynamic scale according to the above equation, thus making this equation exact, and to determine by experiment how far the scale of the gas thermometer departed from the ideal scale With this object in mind he devised a very delicate method, known as the porous plug experiment (*see* THERMODYNAMICS), in which the temperature change accompanying the expansion of a gas in the absence of any conversion of heat to kinetic energy, is measured. Joule and Thomson carried out a long and famous series of experiments, and finally reported in the *Phil Trans.*, (1862), that the deviations of the air thermometer from the absolute scale as above defined are almost negligible, and that in the case of the gas, hydrogen, the deviations are so small that a thermometer containing this gas may be taken for all practical purposes as agreeing exactly with the absolute scale at all ordinary temperatures.

It should be carefully noted that the above equation, defining the thermodynamic temperature scale, does not determine any numbers for temperatures, but only defines the ratio of T_0 to T_1 as equal to $1-W/Q$. Thus we are at liberty to select any number we please for one fixed point, for example, the ice point, leaving the intervals between this point and all others such as the steam point subject to experimental determination; or we can select any convenient interval such as that between the ice and steam points, leaving both their values above absolute zero subject to experiment. We must make one of these two selections only, for the thermodynamic scale, yet there is one more method available for practical purposes through the artifice of setting up an auxiliary scale on which the ice and steam points are 100° apart, and also have permanently assigned numbers, for example, 0° and 100° as they had been used on the centigrade scale for nearly 100 years at the time of Joule and Lord Kelvin These two temperatures on the centigrade scale will differ from the numbers on the thermodynamic scale by a number subject to experiment. Furthermore, all temperatures on the centigrade scale can be assigned numbers differing by this same amount, $(T-t)$, simply as a matter of convenience, and the difference between the scales becomes this constant—$T-t=273.16$, for example. At the time Lord Kelvin was faced with making one of the selections, as above, H. V. Regnault had been using air thermometers in his laboratory in preference to mercury thermometers because of the capricious performance of the latter, and had been accustomed to basing his calculations on the difference between the ice and steam points Had Kelvin suggested and the suggestion prevailed, that a number be permanently assigned to the ice point on the thermodynamic scale, the differences of the two scales at all other points would have had to be tabulated, and the lengthy tables revised from time to time in order to fit the results of future experiments Kelvin chose to suggest that the ice-steam interval be fixed at 100° and this suggestion has prevailed. On this basis the thermodynamic scale has remained, and is known simply as the Kelvin scale, temperatures on it being designated °K. The symbol in equations is usually T.

Further Developments and Various Inventions.—Although the measurements of Regnault in the 1840s and '50s with his gas thermometers in the range 0° to 100° C were in error by a few tenths of a degree according to modern data, he was probably attaining a precision of about 0.1°, and his mercury thermometers did not compare favourably with this precision, varying erratically by tenths of a degree within that range and much more at higher temperatures Very little was known at the time about annealing glass, so it was customary to age the green or new thermometers for many weeks during which the ice point would slowly rise by a degree or more, as the strains in the glass slowly decreased These strains would never disappear and the thermometers would give readings at the fixed points such as ice and steam, differing by tenths of a degree, sometimes changing for months. On the other hand, it was thought that the gas thermometer was providing measurements agreeing with the Kelvin scale to better than 0.1°. For these reasons the gas thermometers, especially the constant volume hydrogen thermometer came to be regarded as the ultimate standard for laboratory work at ordinary temperatures, although they came

into disrepute, as mentioned above, for use at higher temperatures Better glasses for mercury thermometers were developed during the next decades, and we shall see how they were improved to the point where they came to be known and used as primary standards in a limited range, before the developments of electrical methods.

The mercury thermometer was also improved during this period by the introduction of nitrogen into the capillary bore above the mercury Before this time the thermometers had been

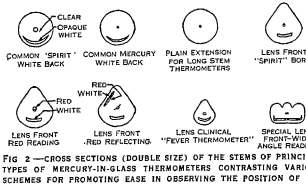


FIG 2.—CROSS SECTIONS (DOUBLE SIZE) OF THE STEMS OF PRINCIPAL TYPES OF MERCURY-IN-GLASS THERMOMETERS CONTRASTING VARIOUS SCHEMES FOR PROMOTING EASE IN OBSERVING THE POSITION OF THE MERCURY

sealed after filling, while the bulb was kept hot enough to run the thread of mercury to the upper end of the stem. Thus when the bulb cooled the space above the mercury contained only its vapour at a pressure corresponding to the temperature of the space By introducing nitrogen into the bulb at some lower temperature, the pressure of the gas will increase as the mercury rises, and counteract the vapour pressure rising with increasing temperature This not only prevents the mercury in the bulb from vapourizing but the nitrogen also retards the vapourization into the space occupied by the nitrogen. In order to best match the varying pressure of the mercury, the proper size of the expansion chamber at the upper end is calculated according to the size of the bore. This is necessary because pressures of a few hundred pounds per sq in. are required at the highest temperatures at which the thermometer can be used. These gas-filled thermometers extended the useful range toward the softening temperature of the glass and in order to take full advantage of the new method of filling, harder glasses were developed, that is, glasses with higher softening temperatures. The first of these were the so-called *verre dur* of France and the type Jena 16, III of Germany. Filling the thermometers with nitrogen spoiled them for the most precise laboratory measurements, because the varying pressures made the scale nonuniform and prevented the application of corrections, but it made them better for general and industrial applications. The useful range was raised to nearly 500° C. (932° F.), although the accuracy above 400° C. was low.

Another invention of the period was the clinical thermometer in a form much as it is currently (1947) known. This is essentially a maximum reading thermometer, that is, designed to indicate the highest temperature to which it has been subjected after the mercury has been shaken down It is made by collapsing a bubble blown in the stem, while the glass is soft, between the bulb and the part of the stem to be calibrated Expert workmanship closes the bore or passage almost completely so that as the temperature falls the mercury thread breaks at the constriction, leaving all that has remained above to be observed at leisure. The bulbs of these thermometers are made small, cylindrical and thin-walled, so that they will come up to the maximum temperature as rapidly as possible. Most clinical, sometimes called medical, thermometers require three minutes or more for all the mercury to reach the body temperature. The small bulbs require that the bore also be exceptionally small, and this in turn has led to the so-called lens-front stems designed to magnify the thread of mercury for easier reading. The scales of these thermometers range from about 33° to 42° C. or 92° to 108° F

Other developments of the period were the resistance thermometer of fine platinum wire first tried by W. Siemens in 1871 without success; the pyrometric cones made of clays and other minerals for the ceramic industries, said to be used first by Lauth and J. H. L Vogt in 1882 but highly developed by Seger and fully described by him in 1886; the thermopile consisting of a large number of closely grouped thermojunctions, devised by Rosetti in 1879, for measuring heat radiation, and many improvements in electrical measuring instruments including the moving-coil reflecting galvanometer by d'Arsonal in 1882. (*See* INSTRUMENTS, ELECTRICAL.). Attempts to estimate very high temperatures by radiation methods met slight success. Josef Stefan had suggested in 1879 that the earlier measurements by John Tyndall on the radiation from incandescent platinum could be represented by the equation $J = \sigma T^4$, and this was established as the law for total radiation (radiation of all wave lengths) by Ludwig Boltzmann in 1884, who in theory substituted radiation as the working substance in a Carnot cycle This law has since been known as the Stefan-Boltzmann law, and has had considerable influence on theories of physics, but its use in pyrometric measurements has been limited mainly to industrial applications.

DEVELOPMENT OF PRECISE THERMOMETRY

Expansion Thermometry.—The famous researches of Callendar and his associates at the Imperial College of Science, London, and the equally well-known work of Chappuis at the Bureau Internationale des Poids et Mesures, Paris, began in the late 1880s and continued into the early 1900s These were the beginnings of modern precise thermometry Chappuis undertook the task of comparing with the highest attainable precision, the temperature scales of carefully made hard-glass mercury thermometers (not nitrogen-filled) and a constant-volume hydrogen thermometer having a platinum-iridium bulb This work covered the range from 0° to 100° C. and was designed to aid in the establishment of standardized temperature measurements in various countries by supplying standard mercury thermometers thus calibrated. The probable accuracy of the individual degrees thus determined, that is, of the international scale of temperatures in this range, was stated by Chappuis to be 0.002°. Callendar developed a compensated constant-pressure gas thermometer with a glass or porcelain bulb and a delicate, sensitive manometer for the close maintenance of a constant pressure, and carried his measurements beyond the boiling point of sulphur. He reported with Ezer Griffiths that the sulphur point was 444.53° C. His interests led him to develop also the platinum resistance thermometer as an instrument of great precision, and to compare it with the gas thermometer up to about 550° C., and to devise the well-known Callendar formulae for expressing the relation between resistance and temperature. Applying these equations for extrapolating, he determined the melting points of silver as 961° and of gold as 1,061° C., values in error by only 0.5° and 2° respectively from the values adopted in 1927 on the international temperature scale.

During the early work of Chappuis and Callendar, the platinum-rhodium thermocouple was made by Henri Le Chatelier, the famous pioneer of industrial pyrometry, to combine with a high resistance galvanometer in portable form for practical purposes. At the same time C Barus, at the U S. geological survey in Washington, was completing a most extensive and thorough study of the thermoelectric properties of a large number of metals and alloys, finally choosing the platinum-iridium alloy to combine with platinum as a thermocouple. Barus was using a constant-pressure gas thermometer with a porcelain bulb surrounded by a rotating muffle in a gas furnace, to measure temperatures up to 1,200° C for the purpose of calibrating his thermocouples. In the same year in which Barus published his final memoir (1892), L. Holborn and Wilhelm Wien at the Reichsanstalt in Berlin, reported their work comparing an air thermometer with the platinum-rhodium thermocouple up to about 1,300° C. Barus retired from the field in that year but Holborn and Wien continued with a more refractory porcelain bulb which enabled them to exceed 1,400° C. a few years later. These pioneering efforts at measuring high temperatures with gas

thermometers were very instructive as to methods and techniques but of little value for their numerical results, and had no significance in the development of methods of high precision at lower temperatures, such as the compensated Wheatstone bridge and four-lead resistance thermometer of Callendar and Griffiths, who were learning and teaching the techniques of precise electrical measurements.

An international committee on weights and measures passed a resolution adopted in 1887, that: "The international committee on weights and measures adopts as the standard thermometric scale for the international service of weights and measures the centigrade scale of the hydrogen thermometer, having as fixed points the temperature of melting ice (0°) and the vapour of distilled water boiling (100°) at standard atmospheric pressure, the hydrogen being taken at an initial manometric pressure of one meter of mercury—that is to say, 1,000/760=1.3158 times the standard atmospheric pressure."

The effect of this action and the subsequent remarkable work of Chappuis at the international bureau was felt mainly in the limited range between the ice and steam points, and here the matter stood officially for more than a quarter of a century Chappuis had transferred the hydrogen scale to four primary standard mercurial thermometers of French hard glass made by Tonnelot, and by means of these four, many other mercury thermometers were standardized for distribution.

Precise thermometry at high temperatures may mean, for example, a precision of 0.1° at the melting point of gold (1,063° C.) as compared with 0.001° at 50° C. However, such precision at high temperatures has never been attained with gas thermometers From 1892 to 1911, the principal contributions to high-temperature gas thermometry were by L. Holborn and A. L. Day at the Reichsanstalt in 1899, using a platinum bulb and nitrogen; by J. A. Harker at the National Physical laboratory of England in 1904, using a porcelain bulb and nitrogen; by Jaquerod and Perrot in 1905, using a silica bulb and various gases and for the first time an electric resistance furnace; by Holborn and Valentiner in 1906, using one bulb of platinum-10% iridium and another of pure iridium, both with nitrogen; by Day and J. K. Clement in 1908, using platinum alloy bulbs with nitrogen; and finally by Day and R B. Sosman using the same type of bulbs of 10% iridium or 20% rhodium with nitrogen at constant-volume. A. L Day and R B. Sosman began their work in 1904 at the U S. geological survey where the measurements reached 1,150° C., then finished the work at the Geophysical laboratory of the Carnegie institution of Washington. Here they reached the melting point of palladium reported as 1,549.2°±2°, determined the melting points of a series of eight metals from zinc to palladium, and transferred all their measurements to a group of platinum-10% rhodium thermocouples, for which they set up interpolation formulae. The monumental and classical work of Day and Sosman has not been duplicated and probably will not again be attempted because of the increased knowledge of other methods of measurement at high temperatures. However, for the next generation, radiation (optical) methods depended upon extrapolation from the melting points of gold and palladium, as determined by Day and Sosman.

Optical and Radiation Thermometry.—During these wonderful developments of gas thermometry, the laws of radiation were gradually taking form. As long ago as 1860, G. R Kirchoff had conceived the idea of the complete radiator, that is, one which has the maximum radiation possible for a given temperature, and which absorbs completely any incident radiation. This is experimentally realized by a hollow enclosure having a small opening. Kirchoff's complete radiator is called a black body (*q.v.*) in physics. He had also concluded that the radiation emission coefficient of any substance is equal to its absorption coefficient, and had called attention to the simple principle that the absorption coefficient plus the reflection coefficient is equal to unity. In 1893, Wien began his studies of the laws of spectral distribution of the radiation from a black body, first reporting the displacement law, which states that the product of the wave length of maximum energy density and the absolute temperature is a constant. Later he published the results of further theoretical considerations, in which he was led to the conclusion that the radiation $J(\lambda, T)$ corresponding to any wave length λ is

$$J = c_1/\lambda^5 e^{c_2/\lambda T}.$$

Wilhelm Wien was awarded the Nobel prize in 1911 for his work on black body radiation Wien's second law was confirmed by many experimenters in the visible spectrum, but when in 1900, Rubens and Kurlbaum tested it at long wave lengths, and found their results in serious disagreement with the law, Max Planck suggested that they add -1 to the denominator This modified equation was found to fit the data and when Planck tried to derive it, he had to assume that the energy of radiation is emitted in multiples of indivisible *quanta* of energy Planck's formula remains in modern physics, although its derivation by him has been superseded by modern explanations from statistical mechanics Planck received the Nobel prize in physics (1918), principally for his quantum theory. The Wien-Planck law was the last radiation law to appear up to 1946, which bore directly on thermometric measurements, but in the final analysis the constant c_2 in this law is best evaluated by its interrelations with many other physical constants The Stefan-Boltzmann law has not helped precise thermometry, and we find that the value of c_2 derived from the Stefan-Boltzmann constant, σ, is farther from the mean than is any other derived value

E. Becquerel suggested as early as 1864 that high temperatures could be measured by the intensity of red radiation from incandescent bodies, but it was not until 1892 that the first pyrometer using the idea was invented Le Chatelier designed a photometric instrument, one for comparing the brightnesses of two sources of light. He arranged a 45° mirror for reflecting the light from a standard source, within the beam from the source being measured The mirror was mounted in the middle of a telescope, and the light from the standard source was matched with that from the other source by means of absorbing glasses and an iris diaphragm to reduce the brightness of the viewed source to that of the standard, in this case an oil lamp. The measuring scale was placed on the iris diaphragm A red glass in the eyepiece limited the light to the red region and thus improved the accuracy of brightness matching, which is difficult when the two halves of a photometric field are sensibly different in colour Preceding Wien, Le Chatelier perforce set up empirical formulae obtained by measuring temperatures with other means to calibrate his instrument. The instrument had a very short scale, a poor standard source, none too good a photometric field and other faults not understood at the time. It was used in laboratories for a number of years, however, and eventually Wien's law was applied to its calibration..

Others attempted to improve Le Chatelier's pyrometer, notably Shore and again Féry, but none of the forms were eminently successful Perhaps the most complicated optical pyrometer to remain in use and on the market for years was that of Wanner (1894) who modified König's spectrophotometer for temperature measurement. Wanner retained the oil lamp as a standard of brightness but included a small carbon filament lamp as a secondary standard Both of these pyrometers were improved somewhat by the adaptation of the standard Hefner amyl acetate lamp, but the Wanner instrument suffered especially in that the form of the source viewed was not visible. It was made more readily portable than the former and became well known in industrial fields, being gradually displaced by the disappearing filament optical pyrometer in the Holborn-Kurlbaum (1901) form of the E F. Morse invention. If the current through the filament of an electric lamp is slowly increased the filament glows red at first, then orange, yellow and white If this filament is placed in the plane of the image of an incandescent object, in a telescope or microscope, the current through the lamp can be adjusted until the filament or a part of it matches the brightness of the image. When this condition obtains, part of the filament becomes invisible against the background of the bright image, and the current required becomes a measure of the tem-

perature of the object. Red glasses are used in the eyepiece to provide the higher accuracy of monochromatic photometry, and absorbing screens are used between the object and the filament to reduce the brightness of the image to the calibrated range of the filament.

C W Waidner and G. K. Burgess (1905) at the U S bureau of standards studied and reported on the optical pyrometers described above and found that only the latter, disappearing filament form gave promise of affording precision. Henning (1910) and C E. Mendenhall (1911) proposed to modify this form by the substitution of a spectrometer for the red glass, and also for measurements at different wave lengths, but it was learned that this did not increase the precision and it did raise the lower limit of temperatures measurable, because of the reduced amount of light passed by the slits of the spectrometer. W. E. Forsythe (1915) showed that an effective wave length can be calculated for a proper type of red glass which just as definite results as can be obtained with the best monochromator, even when the latter has its slits so narrow that less light is transmitted P. D Foote, F. L. Mohler and C. O Fairchild (1917) calculated the preferred form of spectral transmission of absorption screens to provide a perfect colour match of filament and image, and Forsythe (1915) found experimentally that sectored disks employed to reduce the illumination from the source should be placed near the image. A. G Worthing and Forsythe (1914) constructed a laboratory form of the instrument for the special purpose of measuring the temperatures of the filaments of tungsten lamps, and found that diffraction effects at the filament of the pyrometer lamp destroyed the equality of brightness of filament and image, making it necessary to give careful attention to the limiting stops or diaphragms in the optical system. Fairchild and W. H Hoover (1923) showed both theoretically and by experiment that the effects of diffraction can be completely eliminated by proper selection of stops and increased the precision of the instrument to a high degree, obtaining a precision of 0.1° at the melting points of gold and copper, corresponding to 0.2° at the melting point of palladium They also studied the effects of diffraction with sharp-edged flat filaments, and Fairchild (1920) constructed tungsten pyrometer lamps with optically flat windows. These features were incorporated in the improved form of the instrument required to attain the precision noted.

While the instrument itself was being perfected many workers in various laboratories were carrying on much experimental work needed to convert experimental data into temperature and to realize more nearly the thermodynamic scale. Mendenhall (1911) first pointed out that the temperature scale based on the Wien-Planck law is in fact based on a single temperature and the selected value of c_2 in the equation, and that a calibration of the instrument is preferably carried out on this basis. H. E. Ives (1912), P. G. Nuttıng (1914), W. W. Coblentz and Emerson (1917), E. P. Hyde, Forsythe and Cady (1918), and finally K. S Gibson and E. P. T. Tyndall (1923) in extensive and painstaking spectrophotometric tests, measured the relative luminosity function of the eyes of many observers, providing data necessary in all photometric measurements and required in the calculations of optical pyrometry. During this period also a great amount of data was accumulated on the spectral transmission (and its variation with room temperature) of the red glasses and absorption glasses used in fundamental measurements. Foote (1917) in the pyrometry symposium of the Faraday society summarized the interrelations of the constants c_2 and σ with Planck's constant, h. A score or more of scientists from 1898 on experimentally determined values for the Stefan-Boltzmann constant, σ, among whom should be noted for their pioneer work, Kurlbaum, Féry and Drecq, Valentiner, Gerlach and Coblentz. By 1926 the value of c_2 had been fairly well established as equal to 1.432 cm degrees, but we shall find that later determinations altered this mean by a significant amount.

Electrical Thermometry.—Precise resistance thermometry began with the work of Callendar cited above, who found that previous efforts had evidently been careless of the contamination of the fine platinum wire by the reduction of silica in the porcelain spool on which the platinum was wound. Callendar supported the wire on the edges of clean sheet mica so that the wire would be as little contaminated and strained as possible. His results were strikingly successful and he was able to improve his precision again and again over a period of many years. It was no doubt fortunate that the metal platinum was available in relatively high purity, from the beginning of Callendar's work. Owing to the tremendous difficulties of using gas thermometers in experimental work, the use of the Callendar thermometer grew rapidly in all of the principal laboratories of the world, following not only the original studies of Callendar in comparing it with a gas thermometer, but also the work of Chappuis and Harker (1900), Holborn and Henning (1908–11) and Henning and Heuse (1921). Various forms of instruments for measuring resistance with sufficient accuracy were developed as their need appeared Callendar first used an ordinary Wheatstone bridge with a two-lead thermometer, but soon improved the arrangement with Ezer Griffiths by including a pair of dummy leads in the parallel arm of the bridge. F. E. Smith (1912) improved this by attaching two leads to each end of the resistor and switching the connections in such manner as to eliminate the inequality of the two current leads He also developed special forms of the Kelvin double-bridge having six decades, with which measurements could be made by a single reading after three of the leads are adjusted to equality. E. F. Mueller (1916–17) designed a six-decade Wheatstone bridge arranged to avoid the errors of contact resistances and with means for determining the bridge zero and for commutation of the leads. Provisions for readily calibrating these bridges by comparison with a single standard resistor were also included in the arrangements. In order to attain a precision of 1 part in 10,000,000 or better, the resistor coils of manganin were immersed in a thermostated oil bath. Others chose to use potentiometric measurements which require the same four attached leads plus a standard resistor with its four leads. The last three methods are probably still (1947) in use in laboratories of the world, because the original equipment was so costly.

Precise thermometry by means of thermocouples received at least a very favourable start in the investigations of Holborn and Day at the Reichsanstalt in 1900, when they compared the platinum, platinum–10% rhodium thermocouple with the gas thermometer at several good fixed points between 300° and 1,100° C. and found that a simple parabolic expression, $E=a+bt+ct^2$ would represent the relation between e.m.f. and temperature within experimental error, (a few tenths of a degree). C. W. Waidner and G. K. Burgess at the bureau of standards (1909) compared a number of these rare-metal couples with platinum resistance thermometers at five fixed points from the melting point of zinc (*ca.* 419°) to that of copper (1,083), and indirectly confirmed the results of Holborn and Day. However, the interpolation formulae of Day and Sosman mentioned in an earlier paragraph, extended from 320 to 1,550° C. and their temperature-e.m.f. tables were standards of reference for some years These were not only based on gas thermometer measurements, but represented concurrent researches of the highest order of thoroughness—especially as to the purity of all the metals involved—by their associate, E. T. Allen. The precision of electrical measurements attained by another associate, W. P. White, was amazing in excellence. Improved tables were published by other associates, J Johnston (1912) and L H Adams (1913–14 and 1919), the latter publications including tables for copper-constantan up to 385° C., calculated from the formula, $E=a-b(1-e^{-ct})$, wherein e is the Naperian base The precision implied in these tables is not attainable without the precise and accurate measurement of small voltages. (*See* articles on electricity) Quoting from Day and Sosman's *High Temperature Gas Thermometry:* "Briefly, it may be noted in passing that all the thermoelectric measurements without exception were made with . . . a potentiometer of Wolff standard construction by direct comparison with a saturated cadmium cell. The cell first used was one of a series described in a previous paper, which has been compared from time to time with the standard cells of

the national bureau of standards and has never been found to contain an error greater than one or two parts in 100,000."

Thus we see that the art of electrical measurements *per se* had kept pace with the art of electrical thermometry The development of potentiometers (potentiometer here used is not to be confused with its use by electronic engineers to mean a voltage divider) suitable for the measurement of small e m.f.s as required in this art had extended from 1890 to 1910, the Wolff instrument mentioned incorporating the principles developed by several different writers including Hausrauth, White and Diesselhorst. It was a five-dial instrument designed to measure 0.1 microvolt with exactness, and contained no slide-wire usually found in potentiometers designed for less accurate work The standard of reference in the use of a potentiometer is the standard of voltage made available for practical use in the so-called standard cell, which maintains a constant voltage when it is not drained by an appreciable current. The cell in common use (1947) is the Weston unsaturated cadmium cell Its normal voltage is very nearly 1 019 volts. If any laboratory wishes to place its electrical measurements on a basis that can be exactly interpreted by another laboratory, it is necessary to use a standard cell that has been tested and certified by the national bureau of standards of the United States or the corresponding standards bureau of another country.

DEVELOPMENT OF INDUSTRIAL THERMOMETRY

Introduction in Industry.—There are no records of the slow growth of mercurial thermometry from the time of its invention by Fahrenheit in 1714 to the period of Regnault in the 1840s, and few beyond that date to the end of the 19th century, but there were many makers of these thermometers in the early part of the century and their use no doubt grew with such industries as steam power and chemicals which were making good progress in the middle of the century. That they were in demand in the 1880s is attested by the widespread dissatisfaction with their unfitness for high temperatures in industry. From 1885, when Le Chatelier recognized the urgency of the situation, until World War I, pyrometry grew slowly and thermometry rather rapidly. The first book on pyrometry appeared in 1900, many years after mercurial thermometry had developed into a precise art. This was the text of the pioneer Le Chatelier and his assistant Boudoard, and was entitled *Mesure des températures élevées*. Since 1900 there have been many texts and a number of symposia which have recorded both the scientific and the industrial growth. G K Burgess, at the national bureau of standards, a former student of Le Chatelier, who had translated into English two editions of the former text, wrote with Le Chatelier (1911) *Measurement of High Temperatures*. This was an exhaustive text, which brought up to date both theory and practice, and included an excellent bibliography of the subject. Mercury thermometers were mentioned, however, only in connection with the early investigations of Regnault and of Chappuis. These thermometers had long since been completely commercialized and were losing general scientific attention, except in special forms. Mercury thermometers enclosed in metal protecting sheaths with attached scale-housings for the ruggedness required in plant or factory were to become common articles of commerce known simply as industrial thermometers. Thus protected they can not give the accuracy of a bare thermometer because of the flow of heat out through the sheath, nevertheless they have proved to be indispensable in a multitude of applications. Another omission of Burgess and Le Chatelier was the industrial dial thermometer, sometimes called a pressure-spring thermometer. In this instrument, a liquid or gas is enclosed in a metal bulb connected by a capillary metal tube to the pressure spring, a modification of the Bourdon tube found in pressure gauges. This may take the form of a spiral or helix of a flattened metal tube which reacts to internal pressure by a slight unwinding One end of the tube is fixed and the other end is attached to a mechanism for turning a pointer around the dial scale. The early (before 1911) forms were crude and not compensated for simple errors such as expansion of the fluid in the connecting capillary and spring.

From Le Chatelier to World War I, industrial thermometry was limited to the measurement of high temperatures and was called pyrometry Thermocouples made of base metals had begun to compete with the Le Chatelier couple because of their lower cost and higher thermoelectric power. Iron was still condemned as unsuitable for a thermocouple element and many combinations of metals and alloys were tried. The most successful of these was invented by M. A L. Marsh, who combined an alloy of nickel–2% aluminum with nickel–10% chromium This thermocouple was found to be serviceable as high as 1,100° C, and generated an e.m.f four to five times as large as did the platinum alloy couple of Le Chatelier. The optical pyrometers of the Holborn-Kuribaum and the Wanner types were in extensive use; likewise the radiation pyrometers of Féry, Foster and Thwing A commercial form of Callendar's resistance thermometer was having considerable success. Rugged low-resistance millivoltmeters were available for use with thermocouples and radiation receivers, and the earliest forms of recording instruments were manufactured in considerable quantities Of these the recorder developed by Callendar with its Wheatstone bridge circuit for his resistance thermometers, various recording millivoltmeters and the Leeds and Northrup recording potentiometer were outstanding examples.

Industrial Thermometry up to 1920.—The earliest symposium of note was that of the Faraday society held in London in 1917. It was entitled "Pyrometers and Pyrometry" and the papers and discussion indicated primary interests in the high-temperature industries such as metals, glass and ceramics. The symposium was held at the suggestion of Sir Robert Hadfield, prominent metallurgist and president of the society, and in his absence, Sir Richard Glazebrook, director of the National Physical laboratory, presided. Science and practice were brought into sharp contrast by the contributors. Glazebrook stated in his opening remarks, that "(While) I have the utmost respect and regard for the skilled workman . . . I think the time has gone by when it is sufficient to trust to the eye and experience of any skilled workman for the accuracy that is needed in dealing with metallurgical processes. . . ." The consensus of this symposium was that the industries mentioned would profit a good deal from the proper use of pyrometers, but that the instruments must be improved both in ruggedness and accuracy, and the persons using them must learn much more about them. Automatic control or regulation of temperature, which had been barely mentioned by Burgess and Le Chatelier aroused little interest, although there were a number of pyrometric controllers available. Thermometers and expansion thermostats widely used in the industrial processes conducted at lower temperatures did not enter the discussions. In thermoelectric pyrometry, it was reported that (1) base-metal thermocouples are inhomogeneous and so can not provide the accuracy of rare-metal couples, (2) low-resistance millivoltmeters may be robust but the errors are too large, hence high-resistance meters should be used and are on the market, (3) potentiometers are not useful in industry because they are not self-indicating, (4) recorders (millivoltmeter type) are expensive, not properly designed and give too much trouble, and (5) pyrometers should be manufactured with more uniformity so that couples and meters can be interchanged. The inherent limitations and larger errors of radiation pyrometers were discussed both on scientific and practical grounds, but their unsuitability for portable use was not yet clear No particular type was outstanding. Optical pyrometry had not reached many hands and there was a prevalent idea that too much knowledge was necessary to make good use of it. The disappearing-filament type was competing on even terms with the Wanner (spectrophotometric) instrument.

Just two years after this symposium in London, another was held in Chicago (1919), after the progress and developments of wartime had become generally known Once again, it was pyrometry and not thermometry (one contribution), and again metallurgists were especially interested, although this symposium was more pretentious and rather systematically covered the whole

subject as a science, and applications of varied character. The symposium was the final work of a pyrometer committee of the National Research council, which committee had been formed at the suggestion of H. M. Howe, chairman of the engineering division of the council, "for the purpose of developing a pyrometric method suitable for open-hearth steel practice so that the effects of temperature in the various stages of the processes of steel making might be correlated quantitatively with the other factors influencing the production of sound steel" G K. Burgess, chief, division of metallurgy, bureau of standards, was chairman of the committee and of the symposium, and the collecting of the extensive series of contributions was the work of P. D. Foote, chief of the pyrometry section, and W. E. Forsythe of the Nela Research laboratory. The symposium constituted a special series of sessions of a meeting of the American Institute of Mining and Metallurgical Engineers, and this institute published the collection of 59 papers in book form.

There were a number of striking conditions revealed by this symposium: (1) Some U S. industries had advanced tremendously during the preceding few years in the application of pyrometry, but these industries were only the high-temperature ones, particularly metals and to some extent glass, ceramics and Portland cement. (2) It was taken for granted that industrial pyrometry was an important technologic field. (3) Once again there was slight scientific interest in industrial thermometry—that is, thermometry below a red heat. (4) A great many engineering colleges were teaching pyrometry and probably a little thermometry. (5) Electrical thermometry had not yet seriously invaded the field of expansion thermometry at lower temperatures (6) Automatic control (regulation) by means of electrical instruments was barely started, as on-and-off control only, and the physicists and metallurgists currently interested in pyrometry were not in touch with mechanical engineers who had developed the art of automatic throttling control of steam engines, which the latter called governing. (7) Industrial standards of accuracy had progressed slowly and were still well behind those available from the bureau of standards and other research laboratories

The symposium showed that base-metal thermocouples had finally found established acceptance for industrial use, the combinations, copper-constantan, iron-constantan and chromel-alumel being well known. The last named is the combination nickel-10% chromium with nickel-2% aluminum, previously mentioned, the words chromel and alumel being originally trade names for these two alloys. Considerable stress was directed toward the high resistance millivoltmeter, placing the low-resistance instruments in an inferior class Of course this development was partially the result of the growing use of industrial forms of potentiometers, particularly the recording potentiometer invented by Morris Leeds of the Leeds and Northrup Co. A multitude of electrical circuits for potentiometers and so-called semipotentiometers came into being, most of which have fallen by the wayside. Many of the methods for automatic compensation for the e.m.f. of the reference junction of thermocouples were due to W. H Bristol, who founded The Bristol company Another of these was the invention of Felix Wunsch. Extension wires for transferring the reference junction from the head of the thermocouple to the instrument became a common article of commerce, and being costly at first, various schemes for economizing were devised, such as the thermostated cold junction box Much was written about the advantages of burying the cold junction as it was called at the time, in the ground, deep enough to reach a zone of sufficiently constant temperature, a method invented by Anthony Zeleny and ably discussed in the Faraday society symposium by R. S Whipple. It was apparent that industry was becoming accustomed to the higher costs of good pyrometers, and not only the recording potentiometer but a number of good recording millivoltmeters were to be on the market for many years. About one-quarter of the symposium papers were written primarily or partially around the theory and applications of the disappearing-filament optical pyrometer. A number of these were of course concerned with laboratory methods, for example, of determining the temperatures of tungsten lamp filaments and methods of standardising. It was forcibly brought out that industry needed a mass of new data about the emissivity of nonblack bodies, in order to make the optical pyrometer fully useful in any form. Theories of radiation as applied to nonblack bodies were more fully developed to the advantage of industrial applications. Perhaps the optical pyrometer was being used beyond its properly established sphere at this time At any rate, the limitations of both optical and radiation pyrometry were ably treated, and ample warning was issued to persons in industry by the students of the science. Radiation pyrometry was growing slowly, but the unfitness of the method for portable instruments was still in the background.

For the first time, a paper on industrial thermometry appeared in the literature of pyrometry, but in this instance, the author, R. M Wilhelm of the bureau of standards, entitled his paper, "High-Temperature Thermometry" and limited his discussion to the range 100° to 550° C. He described the high-temperature mercurial thermometers, and indicating and recording thermometers of the vapour-pressure, liquid- or gas-filled, and metal-expansion types, implying that they were widely used and required much attention at the bureau of standards No new developments in the field were mentioned, stress being laid on the empirical nature of the calibrations of all of these instruments, and the effect of this on the methods of testing. A new form of resistance thermometer appeared in which a fine platinum ribbon is wound on a small tube made of fused quartz, and over this is melted down an outer jacket of the same material, completely sealing in the platinum resistor and protecting it from contamination by industrial gases. This device was to meet much success even for temperatures as high as 900° C. The errors caused by strains in the embedded platinum amounted to a small fraction of a degree at moderate temperatures, other errors being due mainly to the difficulty of protecting the leads close to the resistor Resistance thermometers made of nickel wire protected for use up to 500° C. were also described, but there seems to have been no attention to the molecular change taking place in nickel at about 325° C., which unfits this metal for such use in this range and beyond.

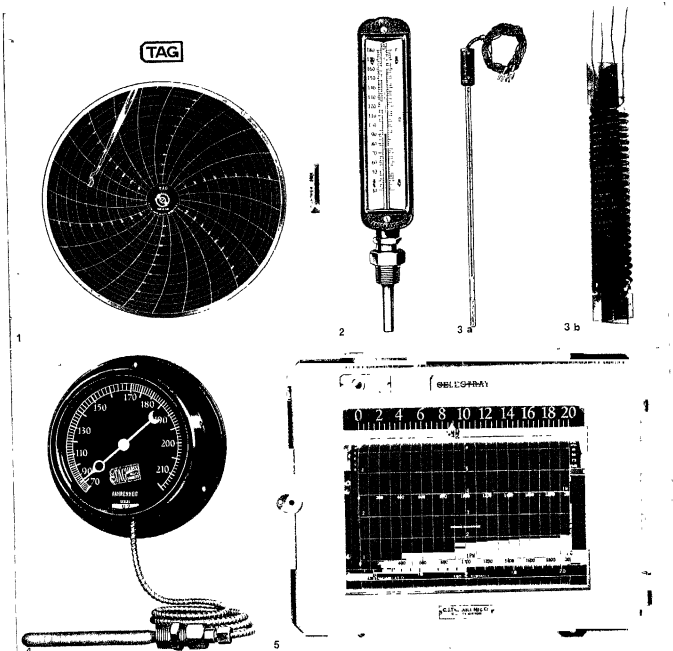
MODERN (FROM 1920) THERMOMETRY

Modern thermometry was brought up to date in 1939–41 and its remarkable growth in the period from the 1919 "Symposium on Pyrometry" was revealed by the third major symposium. Following much preliminary work, the American Institute of Physics in co-operation with the national bureau of standards, the National Research council and a large group of engineering societies in 1939, held a symposium on "Temperature, Its Measurement and Control in Science and Industry" The comprehensive nature both of the major subject and of the symposium itself is revealed by the recorded attendance of more than 800 individuals at 20 sessions where more than 125 papers were presented on scientific and technological subjects of a widely diverse character. The symposium was published in 1941 (see *Bibliography*). Pointed references to it will be found in succeeding paragraphs. The inclusion of many important contributions from the biological sciences was a notable difference from the previous symposia.

The International Temperature Scale.—In 1927, the seventh general conference of weights and measures, representing 31 nations, unanimously adopted an international temperature scale as it was proposed by the bureau of standards, the National Physical laboratory and the Reichsanstalt, which laboratories had been consulting for many years on the best methods to recommend for the practical realization of the thermodynamic scale, and the best values of fixed points to announce. The thermodynamic centigrade scale was recognized as the fundamental scale to which all temperature measurements should ultimately be referable.

On this scale the ice point and steam point are defined as 0° C. and 100° C., respectively, and a series of experimentally determined basic fixed points, with stated means for interpolation and extrapolation are agreed upon.

THERMOMETRY



BY COURTESY OF (1, 2, 4, 5) C. J. TAGLIABUE DIVISION, PORTABLE PRODUCTS CORP., (3) LEEDS AND NORTHRUP CO

INSTRUMENTS USED IN THERMOMETRY

1 Recording thermometer alike in principle to the dial thermometer illustrated, but having a circular paper chart driven by a clock

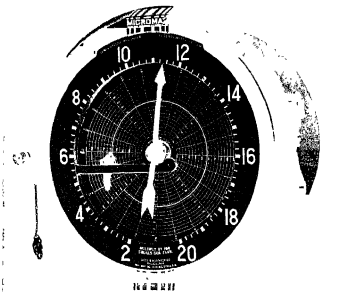
2. Industrial thermometer of glass filled with mercury or other liquid and having a sheathed bulb, windowed frame and threaded member for holding pressure

3 (a) Platinum resistance thermometer in a pyrex glass tube, and (b) a view of the double-helix coil of fine platinum wire wound on crossed mica strips to keep the wire clean and unstrained

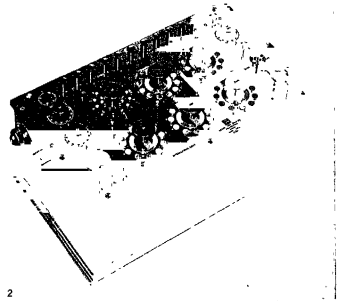
4 So-called dial thermometer of industry having a fluid-filled system of bulb, armoured metal capillary connecting tube and hidden pressure-spring for turning the pointer

5. A potentiometer for recording the voltages of a number of thermocouples in rapid succession on a paper roll-chart, graduated in degrees of temperature The automatic mechanism is photoelectrically balanced

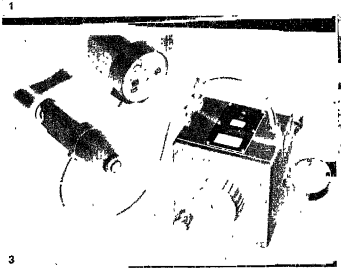
THERMOMETRY



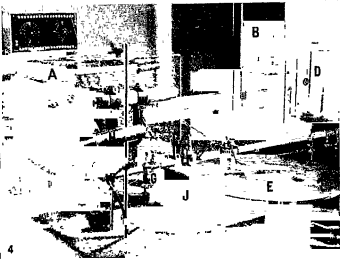
1



2



3



4

BY COURTESY OF (1, 2, 3) LEEDS AND NORTHRUP CO., (4) DR. ROBERT B. SOSMAN AND AMERICAN SOCIETY FOR METALS

INSTRUMENTS USED IN THERMOMETRY

1. A potentiometer for recording the voltages of one or two thermocouples on a circular chart graduated in degrees of temperature. The bold hand and large circular scale are useful where frequent observation from a distance is essential in controlling a manufacturing plant or process. Also used for automatic control and signalling
2. An electrical bridge for platinum-resistance thermometry. Used in research laboratories for high precision measurements in a narrow range of 0 to 111 ohms
3. An optical pyrometer with which temperature is measured by matching the brightness of an incandescent object with that of the tungsten filament of a lamp mounted inside of the telescope shown on the left. The instrument on the right is a potentiometer for measuring the current in the lamp and is calibrated in degrees of temperature. The special flat-windowed lamp is visible in the opened telescope
4. Apparatus for calibration of optical pyrometers in the research laboratory of the U S Steel Corp A is a precision potentiometer; B, a galvanometer, C, Fairchild optical pyrometer; D, jacket of tungsten-ribbon lamp; E, extra lamp; F, standard 0.001-ohm resistor for source-lamp current; G, standard 0 1-ohm resistor for current in lamp of Fairchild pyrometer; H, telescope of mill pyrometer, and J, milliammeter of mill pyrometer

Basic Fixed Points

	°C
Temperature of equilibrium between liquid and gaseous oxygen at the pressure of one standard atmosphere (oxygen point)	−182 97

$t_p = t_{760} - 0.0126\ (p-760) - 0.0000065(p-760)^2$

Temperature of equilibrium between ice and air-saturated water at normal atmospheric pressure (ice point) ..	0 000
Temperature of equilibrium between liquid water and its vapour at the pressure of one standard atmosphere (steam point)	100 000

$t_p = t_{760} - 0.0367(p-760) - 0.000023(p-760)^2$

Temperature of equilibrium between liquid sulphur and its vapour at the pressure of one standard atmosphere (sulphur point)	444 60

$t_p = t_{760} + 0.0909(p-760) - 0.000048(p-760)^2$

Temperature of equilibrium between solid silver and liquid silver at normal atmospheric pressure (silver point)	960 5
Temperature of equilibrium between solid gold and liquid gold at normal atmospheric pressure (gold point)	1 063

Standard atmospheric pressure is defined as the pressure due to a column of mercury 760 mm high, having a mass of 13.5951 g/cm^3, subject to a gravitational acceleration of 980 665 cm /sec^2 and is equal to 1,013,250 dynes/cm.^{2}.

Means for Interpolation.—From the ice point to 660° C. the temperature t is deduced from the resistance R_t of a standard platinum resistance thermometer by means of the formula $R_t = R_0(1+At+Bt^2)$. The constants R_0, A and B of this formula are to be determined by calibration at the ice, steam and sulphur points, respectively The purity and physical condition of the platinum of which the thermometer is made must be such that the ratio R_{1}/R_0 shall not be less than 1.390 for $t = 100°$ and 2.645 for $t = 444.6°$.

From −190° to the ice point, the temperature t is deduced from the resistance R_t of a standard platinum resistance thermometer by means of the formula $R_t = R_0(1+At+Bt^2+C(t-100)t^3)$. The constants R_0, A and B are to be determined as specified above, and the additional constant C is determined by calibration at the oxygen point The standard thermometer for use below 0° C. must, in addition, have a ratio R_{1}/R_0 less than 0.250 for $t = -183°$.

From 660° C. to the gold point, the temperature t is deduced from the electromotive force e for a standard platinum versus platinum-rhodium thermocouple, one junction of which is kept at a constant temperature of 0° C. while the other is at the temperature defined by the formula, $e = a+bt+ct^2$. The constants a, b and c are to be determined by calibration at the freezing points of antimony, silver and gold.

Above the gold point the temperature t is determined by means of the ratio of the intensity J_2 of monochromatic visible radiation of wave length λ cm , emitted by a black body at the temperature t_2, to the intensity J_1 of radiation of the same wave length emitted by a black body at the gold point, by means of the formula

$$\log_e \frac{J_2}{J_1} = \frac{c_2}{\lambda}\left[\frac{1}{1{,}336} - \frac{1}{(t+273)}\right]$$

The constant c_2 is taken as 1.432 cm degrees The equation is valid if $\lambda\ (t+273)$ is less than 0.3 cm. degrees.

The standard couple referred to above was described as having platinum of such purity that the ratio R_{1}/R_0 is not less than 1.390 for $t = 100°$ C , and an alloy of 90% platinum with 10% rhodium. For further information regarding the purity of the substances used, the methods of experimentally realizing the corresponding fixed temperatures, etc. see national bureau of standards *Jour. Research*, vol. 1, p. 635 (1928).

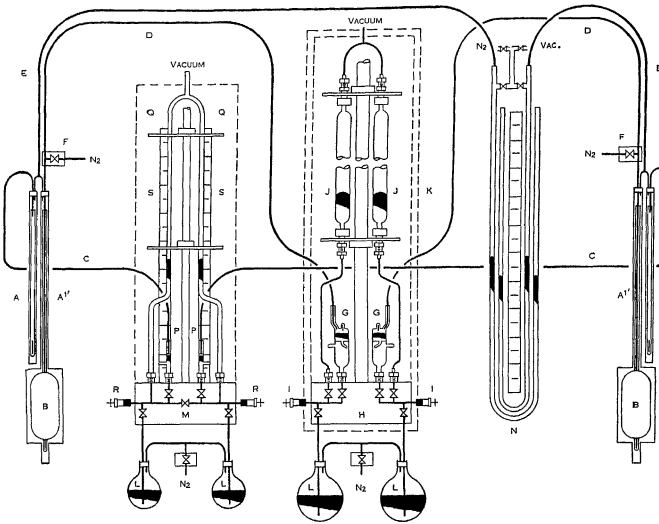
The international temperature scale is to be regarded as a practical scale At the time of its adoption the scale was said to "conform with the thermodynamic scale as closely as is possible with present knowledge, and is designed to be definite, conveniently and accurately reproducible, and to provide means for uniquely determining any temperature within the range of the scale, thus promoting uniformity in numerical statements of temperature " In 1929, H T. Wensel stated in the temperature symposium *Temperature*, that "Among the revisions by which the conformity with the thermodynamic scale might be improved are (1) the substitution of Planck's formula for the form of Wien's formula given in the scale, (2) the use of a slightly higher value for c_2, (3) some modification in values assigned to some of the fixed points to make departures from the thermodynamic scale smaller and more regular, (4) making the junction between the thermocouple and the resistance thermometer ranges at the freezing point of antimony instead of at 660° C., (5) extension of the scale below −190° and (6) better specifications for the standard resistance thermometer." (H T Wensel in *Temperature—Its Measurement and Control in Science and Industry*, Reinhold Publishing Corporation, 1941.) The best value of c_2 had been derived by Wensel in 1939 in the *Journal of Research* from all of the experimental data available as being 1.4362 plus or minus 0.001.

EXPANSION THERMOMETRY

This classification can be regarded as a division of contact thermometry, and as including not only measurements by means of the expansion of gases, liquids and solids but also of the change of pressure of vapours So-called vapour-pressure thermometers are extensively used for industrial purposes, with considerable practical advantages, but they have little scientific value.

Gas Thermometry.—Modern industrial gas thermometry is practised to a limited extent because of the difficulty of correcting for the expansion of the gas in the connecting tube between the bulb and the pressure measuring device, such as the Bourdon tube, or pressure spring On the other hand, scientific interest in precise gas thermometry has not lagged It has been directed to the accumulation of more exact knowledge of the properties of real gases such as nitrogen, hydrogen and helium and the derivation of corrections to be applied to the real gas thermometer scales to convert them to the thermodynamic scale, which would be realized by an ideal gas. Gas thermometry is intimately related to many fields of physics and chemistry through the relation of the universal gas constant R (in the equation of a perfect gas, $pv = RT$) to many other constants, and through the dependence of much of our exact knowledge of these other constants on the value of the ice point, T_0, on the Kelvin or thermodynamic scale. These relations have benefited the art tremendously by maintaining a scientific interest in ever seeking to improve the accuracy of measurements not only at ordinary and high temperatures but at very low temperatures approaching zero on the Kelvin scale. Our knowledge of phenomena near zero depends first on the accuracy of the value selected for T_0.

General thermodynamic theory of the departures of the properties of real gases from the laws of an ideal gas lead to the result $pv = RT + Bp$ for moderate pressures (one or two atmospheres). For the three commonly used thermometric gases mentioned above, the term Bp amounts to less than 0.1% of RT at 0° C. and one atmosphere The coefficient B, called the second virial coefficient is a function of both temperature and pressure, but because Bp is so small, B values may be determined with satisfactory accuracy by varying pv at a constant temperature and writing $B = v - RT/p$ In the language of the investigators in this field, the slopes of the pv isotherms of any gas serve in themselves to determine the departure of the gas from ideal, without the use of any other data. Some investigators set up equations for B as a function of T and use them to smooth the data B values can also be calculated from the Joule-Thompson coefficient, μ, and the specific heat, C_p, at constant pressure Most of the data on gas scale corrections are, however, based on the compressibility, the pv isotherms While a great many workers have contributed to these data, the later work in precise thermometry has been carried out principally in the laboratories of the bureau of standards, the University of Leiden, Massachusetts Institute of Technology (M I T.), University of Wisconsin and the Reichsanstall. Reports are found in the publications of the institutions and especially in *Phys. Rev.*; *Zeit. f. Physik*; *Ann. d. Physik*; *Proc. Amst. Acad Sci.*; *Phil. Mag*; *Proc. Am Acad. Arts Sci.* The 1939 temperature symposium contains a number of im-



FROM BEATTIE, "PROCEEDINGS OF AMERICAN ACADEMY OF ARTS AND SCIENCES" (1941)

FIG. 3 —EXPERIMENTAL GAS-THERMOMETER SYSTEM CONSTRUCTED IN DUPLICATE

The three pressure systems are designed for operating the nitrogen-filled thermometers at constant volume: (1) the main system, B,A', (F),D,G,H,J, (2) the auxiliary system, A,C,P,M,Q, for determining the correction for the dead space, the region of large thermal gradient, and (3) the external pressure adjusting system, steel case to E to N. Mercury reservoirs L are connected through steel blocks H and M to the manometers G, J and P,Q. Bulb is of vitreous silica and connections are steel capillaries and stopcocks. K is a thermostated housing

portant articles in this field and extensive references

These researches have been in the range from 900° C. down to approximately 2° K. (−271° C.), where there has been a much wider choice of materials for thermometer bulbs than at the higher temperatures attempted by Day and Sosman and their predecessors. This has been accompanied by much more accurate auxiliary data such as expansion of the bulb (preferably of fused silica) with temperature and pressure, and temperature of the dead space. The use of helium has revealed its admirable suitability for thermometry from 200° C. down to the lowest limit of gas thermometry. The corrections to its scale are only a few thousandths of a degree down to −150° C. and its boiling point is about −269° C. Nitrogen probably will continue to be used at higher temperatures because of its lower diffusion rate, although the corrections to the Kelvin scale are much larger than those for helium, reaching about 0.5° at 1,000° C for an ice-point pressure of one atmosphere (constant volume thermometer).

Modern gas thermometry has served not only to improve our knowledge of the fixed points on the centigrade scale but especially has it provided a more accurately determined value of the ice point, T_0, on the Kelvin scale. J. A. Beattie, of the M.I.T. laboratory in the 1939 symposium, gives the best value of T_0 considering only the data obtained since 1920, as 273.165± 0.015° K. From the better known value of RT_0, (22.4141± 0.0008) 10^3 cm ^{3} atmos per mole, the best value of R, so important in thermodynamics, is found to be 82.053±0.005 cm.^{3} atmos per mole per °K. which is equivalent to 83.136 10^6 ergs per mole per °K or 1,543 ft lb per mole (lb) per °F. In engineering thermodynamics the Rankine scale is often used in English-speaking countries, named after William Rankine, one of the founders of the science of thermodynamics. This scale bears the same relation to the Fahrenheit scale that the Kelvin does to the centigrade scale, the ice point on the Rankine scale being 1.8 times 273.165 or 491.7° R., and 0° F. being 459.7° R. The scale is occasionally called the absolute Fahrenheit by engineers.

B. E. Blaisdell and J Kaye report in the same symposium on the boiling points of mercury and sulphur on the thermodynamic temperature scale, as realized by the use of two constant volume nitrogen gas thermometers, stating that, "Because of its practical and theoretical importance the relation of the International Scale to the Thermodynamic Scale has been studied in considerable detail at M.I.T. under the general supervision of Prof. J A. Beattie —(in) the range 0° to 444.6° C. (Int)." (B E Blaisdell and J. Kaye in *Temperature—Its Measurement and Control in Science and Industry*, Reinhold Publishing Corporation, 1941) Further reference to the fundamental and painstaking work of this group is made below in paragraphs on electrical thermometry. Blaisdell and Kaye stated that work at M.I.T in the range 0° to 444.6° C. and the work of others in the range −183° to 660° agree in showing that the international scale is low from −183° to 0° C. and from 100° to 444 6°, and high from 0° to 100° and from 444 6° to 660° C. They review the literature from 1890 and recommend the value

444.7° C. for the normal sulphur boiling point on the thermodynamic scale, and for mercury, 356.7° C as an additional fixed point Different determinations on a single gas thermometer showed a greatest difference of about 0.06° at the sulphur point and 0.025° at the mercury point Their two thermometers were found to exhibit a systematic difference of 0.03° at the sulphur point and 0.025° at the mercury point.

H J. Hoge reviewed in the 1939 symposium the situation in regard to means for measuring temperatures below the boiling point of oxygen including helium and hydrogen gas thermometers, and surveyed the literature from 1884, for fixed points from the transition point of helium at 2.2° K. to the oxygen point

Modern Mercury-in-Glass Thermometry.—This is by far the most important division in point of numbers of thermometers used, diversity of applications and general renown. While the mercury thermometer has lost its standing as a primary standard, having given up such a distinction to the platinum resistance thermometer, it must still be regarded in its better grades of workmanship as an instrument capable of furnishing a highly useful accuracy of indication. Particularly is this true in the range from slightly about −40° to 150° C. where accuracies of near 0.01° are attainable in experienced hands. A thermometer of such a grade has its scale etched directly on the glass stem When one considers that the thermal volume expansion of mercury is only about 180 parts per 1,000,000 per °C at room temperature, and that an accuracy of indicating an expansion of only 180 parts in 100,000,000 is attainable, the amazing performance of so simple a device can more readily be appreciated It is the more remarkable in view of the natural instability of glass, even of the special hard glasses employed. To be sure, such an accuracy is obtained only under carefully prescribed conditions of manufacture, calibration and use. First, the thermometer must have been properly annealed during its making, filled with the purest of mercury and sealed off with the correct pressure of nitrogen in the capillary space, that is, just sufficient to prevent the mercury from easily separating during rough handling. Some manufacturers age their thermometers for extended periods at as high a temperature as they can withstand after filling and sealing. This is supposedly an inferior method. Next, the calibration must proceed at a series of successively higher temperatures, must include the ice point and must be carried out with mercury in the stem extending out of the hot bath only far enough to be seen. Now, when the thermometer is used, the measurements must be made under a similar set of conditions. If a thermometer thus calibrated be heated to a higher temperature after having been, for instance, at the ice point for several days, the bulb will expand within a few minutes to the size it had at this temperature during its original calibration. If it now be cooled back to zero the bulb will not promptly recover to the corresponding volume, but will be slightly larger and will gradually shrink to its original size over several days. During this period the thermometer reads low because the bulb is larger than normal. This error is called the ice-point depression, a well-known characteristic of even the best thermometers. The depression at any temperature amounts to nearly 0.01° for every 10 degrees of cooling from a higher temperature, if the observation is made within a few minutes of the attainment of the lower temperature Thus it is apparent that a thermometer graduated in tenths of a degree per division would reveal this phenomenon of hysteresis, but that one graduated in whole degrees would not, unless each division were very large.

The thermometer described in the previous paragraph is known as a total immersion thermometer because it has been calibrated and is normally used with all of its mercury immersed except the tiny bit required to be visible outside of the hot bath. If it is necessary to use it with a considerable part of the capillary thread of mercury extending out of the bath, corrections for this length of emergent stem can be approximated.

A formula for this is: stem correction $=0.00016n(T-t)$ where n is the number of degrees centigrade emergent from the bath, T is the temperature in °C of the bath, and t is the average temperature of the emergent stem. If the calculation is in °F. the coefficient is 5/9 as much. This correction is seldom attempted since the advent of the resistance thermometer and the practice of making many mercury thermometers calibrated for partial immersion. Partial immersion thermometers, so-called, afford relatively accurate indications only when they are used under conditions closely approximating those prevailing during their calibration. They are nevertheless the commoner form of industrial thermometer, particularly when enclosed in a protective sheath and windowed frame.

The upper limit of temperature for which these thermometers can be designed depends not only upon the softening range of the glass but also upon the high vapour pressure of mercury. The commonest glasses made expressly for thermometers permit reliable use up to about 400° C. (752° F.). Those glasses usually contain lead, and the harder borosilicate glasses raise the limit to about 500° (932° F.). Still harder glasses which raise the limit to about 650° C (1,202° F.) are used to some extent, but suffer the competition of thermocouples.

High-temperature thermometers have been made of fused silica filled with the metal gallium which melts at approximately 30° C (86° F.) and boils above 1,600° C. The lower vapour pressure of the liquid gallium at high temperatures is a real advantage, but capillary tubes of fused silica are difficult to make because of the high melting point (1,710° C.) of this oxide, and the combination has not been extensively employed. The lower limit of mercury-in-glass thermometers has been extended by alloying thallium with the mercury in a percentage close to the composition having the lowest melting point, (eutectic mixture) This is at 9.3% thallium, the melting point being −59° C. (−74° F) Such a thermometer is easier to make than the gallium-in-silica, and has been used in limited quantities, but both meet the competition of forms of thermometers described in other paragraphs.

Thermometric Lag.—Whenever a thermometer at one temperature is suddenly immersed in a fluid medium at a higher temperature, heat flows into the thermometer raising its temperature rapidly at first and more slowly as the temperature of the medium is approached. After a sufficient lapse of time no further change of the thermometer can be detected and it is then assumed that the temperature of the medium is indicated. Also if a thermometer is immersed in a medium whose temperature is varying, the thermometer will always be at a different temperature, lower or higher than the medium depending on whether its temperature is rising or falling. It is said that the temperature of the thermometer lags that of the medium. This subject is frequently discussed in relation to mercury-in-glass thermometers, perhaps because such a thermometer, when immersed bare in a stirred bath lags the temperature of the bath in a manner that can be expressed by a simple law, as shown by D R Harper in a bureau of standards bulletin (1912). This law is usually referred to as Newton's law of cooling and as applied in this case states that the rate of change of temperature of the thermometer is proportional to the difference between its temperature and that of the bath. Perhaps it is clearer to consider the thermometer as having a bulb of glass, a poor conductor of heat, full of mercury, a far better conductor, being also a liquid in which convection currents assist in the transfer. The rate of heat flow through the glass of the bulb, according to J. B. Fourier's law is proportional to the temperature gradient. As given by Harper:

$$\frac{d\theta}{dt}=\frac{1}{\lambda}(u-\theta)$$

where u is the temperature of the bath at instant t, θ is the temperature of the thermometer at the same instant and λ is a constant with respect to u, θ, and t.

Considering only the case of a constant temperature of a stirred bath, the solution is:

$$(\theta-u)=(\theta_0-u)e^{-t/\lambda}$$

where e is the base of natural (Napierian) logarithms, approximately 2.718, and θ_0 is the temperature at the start of reckoning time, $(t=0)$. At the time $t=\lambda$, $(\theta-u)=(\theta_0-u)/e=.37(\theta_0-u)$, that is λ is the time required for the temperature differ-

ence to be reduced to 37% of the initial difference. This value of λ is called the time constant of the thermometer under the special conditions of the bath, as to substance (water, oil, etc.) and stirring. An ordinary bare laboratory thermometer has a time or lag constant of 2 to 3 seconds in a well-stirred water bath, 5 or 6 seconds in oil and about 1 minute in well-stirred air to 3 or more minutes in still air. The time required for the difference to decrease to 1% of the initial difference is 4.6λ and the time to reach 0.1% is 6.9λ. For example a bare thermometer for which λ is 2 seconds, when immersed in a stirred water bath which is 10° hotter than the thermometer, will warm 6.3° in 2 seconds, 9.9° in 9.2 seconds and 9.99° in 13.8 seconds.

Harper has shown that a bare thermometer in a bath whose temperature is rising at a constant rate lags in temperature behind that of the bath by λ seconds, if the thermometer has been in the bath long enough to attain the same rate of rise.

These simple relations do not apply to thermometers in a sheath or to other cases where more than one layer of substance is found between the bath and the mercury. Nevertheless thermometers in many forms are arbitrarily characterized by assigning them an experimentally determined lag constant equal to the time required to change 63% of the initial temperature difference as described above. Occasionally this property is based on common logarithms, in which case the constant corresponds to a change of 90% (10% residual).

Liquid-in-Glass Thermometers other than mercury-filled are employed to a considerable extent for measuring temperatures below the freezing point of mercury. The (ethyl) alcohol thermometer is the best known of these, and is used to cover the range from 70° down to −80° C. Many organic liquids can be used, the special requirements being low freezing point, low viscosity, nontoxicity and ability to dissolve a dye and remain stable. Pentane thermometers are useful from 30° down to approximately −200° C., and toluene (occasionally called toluol) thermometers are useful from 150° to −80° C. These liquids, and for that matter, most organic liquids have an expansion coefficient many times larger than that of mercury, hence these so-called spirit thermometers are characterized by a large diameter of the capillary and superior visibility of the red-dyed column of liquid. The liquids are somewhat prone to separate in the column but the droplets are readily rejoined by tapping a side of the stem. Because these liquids all wet the glass, forming a deep meniscus, the top of the column is not as accurately observable as that of a mercury column. Also, during a decrease of temperature, the receding liquid leaves a thin film on the glass, which runs down slowly. While this distributed liquid is running down, the thermometer indicates too low a temperature. In spite of these disadvantages such thermometers are widely used, often in the same ranges as mercury-filled, particularly because of the ease of observing the large red column. Before sealing the top of these thermometers after filling the bulb and sufficient of the bore, the bulb is cooled with dry ice (solid CO_2) and the space above the liquid is left full of air, which materially reduces distillation into the space, and separation of the liquid column.

Fine annealing of the glass of thermometers to be filled with an organic liquid is not generally practised nor is it as essential as in the case of mercury, because of the relatively large expansion coefficient of such liquids and the consequent lesser effect of changes in the volume of the bulb. Also these thermometers are not intended to be read as closely as the mercury-filled.

Modern Dial Thermometers have great industrial importance rivalled only by mercury-in-glass, in point of numbers manufactured and used. They may be divided first into two classes, solid expansion and fluid expansion. The first class is of minor importance, mainly because the indicating dial or scale must be attached directly to the sensitive part and can not be connected by means of a long capillary tube as in the second class. One form of the first class combines a rod, generally of lower expansion, for example, carbon, invar or porcelain, within a tube of higher expansion, for example, brass. Tube and rod are interconnected within the head or case containing the circular scale through a mechanism including the rotating hand or pointer. In another form, a fine spiral of bimetallic ribbon is wound in three layers not touching each other, attached at one end to the closed end of a tube, and at the other end to a small shaft extending up the tube to the head. On this end of the shaft the pointer is directly attached, to rotate through a large fraction of a circle. The multilayered spiral is short, located at the end of the tube, and thus this thermometer is fairly rapid in response compared with the rod and tube form. This article will not include any treatment of the familiar bimetallic thermostat which is widely used in industry and in homes in the highly industrialized countries. The device is seldom used or calibrated as a thermometer.

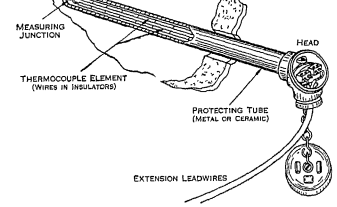
The second class or fluid expansion may be divided conveniently into three subclasses, liquid, liquid-vapour and gas. The usual liquid is mercury, again because of its long range of usefulness—from −40° to somewhat above 500° C. The major portion of the mercury is contained in a strong steel (sometimes stainless) bulb to which is welded a long steel capillary tube having a bore about .01 in. in diameter. The other end of the tube is welded to a Bourdon tube, sometimes called a pressure spring, also of steel, mounted in a case and attached through a mechanism to a rotating pointer. The entire closed system of bulb, tube and flattened pressure spring which has been wound into a spiral or helix, is filled with mercury (to the exclusion of any gas or low-boiling liquid) under a pressure of a few hundred pounds at room temperature. Higher temperatures increase this pressure so that it is maintained well above the vapour pressure of the mercury, while not exceeding the limited strength of the pressure spring, which is highly strained as the liquid expands. With a proper connecting mechanism, the scale of such a thermometer is very nearly uniform and the instrument is a widely accepted article of commerce. In its more highly developed form the expansion of the mercury in the tube and spring is compensated so that tubes up to 250 ft. or more in length can be used without material loss of accuracy. Two forms of compensating device are employed. One consists of a duplicate capillary tube, also containing mercury, and attached to a second pressure spring which opposes the main spring, and the other consists of a wire of nickel-steel threaded through the single tube. This wire is selected to have a negligible expansion (*e.g.* invar) and the space between it and the wall of the capillary bore is adjusted to vary with temperature in correspondence with the expansion of the mercury. A bimetallic spring can be used to separately compensate for the expansion of the liquid in the pressure spring. Such thermometers, especially with the connecting tube protected with an armour of flexible metal or rubber, successfully compete with electrical thermometers and are also made into recorders and automatic controllers of various forms. Organic liquids are occasionally substituted for mercury, but their higher expansions are offset by the primary necessity in any case of keeping the volume of the bore and spring small compared with that of the bulb. Furthermore, most of them have a range of the liquid state comparing favourably with that of mercury. One rather surprising characteristic of the mercury-filled thermometer described in this paragraph is that the bulb, filled with so heavy a liquid can be elevated far above the pressure spring without introducing serious errors. This is because the small error results in the main only from the distortion of the stiff walls of the bulb, which takes place with the change of pressure as the bulb is raised. The presence of a small amount of gas or water, for example, entrapped in the bulb would alter this favourable performance.

The gas-filled pressure spring thermometer has not been extensively used but its application to industrial needs at low temperatures is expected to grow as lower and lower temperatures are more generally employed in industry.

The liquid-vapour thermometer is generally described as a vapour-pressure thermometer. It is commonly used in the range from −30° to 250° C., but no single thermometer is useful for much more than a span of 150°, because this span extends only from the *critical temperature* to a few degrees below the *boiling point* of the liquid substance employed. The pressure in this thermometer corresponds with the temperature of the liquid-

vapour intersurface, hence correct indications are obtained only when this surface is within the bulb This requirement imposes peculiar limitations on the size of the bulb, the length of the capillary and the relation between their volumes, for it is evident that as the temperature of the bulb rises, for example, the volume of liquid decreases while the density of the vapour increases with rising pressure. This instrument has one unique advantage over liquid and gas thermometers in that no compensation for the temperature of the capillary is required. Its unique disadvantage lies in the sluggish action exhibited when the temperature of the bulb varies in the region of the temperatures along the capillary and pressure spring, a condition during which all of the liquid in the bulb may have to distill into the remaining space as the temperature of the bulb rises above that of the tube and spring, or on the other hand all of the liquid in the tube and spring distills into the bulb as the latter cools below the temperature of the rest of the system. Since the relation between temperature and the saturated vapour is not linear, but can be expressed approximately by a logarithmic relation, the scale of this thermometer is markedly nonuniform, with a crowding of divisions at lower temperatures. This peculiarity of the scale is met by suiting the range to the application so that temperatures are more often found near the upper limit where they can be easily read This statement applies to any of the many different substances used in these instruments, which are selected for their stability and temperature-pressure relation It is especially important in the use of these thermometers that they not be heated appreciably above the maximum temperature for which they are intended, because this is apt to strain the pressure spring permanently

Electrical Thermometry.—This is a rather loose expression and here is intended to include resistance and thermoelectric instruments; that is, in the first subdivison, "a thermometer in which the resistance of a definite part, the resistor, serves as a measure of temperature," and in the second subdivision, "a thermometer whose indications depend upon the e m f. of a thermocouple. It ordinarily consists of a thermocouple, connecting



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FIG 4.—INSTALLATION OF INDUSTRIAL FORM OF THERMOCOUPLE THROUGH FURNACE WALL SHOWN CUT AWAY. THE EXTENSION LEADWIRES ARE CONNECTED TO AN ELECTRICAL MEASURING INSTRUMENT, ORDINARILY READING TEMPERATURE (L & N CAT. N-33A, P. 6)

leads, and an instrument for measuring e.m.f." A thermocouple is "a pair of dissimilar electrically conducting materials joined together at one end, in which a difference in temperature of the junctions from that of the other ends generates an e.m.f."

The resistance thermometer affords the greatest precision of all forms of temperature measuring devices in ranges below 660° C., and in its finest constructions is widely used in scientific and industrial laboratories. On the other hand it is made in rugged and less expensive forms for use in measuring the temperatures of manufacturing processes, rotating machines, stationary structures, air and air-conditioning equipment, and a multitude of other applications where temperatures do not exceed about 150° C. (302° F). Most industrial forms employ a resistor of nickel wire, occasionally copper or platinum wire, wound in a helix or coil and protected in a sealed metal tube. The insulation on the wire was organic, as of practice in 1946, but it was expected that developments of new inorganic materials for insulation would bring thermometers on the market for use at higher temperatures These would use platinum in place of nickel in many cases because the latter undergoes a molecular transformation between 300° and 350° C., accompanied by troublesome changes in resistance with rising and falling temperatures; also it is not available in high purity, and can not well be annealed after winding in the form of insulated wire Platinum can readily be obtained with a purity better than 99 99%, and for industrial use thermometers made of such metal do not require annealing at a high temperature, to reproduce a standard resistance-temperature relation

Platinum resistance thermometers made up in strain-free form according to the teachings of T S Sligh, J A Beattie and C. H Meyers, and mounted in hermetically sealed pyrex glass tubes filled with clean dry air, nitrogen or helium for small lag, display an astonishing stability of resistance even at temperatures above 600° C Slow changes of resistance of a few parts per 1,000,000 can be detected, however, during long continued use, and proper corrections to a few parts in 10,000,000 are on occasion reliably applied. These thermometers have four leads usually made of gold wire, extending from the coil to the head. Short lengths (an inch or so) of platinum wire connect the gold to the resistor in order to reduce the heat conduction to the leads A convenient value of the resistance for most purposes is 25 5 ohms such that the variation is approximately 0 1 ohm per degree centigrade.

The expression $R_t = R_0(1+At+Bt^2)$ for the relation between resistance and temperature for platinum, as found above in the definition of the international temperature scale gives the same set of resistance-temperature values as the original Callendar formula:

$$t = \frac{R_t - R_0}{R_{100} - R_0}(100) + \delta\left(\frac{t}{100} - 1\right)\frac{t}{100}$$

both formulae being in the first power of R_t and the first and second power of t. The first expression above requires slightly less calculation, but the Callendar equation is still used in some laboratories The group at the Massachusetts Institute of Technology proposed the addition of the normal boiling point of mercury to the international temperature scale, because according to their own work a cubic equation is required to fit the experimental data with platinum resistance thermometers to the gas thermometer data, and this in turn requires the addition of the third fixed point above 0° C. This group adds the term in t^3 to the Callendar formula.

These formulae are empirical, set up to fit experimental data, and have no theoretical support; in fact, modern physical theories of atomic and crystalline structure and the conduction of electricity show that theoretical support will require a great deal of data not available on the conductivity of very pure metals free from strain and a tremendous amount of mathematical calculation. It is highly probable that the precise information on pure platinum will be used to support theory, rather than the reverse

Modern methods of measuring resistance are fundamentally the same as those described above in the paragraphs on precise thermometry. The Mueller bridge has been improved in convenience by including all the accessories in one case, including a thermostat and a dry-insulation box enclosing the resistor coils of larger values. The new gold-chromium alloy described by T. B. Godfrey in *Jour. Res.*, national bureau of standards (1939) provides a material having a coefficient so small that (according to E. F. Mueller) the resistances of the coils will not change by more than 1 or 2 parts in 1,000,000 within the ordinary range of room temperatures Resistors of this alloy can be made of very fine wire and are especially suited for standards of reference. It is problematical that they will replace thermostated manganin in the resistance measuring bridges. However, since an entire bridge can be rechecked by the user with a single reference standard,

this alloy will improve the reliability of measurements from many laboratories. A multitude of forms of indicating, recording and controlling instruments based on the Wheatstone bridge are found in industrial applications. In the better classes of these, three copper leads are always used between the resistor (thermometer) and the measuring instrument, because in many instances these leads may be hundreds of feet long For example, scores of such thermometers having nickel coils sealed in brass tubes, were permanently embedded far within the tremendous mass of concrete of Hoover dam, and again in the Bonneville and Grand Coulee dams These were connected with recording instruments to furnish information on the slow controlled cooling of the concrete masses Many modern manufacturing plants are widely scattered small units, particularly if hazardous substances are being made Here again if the temperatures employed are low, the resistance thermometer with long leads is being used successfully in competition with thermocouples and potentiometers It is also found in refrigerated ships for carrying fruits from tropical and semitropical countries. The thermometers and long leads extending into the far reaches of the ships' holds are entirely sealed in lead sheaths to protect them from the salt corrosion.

By 1946, thermocouples were very well known throughout industry not only for temperatures approaching a red heat where various forms of fluid expansion thermometers fail, but in a great many applications where the latter thermometer is inconvenient as to size or shape, and the capillary tube connection to metal bulbs would be excessively long. The thermocouples in common use are limited to those made of a relatively few combinations of metals and alloys which have been found to be suitable for the purpose. The required characteristics include: (1) a thermal e.m.f. large enough to be readily measured, (2) an e.m f increasing continuously with rising temperature over a considerable range, (3) freedom from significant change of e m f by changes of crystalline structure or other internal phenomena, (4) resistance to oxidation, corrosion or contamination, (5) homogeneity and reproducibility to fit an established standard relation between temperature and e.m f. The combinations that have been found to meet these requirements best are: (1) platinum with platinum—10% rhodium (also 13%), (2) copper with constantan, (3) iron with constantan and (4) chromel *P* with alumel. The combination of chromel *P* with constantan is occasionally used because of a relatively large e.m f Metals and alloys having high melting points such as molybdenum (2,625° C.) and tungsten (3,410°) but which are easily oxidized at a few hundred degrees are sometimes used successfully in an atmosphere of hydrogen above 2,000° C. The so-called rare-metal couples (No. 1 above) are useful from 0° to nearly 1,500° for extended exposures and occasionally to 1,700° or higher. Corresponding temperatures for copper-constantan are —200° to 350° (max. 1,000°), for iron-constantan are —200° to 750° (max 1,000°), for chromel-alumel are —200° to 1,200° (max. 1,350°). The nominal composition of constantan, which is also used in larger quantities for resistor wire, is 55% copper and 45% nickel. Chromel, identified as chromel *P* to distinguish it from electrical heating wire, has retained its original composition of 90% nickel with 10% chromium, but alumel is 95% nickel with aluminum, silicon and manganese added.

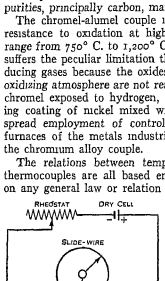
The platinum, platinum-rhodium thermocouple invented by Le Chatelier is noted for its extreme stability and freedom from internal changes, its use as the primary device for reproduction of the international temperature scale in the range 660° C. to 1,063° C.; it is noted also, as the most suitable transfer device in researches with gas thermometers, and in the kilns and tanks of the ceramic and glass industries Here it is always used carefully protected in a refractory porcelain insulator and tube. It is most interesting to observe that the metals of which this couple is made have a purity of the highest order, spectroscopic analysis revealing scarcely the slightest trace of impurity This cannot be said of any of the other metals employed for thermocouples although the copper generally used is so pure as to require the spectroscope to detect slight traces of iron and silicon perhaps and dissolved oxygen. While platinum of the purity found in resistance thermometer and thermocouple wire is the primary thermoelectric reference standard, the best grade of commercial copper wire makes an excellent standard which can be relied upon to a few microvolts for a 200 centigrade degree interval.

The copper-constantan thermocouple is noted for its well-established temperature e.m.f. relation from about —260° C to 350° C., its low cost, and the not inconsiderable adaptability to the use of long extension leads of the same composition and relatively low resistance. Also, as compared with iron, copper oxidizes very slowly at ordinary temperatures at which iron must be protected from rusting

The iron-constantan couple is the most widely used of any in industrial applications because it is inexpensive and has a useful range well above that of copper. The iron is selected not for its high purity but for its reproduction of established standard tables of temperature versus e.m.f. This iron has about 0 1% of impurities, principally carbon, manganese, silicon and oxygen.

The chromel-alumel couple is well known for its outstanding resistance to oxidation at high temperatures, especially in the range from 750° C. to 1,200° C., where it is most often used It suffers the peculiar limitation that it must not be exposed to reducing gases because the oxides of chromium which form in an oxidizing atmosphere are not readily reducible, such that oxidized chromel exposed to hydrogen, for example, develops a conducting coating of nickel mixed with chromium oxides The widespread employment of controlled atmospheres in heat-treating furnaces of the metals industries accentuates this limitation on the chromium alloy couple.

The relations between temperatures and e m f. for various thermocouples are all based entirely on experimental data, not on any general law or relation of theoretical physics. In a simple thermoelectric circuit of two metals joined into a closed loop, there are, supposedly four sources of e.m f., one at each junction and one in each leg of the couple where it passes through the temperature gradient. J. C. A. Peltier discovered in 1834 that when an electric current is passed through the junction of two dissimilar metals the junction is heated or cooled depending on the direction of flow. This means that an e m f exists at the junction. Applying the second law of thermodynamics, in 1851, W Thomson (later Lord Kelvin) showed that if only the Peltier e m.f. supplied the Seebeck current, the relation between temperature and e m f. should be linear. This was known experimentally not to be the case, so Thomson concluded that there must be another source of e.m f. In 1854, he showed that when an electric current flows in a homogeneous conductor through a temperature gradient, in general a transference of heat takes place along the conductor depending on the relative directions of current and gradient, and the material or substance (metal). This strongly implies the existence of an e.m f developed along the conductor, and this is called the Thomson e m f. It has never been separately detected or measured in a manner generally acceptable as conclusive, although it is conceded that the existence is reasonable. Thomson's reasoning leads to the conclusion that an e m f. is developed along the conductor, and all experimental data show that this is independent of the form of the temperature gradient, and depends only on the temperatures of the junctions. Thus it is reasonable to conclude further that in the use of a thermocouple the reality of the Thomson e.m f. is inconsequential, since the total e m f which is all that can be measured directly, is dependent only on the temperatures of the junctions.



BY COURTESY OF LEEDS AND NORTHRUP CO.
FIG 5.—A SIMPLIFIED DIAGRAM OF THE ELECTRICAL CIRCUIT OF A POTENTIOMETER FOR USE WITH A THERMOCOUPLE (L & N CAT. N33A, P 13)

This statement does not apply to an inhomogeneous thermocouple.

Analytical expressions have been set up for the platinum, platinum-10% rhodium thermocouple and the copper-constantan couple but these are applicable over limited ranges For example, the expression $E=a+bt+ct^2$ is used in the specifications for reproducing the international temperature scale between 660° C. and 1,063° C. with the former couple, and Adams used the equation $E=at+b\ (t-e^{-t})$ between 0° C and 350° C for the latter couple Adams used the same form of equation with different constants for the range 0° to −218° C. The expressions are primarily useful for the calculation and construction of tables for reference, from which deviation curves or tables can be constructed for particular calibrated couples. The temperature-e.m.f. tables for iron-constantan and chromel-alumel couples reveal that no expression as simple as those given above would suffice even as a rough approximation.

The calibration of thermocouples can be accomplished by many methods depending upon the accuracy desired, the range of temperature, the type of couple and the means available. It is apparent from the definition of the international temperature scale, that if a couple is expected to furnish accurate measurements agreeing with this scale, it must be compared with a platinum resistance thermometer from −190° to 660° C., with a platinum, platinum-10% rhodium couple from 660° to 1,063° C. and with a proper optical pyrometer above 1,063° C. The most accurate calibrations are made in a stirred liquid bath by direct comparison with a resistance thermometer from −190° to about 350° C., and from this temperature to 660° C. by testing at established freezing points of pure substances. Between 660° and 1,063° C. direct comparison with a standard platinum couple is preferred, and this method and direct comparison with an optical pyrometer are both used above the latter temperature, the comparison with the couple being the more convenient up to about 1,450° C. Excellent calibrations are also obtained by testing at fixed points below 350° C. In all cases the data should be reduced to deviations from the standard tables of temperature versus e.m.f. identified with the couple undergoing calibration. The electrical instruments (potentiometer and galvanometer) needed are determined by the thermoelectric powers of the various couples For example, copper-constantan has a thermoelectric power of 17 microvolts (1 microvolt = 10⁻⁶ volt) at −190° C., increasing to 32 at 0° C and 60 microvolts at 350° C. The standard platinum-10% rhodium couple gives only 5·5 microvolts at 0° increasing to 10 at 500° and to 12 at 1,200° C Iron-constantan gives 25 microvolts at −190° increasing to 52 at 0°, 56 at 500° and 60 at 1,000° C. Chromel-alumel gives 40 microvolts at 0°, increasing to 43 at 500°, and decreasing to 36 at 1,200° C. The range of the potentiometer need not exceed 60 millivolts (0·06 volt) but an accuracy of a small fraction of 1 microvolt may be needed.

Modern electrical instruments for use with thermocouples can be classified as millivoltmeters and potentiometers or as precision instruments for the laboratory and industrial instruments, or as indicators, recorders and recorder-controllers. There is an intermediate class of semiprecision portable potentiometers for general use These and the industrial potentiometers are all built around the so-called slide-wire, that is, a resistor with sliding contact, while the precision potentiometers have three or more dial switches for connecting between fixed resistors, after the manner of the precision bridge. The art of manufacturing potentiometers of many forms is highly developed and, in the classes for industrial applications, has been making extensive use of photoelectric and electronic devices for rapid recording and better controlling The developments from many other arts have been incorporated, particularly from electronics, also small motors, mass production of small parts and the vast array of new materials of construction, the light alloys and stainless steels, the synthetic moulding materials and other plastics for insulation. In a few directions, practice has become standardized to some extent. Industrial instruments are provided with automatic reference-junction compensation, employing the bimetallic spring in millivoltmeters, and the Wunsch branch circuit with its nickel or copper compensating resistor in potentiometers. Laboratory instruments are more often designed for immersion of the reference junctions in an ice bath, because of the greater accuracy intended Recording potentiometers have almost completely removed recording millivoltmeters from the industrial scene and were themselves showing, in 1946, a strong trend toward two divisions of general form—the single point recorder with a circular chart for one day's record, and the multiple point recorder with a 10-day roll-chart having rectangular co-ordinates On the other hand it appears that many kinds of recording potentiometers will remain available: the mechanically balanced with a galvanometer having a boom or pointer, the electronically balanced in which the thermoelectric current is chopped and amplified to drive a reversible motor, and the photoelectric-electronically balanced with a reflecting galvanometer, photo tube and amplifier. Industry is demanding and getting instruments of extraordinary precision considering the severe requirements for ruggedness and reliability Industrial recording to 1° F. is not uncommon, and automatic control of some processes to ½° or even 0.1° has been attained

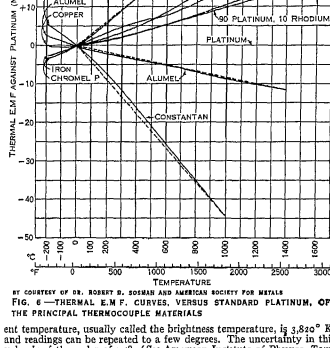
Modern Optical Pyrometry consists for the most part of that of the disappearing-filament pyrometer, because this has been found to afford the greatest precision and accuracy for research work and in addition the greatest convenience for practical applications. The form of the precision instrument found at the national bureau of standards remains that developed by Fairchild and Hoover, and duplicates or similar instruments are found in many other laboratories including some of the national laboratories The principal commercial form is that made by the Leeds and Northrup company in the United States, the optics of this instrument being similar to that of the laboratory type. It is equipped, however, as a portable instrument, with a unique type of slide-wire potentiometer, designed for rapid use. The specially constructed lamps used in these instruments are highly evacuated so that the tungsten filament of wire or ribbon form will withstand heating to 1,500° or 1,600° C. for hundreds of hours without serious change. While gas filling would reduce the rate of evaporation of tungsten from the surface of the filament, it would render the lamp subject to changes in ambient temperature, and introduce great lag in its response to adjustments in the heating current. Fairly high temperatures can be measured without heating the lamp much above 1,400° C. by the use of properly selected absorption screens, under which circumstance, the lamp will retain its original calibration remarkably well for many years

Such pyrometers, which are extensively used, are calibrated at the national laboratories, either by comparison with the standard instrument or by sighting them on large tungsten-strip lamps which have been calibrated for the particular purpose at the national laboratory. Primary calibrations below the gold point, in the range of the international temperature scale defined by the platinum couple, are made by sighting the instruments into black body tubes immersed in freezing metals. Supplementing these points are measurements on a black body furnace held at a fixed temperature such as the melting point of gold or palladium, with a calibrated screen interposed. This screen may be either a sectored rotating disk, whose open sector has been mechanically measured on a circular dividing engine, or an absorbing coloured glass whose transmission has been measured by comparison with a sectored disk or with the mirror system. Fixed points Primary calibrations above the gold point are of course all based upon this one point (1,063° C) and the constant c_2 in the Wien equation, but both the methods described for use below this point are used in the higher range in order to determine the relation between temperature and lamp current at reasonably small intervals of about 200° C. A complete table of temperature-current values is tediously built up by smoothing the deviations from a reference table or curve based on an equation such as $i(current)=a+bt+ct^3+dt^5$, the four constants of which are determined from four selected calibration points. These may be 660°(m.p. of Al), or 778°(Cu-Ag eutectic), 960.5°(Ag), 1,063°(Au) or 1,083°(Cu), and 1,554.5°(Pd). The interval from the copper point to the palladium point is so large that it is preferable to establish at least two points in between by the use of sectored disks or absorption screens to step down from the upper point. The most accurate measurements above the gold point are obtained by keeping the pyrometer lamp at a current value nearly corresponding with that determined for the gold point, and choosing an absorption device to nearly fit the extrapolation desired, for example, from gold to the platinum point (1,773.5° C) However, for much higher temperatures the pyrometer lamp has to be raised toward the palladium point in order to make use of screens of accurately measurable transmission

The equations employed in the calculations of temperatures measured with absorption screens or sector disks are derived from Wien's law. $J(\lambda,\theta)=c_1\lambda^{-5}e^{-c_2/\lambda\theta}$, where λ denotes the wave length in cm., θ the absolute temperature of a black body, $J(\lambda,\theta)$ the intensity in the wave band $\lambda-d\lambda$, c_2 a constant=1.432 cm. degrees and c_1 a constant the value of which has no significance in pyrometry since it disappears in working equations. The primary working equation is found as follows. If J_1 is the intensity of radiation at θ_1, J_2 that at θ_2 and R is the ratio of J_2 to J_1, then $\log R=\frac{c_2}{\lambda}\log_e\left(\frac{1}{\theta_1}-\frac{1}{\theta_2}\right)$.

The wave length λ in the last equation is usually written λ_e to signify the mean effective wave length for the interval θ_1 to θ_2, taking into account the transmission of the red glass filter and the luminosity function of the observer's eye. While the constant c_2 is assigned the value 1.432 cm degrees in the definition of the international temperature scale, Wensel, *Jour. of Res*, 22, p. 375 (1939) concludes that the best value (also consistent with the best values of related physical constants) is 1.436±.001. Using this value instead of 1.432 in the calculations of temperatures above the gold point would lower them by 2° at the melting point of palladium (1,554 to 1,552° C.), m.p. of platinum from 1,773 to 1,770 and of tungsten from 3,410° ±20 to 3,395°±20. The use of Wien's law, instead of that of

Planck in which — 1 is added to the denominator, introduces a small recognized error amounting to only about 1° at 3,000° K when red light is used. The error at very high temperatures is large, reaching 15° at 5,000 and 45° at 6,000° K. Such high temperatures are readily measured with the disappearing-filament pyrometer without overheating the pyrometer lamp simply by using two absorbing screens or one combined with a sector disk. Another most interesting fixed point for high-temperature work is that of the positive crater of the carbon arc. Using a properly operated electric arc and a positive electrode of purest carbon (readily obtainable for spectroscopic work) the apparent temperature, usually called the brightness temperature, is 3,820° K and readings can be repeated to a few degrees. The uncertainty in this value is of the order of 15°. (See American Institute of Physics, *Temperature, Its Measurement and Control in Science and Industry*, p. 1148 [1941].)



BY COURTESY OF DR. ROBERT B. SOSMAN AND AMERICAN SOCIETY FOR METALS

FIG. 6.—THERMAL E.M.F. CURVES, VERSUS STANDARD PLATINUM, OF THE PRINCIPAL THERMOCOUPLE MATERIALS

In the practical application of the above optical pyrometer, in many cases black body conditions are not met and cannot be achieved. Here corrections can be made for the emissivity of the incandescent object such as a stream or crucible of molten metal, a tungsten filament of an electric lamp, or the hot cathode of an electronic tube. Many values are known and published, one extensive list being furnished by A. G. Worthing (See *Temperature, Its Measurement and Control in Science and Industry*, p. 1164) in an authoritative article which includes a thorough discussion of the theories of emission.

Limited success had been attained by 1946 in the employment of photoelectric devices to take the place of the optical pyrometer. These were generally useless below 1,000° C. because of the low sensitivity to infra-red radiation and do not compare favourably with the tungsten lamp in stability during extended use. Many different forms of so-called colour pyrometers have been invented from time to time. In these intriguing instruments the intensities of radiation of two bands of wave lengths are compared and interpreted by calibration, as corresponding to some temperature. Some designs have been highly commendatory for their simplicity, but by 1946 none had met marked acceptance. The photoelectric devices were more promising and afforded a potential means for automatic recording especially at high speeds as required, for example, in the modern hot-rolling mills for the manufacture of steel products.

Modern Radiation Pyrometry.—This is pyrometry in which heat radiation of all wave lengths is used as a measure of temperature, is generally confined to the field of industrial applications and is seldom employed in research work. Relatively useful designs have been perfected for the ceramic and steel industries but they lack the amazing precision of the optical pyrometer, and are generally set up to remain in a fixed position where they can be checked with an optical instrument and *in situ* corrections be determined. These pyrometers are constructed of a receiver of heat radiation consisting of a thermocouple junction or small group of junctions, mounted in a housing which can be water-cooled if necessary, and in which reference junctions of the couples are so disposed as to give the least errors from variations in the temperature of the whole receiver. Such instruments are especially valuable in those applications where recorded temperatures are essential, and where immersed thermocouples cannot withstand the heat, or corrosive vapours or gases. The practice of attaching the receiver of these instruments to the open end of a tube which is closed at the other end and inserted into a furnace has promoted the successful application of these instruments because it not only protects the receiver from flame and smoke but also permits sighting it through an atmosphere free from carbon dioxide and water vapour, gases which are not transparent to infra-red radiation. The thermal lag that is introduced by the thick-walled tube is not a deterrent to this practice where the lag of the furnace itself is large.

Attempts to design a radiation pyrometer in which the radiation from a standard source is compared with that from the source to be measured had not been notably successful up to 1946. Victory in this direction would solve the major difficulty of radiation pyrometry in which the total radiation received must always give the same response of the receiver, which means in turn that the heat lost from the receiver with a particular value of the incident radiation must always be the same. An attempt to improve the characteristics of practical radiation pyrometers is that of T. R. Harrison and W. H. Wannamaker who described their analysis of the problem and its solution in the 1939 temperature symposium. We are not concerned here with the measurement of heat radiation for purposes other than the estimation of the temperature of the source.

Special Methods and Devices for the measurement of temperatures are legion, but few have remained in use long after their faults have been discovered. The outstanding instance of a special device which has been in use consistently for more than half a century is the pyrometric cone mentioned in an early paragraph of this article. This has proved to be perhaps the most useful tool of the ceramic industries. It serves as an auxiliary temperature indicator which is inexpensive and can be placed in all parts of a kiln so that uniform conditions can be attained. The characteristics of a complete set of these cones were exhaustively investigated by C. O. Fairchild and M. F. Peters, *Jour Am. Cer. Soc.* (1926). Other devices such as fusible salts and eutectic alloys have found occasional acceptance and are generally available. Any thermal property of a material can be regarded as a means for measuring temperature, such as variation of the velocity of sound with temperature, or the variation of magnetic permeability, or of elastic modulus. Special methods and techniques for measuring flame temperatures have been eminently successful, including the use of thermocouples, the spectroscopic line-reversal method in which the flame is coloured with metallic vapours and optical methods applied to soot-forming luminous flames. The temperatures of incandescent gases can also be deduced from measurements of either band- or line-spectra. Where the measurement of temperature is incidental to the primary purpose of measuring something else, reference should be made to the major topic. Also, reference may be made to many of the sciences in which temperature is particularly significant, such as meteorology, biology, geophysics and astronomy, heating and power, refrigeration, ceramic and metals industries and the thermal processes of the food, oil and chemical industries.

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THERMOPYLAE, a Greek pass leading from Locris into Thessaly between Mount Oeta and the Maliac Gulf; chiefly famous for the heroic defense by the Spartan king, Leonidas, with 300 soldiers against the Persian army of Xerxes advancing upon Greece in 480. (See LEONIDAS.) Two other battles here are famous. In 279 B.C. Brennus and the Gauls were checked for several months by a Greek army under the Athenian Calippus; and in 191 Antiochus of Syria vainly attempted to hold the pass against the Romans under M'. Acilius Glabrio. In the time of Leonidas the pass was a narrow track (probably about 14 yd. wide) under the cliff. In modern times the deposits of the Spercheius have widened it to a breadth of 1½ to 3 mi. broad. The hot springs from which the pass derived its name still exist close to the foot of the hill. There is one large spring used as a bath and four smaller ones, and the water, which is of a bluish green colour and contains lime, salt, carbonic acid and sulphur, is said to produce good effects in scrofula, sciatica and rheumatism.

See G. B. Grundy, *Great Persian War*, pp. 277–291 (1901).

THERMOSTAT. A device to regulate automatically the temperature produced by a heating apparatus; in some cases to maintain the temperature at a definite degree While thermostats differ greatly in detail, their principle is always the same, they take advantage of the expansion produced by heat to control the source of heat They can be applied to boilers or heating apparatus of all sorts, whether fired by solid or gaseous fuel, or by electricity

Thermostats may be summarized under two principal headings:

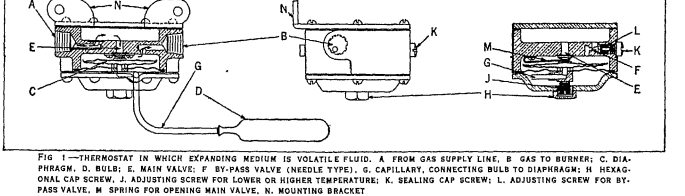


FIG 1.—THERMOSTAT IN WHICH EXPANDING MEDIUM IS VOLATILE FLUID. A FROM GAS SUPPLY LINE, B GAS TO BURNER; C, DIAPHRAGM, D, BULB; E, MAIN VALVE; F BY-PASS VALVE (NEEDLE TYPE), G, CAPILLARY, CONNECTING BULB TO DIAPHRAGM; H HEXAGONAL CAP SCREW, J, ADJUSTING SCREW FOR LOWER OR HIGHER TEMPERATURE; K, SEALING CAP SCREW; L, ADJUSTING SCREW FOR BY-PASS VALVE, M SPRING FOR OPENING MAIN VALVE, N, MOUNTING BRACKET

(1) those in which the expanding medium is fluid and (2) those in which the sensitive part is metallic

In either form, expansion or contraction with change of temperature affects fuel consumption and the production of heat

In gas-fired hot water apparatus, in which a thermostat is commonly used, the regulators are worked by a capsule, containing volatile fluid, placed in close proximity to the water being heated, as the temperature rises the fluid expands and reduces the size of the passage through which the gas is conveyed to the burners. Figure 1 shows a section through such a thermostat. A small orifice or by-pass is generally provided, around the main gas passage, to maintain a small gas flame whatever condition prevails in the main passage. This prevents the gas from being entirely extinguished *See* also REGULATION, AUTOMATIC.

The rod thermostat is another form of thermostat often used in gas apparatus. It is of very simple construction. As the temperature rises the tube enclosing the rod lengthens, thereby drawing the rod outward and reducing the gas-way.

When either form of thermostat is used, the process is reversed when water is drawn off. Upon cold water entering the apparatus the contraction of the thermostat allows more gas to pass, so that the temperature again rises. (*See* REGULATION, AUTOMATIC.)

THÉROIGNE DE MERICOURT, ANNE JOSÈPHE (1762–1817), a Frenchwoman who was a striking figure in the Revolution, was born at Marcourt (from a corruption of which name she took her usual designation), Luxembourg, on Aug. 13, 1762. She was the daughter of a farmer, Peter Théroigne. She was educated in the convent of Robermont. She was quick-witted, handsome, passionate in temper and had a vigorous eloquence, which she used with great effect upon the mobs of Paris during the few years of her life (1789–93) which are of historical interest. She left her home because of a quarrel with her stepmother. As a courtesan she visited London (1782), and Genoa as a singer (1788) In Paris on the outbreak of the Revolution, she was surrounded by a coterie of well-known men, chief of whom were Jerôme Pétion de Villeneuve and Camille Desmoulins.

She was again in Paris in Jan. 1792, where she often spoke in the clubs. Even in the national assembly she would violently interrupt the expression of moderatist views. Known as "la belle Liégoise," she wore a riding habit, a plume in her hat, a pistol in her belt and a sword at her side, and excited the mob by violent harangues. Associated with the Girondists and the enemies of Maximilien Robespierre, she became in fact the "Fury of the Gironde." She commanded in person the 3rd corps of the so-called army of the faubourgs on June 20, 1792, and shares a heavy responsibility for the riots of Aug. 10. She took no part in the September massacres, and, moderating her conduct, became less popular from 1793 Toward the end of May the Jacobin women seized her, stripped her naked and flogged her in the public garden of the Tuileries The following year she became mad; she died at La Salpetrière on June 9, 1817

See E and J. de Goncourt, *Portraits intimes du XVIIIe siècle* (2 vols., 1857–58); M Pellet, *Etude historique et biographique sur Théroigne de Méricourt* (1886); L. Lacour, *Les Origines du féminisme contemporain. Trois femmes de la Révolution* (1900); Vicomte de Reiset, *La Vraie Théroigne de Méricourt* (1904), and the play *Théroigne de Méricourt* of M. Paul Hervieu, produced at the Théâtre Sarah Bernhardt in 1902.

THERSITES, the ugliest man in the Greek camp before Troy, a railing demagogue (*see* Homer, *Iliad* ii, 212), was a relative of Diomedes (*q.v.*).

THESEUS was the great hero of Attic legends and the son of Aegeus, king of Athens, and Aethra, daughter of Pittheus, king of Troezen, or of Poseidon and Aethra The legend relates that Aegeus, being childless, went to Pittheus, who contrived that Aegeus should have intercourse with Aethra, who in due time brought forth Theseus. On reaching manhood Theseus was sent by his mother to Athens. He encountered many adventures on the way First he met and slew Periphetes, surnamed Corynetes (Clubman). At the isthmus of Corinth dwelt Sinis, called the Pine Bender, because he killed his victims by tearing them asunder between two pine trees Theseus hoisted the Pine Bender on his own pine tree Next Theseus despatched the Crommyonian sow (or boar). Then over a cliff he flung the wicked Sciron, who used to kick his guests into the sea, while perforce they washed his feet. In Eleusis Theseus wrestled with Cercyon and killed him. Later he slew Procrustes, who fitted all comers to his only bed by lopping or racking them to the right length. He found his father married to Medea, who had fled from Corinth. Being a witch, she knew Theseus before his father did, and tried to persuade Aegeus to poison his son; but Aegeus recognized him Theseus was now declared heir to the throne, and the Pallantids[1], who had hoped to succeed the childless king, conspired against him, but he crushed the conspiracy He then attacked the fire-breathing bull of Marathon and brought it alive to Athens, where he sacrificed it to Apollo Delphinius. Next came the adventure of the Cretan Minotaur (*q.v.*).

While Theseus was on his way to Crete, Minos, wishing to see whether Theseus was really the son of Poseidon, flung his ring into the sea. Theseus dived and brought it up, together with a golden crown, the gift of Amphitrite. He landed on the return voyage at Delos, and there he and his comrades danced the crane dance, whose complicated movements were meant to imitate the windings of the Labyrinth. In historical times, this dance was still danced by the Delians round the Altar of Horns. Theseus had promised Aegeus that, if he returned successful, the black sail with which the fatal ship always put to sea should be exchanged for a white one. But he forgot his promise; and when Aegeus, from the Acropolis at Athens, descried the black sail out at sea,

[1]The sons of Pallas, the brother of Aegeus. Aegeus and Poseidon are quite possibly one and the same

he flung himself from the rock and died Hence, at the festival which commemorated the return of Theseus there was always weeping and lamentation Theseus now carried out the union of the various Attic communities into a single State He extended the territory of Attica to the isthmus of Corinth

He transformed the Isthmian ceremony in honour of Melicertes by adding games in honour of Poseidon. Alone, or with Heracles, he captured the Amazon princess Antiope Thereafter



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THESEUS (ON RIGHT) AND PEIRITHOUS RESCUING LAODAMEIA (HIPPODAMEIA) FROM VIOLATION BY THE CENTAURS. FROM A GREEK VASE FOUND AT ANZI (BASILICATA) NOW IN THE BRITISH MUSEUM

the Amazons attacked Athens. Antiope fell fighting on the side of Theseus. By her he had a son, Hippolytus (*q v*). Theseus is also said to have taken part in the Argonautic expedition and the Calydonian boar-hunt He compelled the Thebans to give up the unburied bodies of the Seven (*see* OEDIPUS).

The famous friendship between Theseus and Peirithous, king of the Lapiths, originated when Perithous heard of the strength and courage of Theseus, and desired to put them to the test. Accordingly, he drove away from Marathon some cows which belonged to Theseus. The latter pursued, but when he came up with the robber the two heroes were so filled with admiration of each other that they swore brotherhood At the marriage of Peirithous, a fight broke out between the Lapiths and Centaurs (*q v*). Theseus and Peirithous now carried off Helen (*q v*) He now descended to the lower world with Peirithous, to help his friend to carry off Persephone But the two were caught and confined in Hades till Heracles came and released Theseus. When Theseus returned to Athens, he found that a sedition had been stirred up by Menestheus, a descendant of Erechtheus, one of the old kings of Athens Failing to quell the outbreak, Theseus in despair sent his children to Euboea, and after solemnly cursing the Athenians sailed away to the island of Scyros, where he had ancestral estates. But Lycomedes, king of Scyros, took him up to a high place, and killed him by casting him into the sea His ghost was said to have appeared in the Athenian ranks at Marathon. When the Persian war was over, the Delphic oracle bade the Athenians fetch the bones of Theseus from Scyros and lay them in Attic earth. This was done, in 469, by Cimon. His chief festival, called Theseia, was on the 8th of the month Pyanepsion (Oct. 21), but the 8th day of every month was sacred to him.

The well-preserved Doric temple to the north of the Acropolis at Athens, commonly known as the Theseum, is certainly not his shrine. There were several (according to Philochorus, four) temples or shrines of Theseus at Athens

See (a) of ancient works, especially Plutarch's *Theseus*, (b) of modern works, L. Preller, ed. C Robert, *Gr. Mythologie*, ii p. 676 ff. (4 vol., 1887–94); L. R. Farnell, *Hero-Cults*, p. 337 ff. (1921); Stending in Roscher's *Lexikon*, *s.v.* (good bibliography) also O. Gruppe, *Griechische Mythologie*, i pp. 582–608 (Munich, 1898).

THESMOPHORIA. A very ancient festival, celebrated by women in many parts of the Greek world (as Attica, many places in the Peloponnesos, Boeotia, several islands, the coast of Asia Minor, Cyrene, Italy and Sicily, but not generally among the Dorians) in honour of Demeter *Thesmophoros*, which does not mean, as the ancients usually supposed, *legifera Ceres* (Virg., *Aen.*, iv. 57), since the festival can in no way be connected with the bringing or establishing of laws or customs (*θεσμοί*). It is possibly "bringer of treasure or wealth," an obsolete sense of *θεσμός*, of which a few traces remain; or perhaps better (Frazer, *Enc. Brit.* 9th ed; Nilsson, *Griech Fest*, p 324), the name Thesmophoria is the primary one, from which the epithet of the goddess is derived, and it means "the carrying of things laid down," the radical meaning of *θεσμός*, referring to the curious fertility-charms described below.

As no men were admitted to the rites, and in any case they were largely secret (for the reasons *see* MYSTERY), we have nothing like a full description (but *see* H. J. Rose, *Primitive Culture in Greece*, 1925).

The celebrants were women who seem to have been at least generally married, and who must be free. They observed chastity for some days (nine, according to Ovid, a likely number considering its magical connotations), and abstained from certain foods; thus, they must not eat pomegranate-seeds The festival lasted three days, although in Attica it was lengthened by the addition of other celebrations of a similar character, the Stenia and the Halamusian Thesmophoria, making five days in all, Pyanopsion 10–14 But the original days were Pyanopsion 12–14 only, *i.e.*, about the beginning of October, and shortly after the Pyanopsia (*see* PYANEPSIA). The days were called respectively *Anodos* (or *Kathodos*), *Nesteia*, *Kalligeneia*. *Anodos* (ascent) is often taken to mean the "going up" of the women to the Thesmophorion, or precinct of Demeter, but this does not explain why the day should also be called *Kathodos*, or descent As the name of the second day, which signifies "fasting," describes what the celebrants then did, it is plausible to take the first day as having been called Ascent and Descent, and to connect it with the rite known to have been performed at some time in the festival. Pigs were thrown into an underground chamber, called a *megaron;* they were probably alive, but the text (Clement of Alexandria, *Protrept.*, p 14 Pott) is corrupt and uncertain. At all events they were left there until such parts of them as were not eaten by the guardian snakes of these underground sanctuaries had had time to rot. The remains were then brought up by certain women who had observed chastity for three days and were called *ἀντλήριαι* or drawers up—the verb *ἀντλεῖν* means to pump or draw off water, and it is strange that its cognate noun should be used in this way. These women also carried, or some of the celebrants did, certain well-known symbols of fertility, including pine-cones and "figures made of flour of wheat, in imitation of the shapes of serpents and of men" The remains of the pigs were laid on an altar, and if taken and mixed with seed were believed to ensure a good crop Apparently the figures, like the pigs, were thrown into the chasms; but our authority here (a scholiast on Lucian, first published by Usener in *Rheinisches Museum*, xxv. p. 548) is both confused and manifestly corrupt; he seems to be confusing the Thesmophoria with a quite different festival, the Arrhephoria. If, however, pigs, pine-cones, figures and all were thrown into the *megara* and "pumped" out again, it is very intelligible magic. These objects are all, in their nature, connected with fertility—a fertile beast, a seed-vessel, a preparation of grain shaped like a creature supposed to be full of earth-magic (the serpent) and like a man, perhaps a phallic figure They are then put into a holy place, left there to acquire additional *mana* from the sacred surroundings and the touch of the sacred serpents, real or imaginary, who live there, and finally taken out again by pure agents, whose chastity has, so to speak, insulated them Finally, they are laid on a holy altar, whence they are taken, heavily charged now with potency, and used to bring the blessing of fertility. To mix all manner of magical things with seeds to make them sprout better is a widespread savage custom; the Khonds, for instance, bury the flesh or ashes of a human victim (*meriah*) in their fields, or did so until the British Government stopped their horrible practices.

The ancients tried to explain all these matters as commemorations of the abduction of Kore; but it is rather the legends which have grown out of the ritual, now no longer understood. In modern times it has been found possible to conjecture a reason for them; but it is to be remembered that, owing to the fragmentary state of our knowledge, the above is offered as a conjecture only, especially as regards the date of the rite.

The *Nesteia* is easily enough explained; we know that the

women fasted, sitting upon the ground. Fasting is a common piece of agricultural magic, and contact with the ground is also common; for a Greek parallel we may refer to the ancient Dodonaean priesthood of the *Selloi*, who slept on the earth (Homer, *Il.*, xvi. 235). The third day, *Kallogeneia*, is "the fair birth." We need not take it as originally referring to anyone so definite as Kore; it rather indicates the happy issue of all this magic, and doubtless of much more which we do not know, in the fertility of the ground and doubtless of men and beasts as well. It remains only to add that the Thesmophoria, or at least a great part of it, was carried out at night by torchlight, and that it was accompanied by ceremonial coarse abuse (*αἰσχρολογία*) between the women; again a common means of promoting fertility.

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(H. J. R.)

THESPIAE, an ancient Greek city of Boeotia, on level ground commanded by the low eastward spurs of Mount Helicon. The deity most worshipped at Thespiae was Eros, whose primitive image was an unwrought stone. The town contained many works of art, among them the Eros of Praxiteles, dedicated by Phryne in her native place, one of the most famous statues in the ancient world. It was carried off to Rome by Caligula, restored by Claudius, and again carried off by Nero. There was also a bronze statue of Eros by Lysippus. The Thespians also worshipped the Muses, and celebrated a festival in their honour in the sacred grove on Mount Helicon. Remains of the ancient citadel are still to be seen, solidly and regularly built. To E. and S. foundations bear witness to the extent of the ancient city. The neighbouring village Eremokastro, on higher ground, was thought by Ulrichs to be probably the site of ancient Ceressus. In 1882 there were discovered, about 1,900 yd. east of Eremokastro, on the road to Arkopodi (Leuctra), the remains of a tomb of the 5th century B.C., with a colossal stone lion, probably that of the Thespians who fell at Plataea.

History.—Thespiae figures chiefly as an enemy of Thebes, whose centralizing policy it had all the more to fear because of the proximity of the towns. During the Persian invasion of 480 B.C. it stood almost alone among Boeotian cities in serving the national cause. Seven hundred Thespians accompanied Leonidas to Thermopylae and of their own free will shared his fate. The remaining inhabitants, though their city was burnt by Xerxes, furnished 1,800 men to the Greek army at Plataea. In 424 B.C. the Thespian contingent at Delium sustained heavy losses, and in the next year the Thebans took advantage of this to accuse Thespiae of friendship towards Athens and to dismantle its walls. In 414 they interfered again to suppress a democratic rising. In the Corinthian war Thespiae sided with Sparta, and between 379 and 372 repeatedly served the Spartans as a base against Thebes. In the latter year they were reduced by the Thebans and compelled to send a contingent to Leuctra (371). It was probably shortly after this battle that the Thebans destroyed Thespiae and drove its people into exile. Later the town was rebuilt and in 171 B.C., true to its policy of opposing Thebes, sought the friendship of Rome.

BIBLIOGRAPHY.—*See* Herodotus, v. 79, vii. 132–ix. 30; Thucydides, iv. 93, 133, vi. 95; Xenophon, *Hellenica*, iv., vi.; Pausanias, ix. 23, 8–24, 2, 26–27; Strabo, ix. pp. 409–10.

THESPIS, Greek poet, of Icaria, in Attica (6th cent. B.C.), generally considered the inventor of tragedy, flourished in the time of Peisistratidae. According to Diogenes Laertius (iii. 56), he introduced for the first time in the old dithyrambic choruses a person distinct from the chorus, who conversed with the leader, and was hence called *ὑποκριτής* ("answerer"). His claim to be regarded as the inventor of tragedy in the true sense of the term depends upon the extent to which this person was really an "actor." (*See* DRAMA.) Suidas gives the titles (of doubtful authenticity) of several of his plays (not confined to the legends of Dionysus, but embracing the whole body of heroic legends), but the fragments quoted in various writers as from Thespis (*see* Nauck, *Tragic Fragments*) are probably forgeries by Heracleide of Pontus. The statement of Horace (*Ars Poetica*, 276) that Thespis went round Attica with a cart, on which his plays were acted, is due to confusion between the origin of tragedy and comedy, and a reminiscence of the scurrilous jests which it was customary to utter from a waggon (*σκώμματα ἐξ ἁμάξης*) a certain religious festivals. A. and M. Croiset (*History of Greek Literature*, Eng. tr., 1904), who attach more importance to the part played by Thespis in the development of tragedy, accept the testimony of Horace. According to them, Thespis, actor and manager, transported his apparatus on a cart to the deme in which he intended to produce his drama, formed and trained a chorus, and gave a representation in public. (*See also* DRAMA.)

THESSALONIANS, EPISTLES TO THE, two books of the New Testament. These earliest extant letters of Paul mark the beginnings of Christian literature. Fortunately we can date them as written from Corinth early in A.D. 50, under the circumstances of the life of Paul (*q.v.*) related in Acts xviii. The designation "Missionary Epistles" is sometimes applied to the pair because they stand apart from the "Major" four addressed to Galatia, Corinth, and Rome, being as yet unaffected by the Judaizing reaction. They thus afford a simpler view of the normal type of gospel preached by Paul in Gentile territory, with the reactions it encountered. The designation "Eschatological" would be more distinctive, because doctrinally they chiefly reflect the difficulties raised among Greek converts by the proclamation of "Christ and the resurrection" (Acts xvii. 22–32, *cf.* I, i. 9–10). The drama of a return of the glorified Jesus to judgment and renewal of the world, represented in such books of "Prophecy" as the Revelation of John (*see* APOCALYPSE; JOHN, THE APOSTLE), was taken over by the primitive Church from contemporary Jewish Apocalypse, but in Paul's letters and in Greek Christianity generally is gradually modified and pruned of its crudities. We should not fail to note that in Acts xv. 32 Silas, or Silvanus, whom Paul here associates with himself as joint author, is specifically called a "prophet."

First Epistle.—Both Thessalonian epistles are replies to communications from that newly founded church, probably not in oral form alone. I., i.–iii. reviews Paul's whole relation to it by way of defence against insinuations from outsiders ascribing his missionary activities to selfish motives. Paul reminds his converts that, when among them, he had been called for the respect and support which were his due, but had depended for support on his own labour, supplemented by voluntary gifts from churches previously founded, showing toward them only the care and solicitude of a parent. He had been driven out by the jealous hostility of the Jews, who here showed that bitter antagonism shown against the prophets of old, against Jesus, and the mother church in Jerusalem; but he still hopes to return. If his prayers and hopes are frustrated it will be due only to the machinations of Satan, not any failure on his part. A practical section follows in iv. 1–12 urging increased efforts against sexual impurity (a besetting sin of the Greek churches), greater brotherly love, and a life of orderly industry forestalling possible charges from outsiders of idle fanaticism. Practical advice leads over to doctrinal instruction. Individuals have been disturbed in their faith by the death of some members of the brotherhood before the expected Coming. Paul re-assures them by citing a "word of the Lord." This is not, as sometimes imagined, a transmitted report of some saying of the earthly Jesus, whose authentic teachings are of very different stamp, but a message from the glorified "Lord" in "the Spirit," that is, through the type of "prophecy" illustrated in the messages of Jesus "in the Spirit" to the churches of Asia (Rev. i. 1 *ff.*). In I., iv. 13–18 Paul applies such parts of this primitive apocalypse as will serve to "comfort" those in danger of losing their Christian hope, and passes at once in v. 1–11 to further practical exhortation to watch and be sober as children of the light about to dawn, not overtaken like the sinful world by the Coming of the Lord to judgment. After direction to leaders and laity alike to co-operate toward a blameless and orderly communal life, with instructions that the letter be read in public assembly, Paul pronounces his apostolic benediction.

Second Epistle.—The second epistle continues the correspondence after an interval so brief that outward conditions appear unchanged, while leading features of the preceding letter are continued and accentuated In particular the unfamiliar Jewish eschatology is explained and developed Chapter i. repeats with further detail the proclamation of the Coming of Christ to judgment of I., i 10, and justifies the doctrine of "wrath" against persecuting unbelievers in contrast with "rest" and "glory" for the saints But in ch ii. a new factor appears Before the hoped-for Advent the "mystery of lawlessness" now at work in the world must culminate in a counter-manifestation of Satan's power. An Antichrist (*q.v.*) will appear "in the temple of God" claiming divine honours there after the manner of the desecration of Antiochus, self-styled "God-manifest," predicted in Daniel The programme of redemption will begin by the slaying of Antichrist by the breath of the Lord's mouth at his Coming. Momentarily Satan is held in check by Roman power The closing chapter (iii.) resumes the admonitions of I, v 12–28, re-enforcing disciplinary measures to be taken against the "disorderly."

Authenticity.—Objections once urged against the authenticity of I have lapsed, but some still question II Slight changes of diction, usually toward more emphatic form in II, need not detain us Doubts aroused by the suspicions expressed in II, ii. 2 and iii 17, are not warranted Actual circulation of spurious letters during the lifetime of the reputed author is indeed improbable. But this is not implied Paul has heard of misrepresentations of his teaching and wishes to remove all conceivable excuse for it. The strong language of II, ii. 2 against an alleged Pauline doctrine of the Day of the Lord as "now present" no more presupposes actual utterance by "spirit" (*ie*, "prophecy"), or by "word" (of Jesus), or "by letter purporting to be from us" than the stronger language of Gal. i. 8 presupposes actual anti-Pauline preaching by "an angel from heaven." However, spurious epistles were common enough in Paul's time. It is interesting to see how he already guards himself against this possibility by the device later exemplified in Gal vi 11–18 and illustrated by many actual documents among the Oxyrhynchus papyri, by attaching to the dictated letter an autographed farewell "in mine own hand"

Serious objections to the authenticity of II are of two kinds, (1) from its similarity to I. both in formal arrangement of material and in language; (2) from its unexpected attachment of the Antichrist doctrine to Paul's eschatology.

The similarity of material and structure is probably sufficient to prove dependence, possibly even literary dependence But why not? Intrinsic probability as well as the known practice of the ancients suggests that a copy of I. would be available at Corinth for Paul's use in continuing the correspondence. There remains thus, as the only serious objection to the authenticity of II. its belated supplement to Pauline eschatology. The Antichrist doctrine, if not actually opposed to his teaching elsewhere, is almost unmentioned (but *cf* I. Cor. xv. 24–28 and "Belial" in II. Cor. vi. 15). Did Paul forget to mention this preliminary crisis when seeking in I., v 1–11 to allay excitement at Thessalonica over the expected immediate Coming and to restore orderly industry? Was the working of the "mystery of iniquity" an afterthought?

For answer we must consider the occasion for his introducing the (apocalyptic) "word of the Lord" cited in I, iv. 15–17. It was to restore the hope of certain converts grieved by recent bereavement, and professedly contains but a part of the teaching. Paul purposely limited himself to the single lesson in I., v. 1–11 of watchfulness in view of the uncertainty of the hour. But his readers, reminded of the revelation, seem now to feel that a little more definite information concerning the "times and seasons" would greatly help. If the Antichrist paragraph of II. be read as in reply to an intimation of this kind, probably by letter, while the fact is kept in mind that in both letters the subject is repeatedly declared to be no new doctrine but something preached from the beginning by Paul and his fellow-missionaries, it will be easier to realise that it is not an afterthought with which we are here dealing, but rather something earlier and primitive, brought now to the surface by further development of the subject.

BIBLIOGRAPHY.—The most careful study of I. and II. Thess., with full bibliography will be found in the *International Critical Commentary* by J. E. Frame, 1912 Similar ground is taken by E. von Dobschütz in Meyer's Commentary (1909) and by M. Dibelius in Lietzmann's *Handbuch* (1911), also by Geo Milligan (1908) and J. Moffatt (in *Expositor's Gr. Test*, 1910). Against the authenticity of II *see* H J Holtzmann (*Einl* 1892 and *Zeitschr. f. ntl Wiss*, 1901), Pfleiderer, *Urchristenthum* (1902), and Wrede, *Echtheit des zweiten Thessalonicherbriefes* (1903). On the relation to Synoptic apocalypse *see* Bacon, *The Gospel of Mark* (1925) (B. W Ba.)

THESSALY, a district of northern Greece, between Macedonia and the Hellenic countries towards the south, and between upland Epirus and the Aegean It forms an irregular square of about 60 m in each direction, for the most part level, but with well-marked boundaries, the Cambunian mountains on the north, Othrys on the south, the massive chain of Pindus, the backbone of this part of Greece, on the west, while at the north-eastern angle is Olympus, separated by the gorge of Tempe (*q.v.*) from the coast range of Ossa and Pelion, standing in a continuous line to the south-east. Three peaks of Pindus are over 5,000 ft., and Olympus, Ossa and Pelion reach respectively 9,790, 6,398 and 5,350 feet The country within these limits is drained by numerous confluents, which pass into the sea through the gorge of Tempe

Through Thessaly, therefore, lie all land routes between peninsular Greece and the north An important pass from Petra in Pieria debouches west of Olympus on the plain north of Larissa By this Xerxes entered (Herodotus vii 173), and when the Greeks heard of this passage, they gave up their defence of Tempe The main communication with Epirus passed over Mount Lacmon by the upper Peneius to Aeginium in the north-west angle By this route Julius Caesar arrived before the battle of Pharsalia. Another pass, farther south by Gomphi, leads to the Ambracian gulf. The great southern pass of Coela crosses Mount Othrys nearly north of Thermopylae

Though Thessaly is the most level district of Greece, it is composed of sections, divided by ranges of hills; Upper Thessaly, to the west and south-west, contains the higher course of the Peneius and all tributaries from the south—Enipeus, Apidanus, Onochonus and Pamisus. Lower Thessaly, from the central ridge west of Larissa to the foot of Ossa and Pelion, is inundated by the Peneius, the flood-water forming the Lake Nessonis, and, when that is full, pouring into Lake Boebe. The chief city of the lower Thessaly was Larissa; in the south at the pass of Coela is another plain, containing a small lake, formerly called Xynias, and low hills separate this from the town of Thaumaki, which overlooks the main upper plain "like a vast sea" (Livy xxxii. 4) The Plain of Pharsalia, intersected by the Enipeus, lies north-east of this, and still farther another battlefield, Cynoscephalae. The political divisions follow the physical, Pelasgiotis being the lower plain of the Peneius, Hestiaeotis and Thessaliotis respectively the north and the south portions of the upper; the fourth, Phthiotis, towards the south-east, was geographically separated by the watershed of Mt. Othrys and its north-east spurs. The landlocked Pagasaeus Sinus (Gulf of Volo), extends from Pagasae at its head to Aphetae at its narrow outlet, where the chain of Pelion turns at right angles to south-west in broken ridges, while on the opposite side rise the heights of Othrys. In the heroic age Phthiotis was the legendary birthplace of Greek navigation in the story of the Argonauts. Hence Achilles came and, according to Thucydides (i 3), it was the cradle of the Hellenes Iolcus, the centre of many legends, is near the modern Volo. Near Iolcus, later, Demetrius Poliorcetes founded Demetrias, called by Philip V. of Macedon one of the "fetters of Greece," Chalcis and Corinth being the others.

The history of Thessaly is closely connected with its geography. From the earliest times Thessaly has had a separate history controlled by its situation. The fertility of the land offered a temptation to invaders, and was thus the primary cause of early migrations. Its first Neolithic culture combined Danubian characters with elements from the "Tripolje" culture of Ukraine; a second phase reinforces the latter elements, at Dimini near Volo. Then long decadence resulted from the spread, first of "Helladic," then of "Minyan" culture from the south Finally, just as Mycenaean exploitation was beginning in the 13th century, fresh

northern invaders from Macedonia wrecked all At this point language and legend supplement archaeology Thessalian Greek is of the Aeolic group, akin to Boeotian, but between lie the "West Greek" dialects of Phthiotis, Malis, and Doris, subsequently intruded Aeolic genealogies go back to the early part of the 14th century, whereas the Doric and West Greek expansion is referred to the 12th Tradition brought both Thessalians and Boeotians from Arne in the north-west, imposing powerful aristocracies on the older inhabitants, who retained political coherence only among the marginal hills in Perrhaebia, Magnesia, and the like. The rich lowlands were the natural home of powerful families such as the Aleuadae of Larissa and the Scopadae of Crannon; and the absence of elevated positions was unfavourable to the foundation of cities, which might have fostered freedom and democracy. The plains, also, were suited to the breeding of horses, and consequently the force in which the Thessalians were strong was cavalry, a kind of troops usually associated with oligarchy. The wealth and the semi-Hellenic character of the people (for, in race, as in geographical position, the Thessalians held an intermediate place between the Macedonians and the southern Greeks) held them aloof from national sentiment, and at the time of the Persian wars the Aleuadae joined the enemy. United, as under Alexander and Jason, of Pherae, in the 4th century, the Thessalians were formidable, but they seldom combined for long, and consequently had little influence in Greece. From the 4th to the 2nd century they were usually vassals of Macedon

For several centuries during the middle ages Rumanian immigrants formed so large a part of the population of Thessaly that that district was called by the Byzantine writers Great Wallachia (Μεγάλη Βλαχία); the Jewish traveller, Benjamin of Tudela, so describes it in the latter half of the 12th century. Now, only a few Vlach (Ruman) colonies remain, principally on the west of Olympus and in some gorges of Pindus. The Turkish conquerors settled in the larger towns and in great ranches. The Greeks form so large a majority that, even while the country belonged to the Ottomans, Greek was the official language. Thessaly was ceded to the Greek kingdom by the Porte in 1881. The whole area was a battlefield in World War II. The port of Volo, almost the only outlet of trade, has a steamer service to Athens. Railways run: (1) from Volo by way of Velestino (ancient Pherae) to Larissa (q.v.); (2) from Velestino to the west by Pharsala (Pharsalos), Domokos (Thaumaki), Karditsa and Trikkala (Trika), to Kalabaka (Aeginum), in the upper valley of the Salambria (Peneius); (3) the main line from Athens to Salonika enters Thessaly by the Coela pass west of Othrys, reaches Larissa, and proceeds by the gorge of Tempe and the sea front of Olympus. Thessaly is essentially an agricultural and pastoral district.

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THETFORD, a market town and municipal borough of England, mostly in the south-west of Norfolk, but partly in Suffolk, 95¼ mi. N.N.E. from London by the L.N.E.R. Pop. (1938) 3,990. In the time of Edward III the town had twenty churches and eight monasteries. There are now three churches principally of Perpendicular flint work; and a few monastic remains, the chief being two gate-houses. The most important relic of antiquity is the Castle Hill, a mound 1,000 ft. in circumference and 100 ft. in height. The grammar school was founded in 1670. In King Street is the mansion-house occupied as a hunting-lodge by Queen Elizabeth and James I. Brewing and tanning are carried on; and there are also manure and chemical works. The town is governed by a mayor, 4 aldermen, and 12 councillors. Area, 11 sq.mi.

Tradition tells that Uffa, who probably threw up the earthworks called the Castle Hill, established the capital of East Anglia here about 575. In 1290 its principal officers were a mayor and coroner, afterwards assisted by eight burgesses, whom Henry VIII. increased to ten. The town, never very prosperous since the Conquest, had then fallen into great decay, but the petitions of the burgesses for a charter were not heeded till 1573 when Elizabeth incorporated it under a mayor and common council This charter, restored in 1692 after its surrender to Charles II , remained in force till 1835 when the borough was re-constituted

See A. L. Hunt, *Capital of East Anglia* (1870); T. Martin, *History of Thetford* (1779).

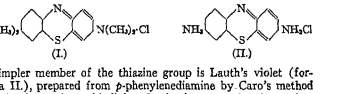
THETIS, in Greek mythology, daughter of Nereus, wife of Peleus and mother of Achilles. The chief of the 50 Nereids, she dwelt in the depths of the sea with her father and sisters. When Dionysus leaped into the sea to escape from the pursuit of Lycurgus, king of the Thracian Edones, and Hephaestus was flung out of heaven by Zeus, both were kindly received by Thetis Again, when Hera, Athena, and Poseidon threatened to bind Zeus in chains, she sent the giant Aegaeon, who delivered him out of their hands. She was married against her will to Peleus (*q.v.*; *see* also ACHILLES). Thetis is used by Latin poets simply for the sea

THEUNIS, GEORGES (1873–), Belgian statesman, was born at Montegnée, near Liége, on Feb. 28, 1873. In Jan. 1916 he attended the Inter-Allied Relief Commission in London and in 1919 represented Belgium on the Reparations Commission. In 1920 he became finance minister in Carton de Wiart's coalition ministry, the aims of which Government were first to settle the reparations question, with due regard to Belgium's prior claim and secondly to maintain the entente between the Allies Theunis represented Belgium at the Inter-Allied Conferences of San Remo 1920, London 1924 and Paris 1925, which resulted in the adoption of the Dawes Plan and a corresponding inter-Allied settlement His home policy was to place Belgian finance on a sound basis and to reconstruct the devastated regions His cabinet resigned in April 1925, after the elections in which the democratic parties triumphed. In Aug. 1925 Theunis was sent by his Government to Washington to discuss the question of the Belgian debt to U S A. This mission resulted in an agreement which was submitted to the parliaments of the two countries. Theunis presided over the World Economic Conference at Geneva in 1927; he was also chairman of the permanent consultative economic committee formed to continue the work of the conference. From November 1934 until March 1935 he was prime minister.

THEURIET, CLAUDE ADHÉMAR ANDRÉ (1833–1907), French poet and novelist, was born at Marly-le-Roi. The best of his novels are: *Le mariage de Gérard* (1875); *Raymonde* (1877); *Le fils Maugars* (1879); *La maison des deux Barbeaux* (1879), *Sauvageonne* (1880), *Reine des bois* (1890); *Villa tranquille* (1899); *Le manuscrit du chanoine* (1902). Theuriet died on the 23rd of April 1907.

THIAZINES, in organic chemistry are compounds containing a ring system of one sulphur atom, one nitrogen atom and four carbon atoms. The most important thiazine is methylene-blue (formula I), a basic colouring matter employed in dyeing and printing on cotton mordanted with antimonyl tannate. It is also used as a microscopic stain and as a reagent in bacteriological and histological researches. Methylene-blue was first discovered by H. Caro in 1876, who prepared it by oxidising *as*-dimethyl-*p*-phenylenediamine (obtained from *p*-nitrosodimethylaniline) with ferric chloride in presence of hydrogen sulphide. The preparation was rationalised by A. Bernthsen in 1887 who converted dimethyl-*p*-phenylenediamine into its thiosulphonic acid and oxidised this intermediate with chromic acid in the presence of a molecular proportion of dimethylaniline. Methylene-blue is frequently sold in the form of its zincichloride,

$$2C_{16}H_{18}N_3SCl,\ ZnCl_2,H_2O$$



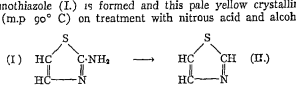
(I.) (II.)

A simpler member of the thiazine group is Lauth's violet (formula II.), prepared from *p*-phenylenediamine by Caro's method of oxidation or from thiodiphenylamine by successive dinitration, reduction and oxidation (Bernthsen). The thiazine series of dyes also includes acidic colouring matters such as Brilliant Alizarin

Blue, prepared by condensing β-naphthaquinone-6-sulphonic acid with the thiosulphonic acid of a dialkyl-p-phenylenediamine For further information *see* the Colour Index of the Society of Dyers & Colourists (Edited by F. M Rowe, 1924)

THIAZOLES, in organic chemistry, a series of compounds containing five-membered rings of one nitrogen, one sulphur and three carbon atoms. The most prominent thiazole derivative is the dyestuff, primulin, discovered by A G Green in 1887, which dyes unmordanted cotton in yellow shades The dyed fabric can be treated with nitrous acid, when the dye is diazotised (*see* DIAZO-COMPOUNDS) so that varying shades of red, brown and claret are produced on dipping the prepared material into solutions of developers (β-naphthol, resorcinol, α-naphthylamine, etc).

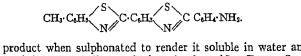
When thiourea and chloroacetaldehyde, or preferably dichloroether, $CH_2Cl\text{-}CHCl\text{-}O\text{-}C_2H_5$, are condensed in aqueous solution, 2-aminothiazole (I.) is formed and this pale yellow crystalline base (m.p 90° C) on treatment with nitrous acid and alcohol



(I) (II.)

loses its amino-group for hydrogen giving rise to thiazole itself (II), which is a colourless liquid boiling at 117° C and smelling like pyridine (Traumann, 1888).

When p-toluidine and sulphur are heated at 200° C, a complex product known as "primulin base" is obtained which consists mainly of the following thiazole derivative



This product when sulphonated to render it soluble in water and converted into its sodium salt is primulin (*See* DYES, SYNTHETIC.) (G. T. M)

THIBAUT (or THEOBALD) **IV.** (1201–1253), count of Champagne and Brie, and king of Navarre, French poet, was born at Troyes in 1201 His father, Thibaut III of Champagne died before his son's birth, and his mother, Blanche of Navarre was compelled to resign the guardianship of the young prince to Philip Augustus, king of France, but there is little doubt that the child was acquainted with Chrétien de Troyes and the other trouvères who found patronage at the court of Champagne Thibaut's verses belong to what is called "courteous" poetry, but they have a personal note that distinguishes them from mere exercises. They are addressed to Blanche of Castile, the wife of Louis VIII., and Thibaut's relations with her have been the subject of much controversy. The count took part with Louis in the crusade against the Albigenses, but in 1226, with no apparent reason, left the king and returned to Champagne. Three months later Louis died under doubtful circumstances, and Thibaut was accused by his enemies of poisoning him

The real reason for Thibaut's desertion appears to have been a desire to consolidate his position as heir-apparent of Navarre by an alliance with the disaffected nobility of the south of France, but from this confederation Blanche was skilful enough to detach him. The resentment of the league involved him in a war in which Champagne was laid waste, and his capital saved only by the royal intervention In 1234 he succeeded his uncle, Sancho VII., as king of Navarre, and from this period date his most fervent songs in praise of his lady. The crusade turned Thibaut's thoughts to religion, and he announced his intention of singing henceforth only in honour of the Virgin. Unfortunately his devotion took darker forms, for before sailing for the Holy Land he ordered and witnessed the burning of a hundred and eighty-three unfortunate men and women convicted of Manichaeism. The years 1239 and 1240 were spent in Palestine, and from the time of his return Thibaut devoted himself to efforts for the improvement of his dominions that won for him the title of *le Bon.* He died at Pampeluna on July 14, 1253.

Thibaut was the most popular of all the 13th century songwriters, and his work is marked by a grace and sweetness which he owes perhaps in part to his association with the troubadours of the south He is said to have set his own songs to music It seems doubtful whether the notes that have come down to us can with justice be attributed to him, but there is no contesting the musical quality of his verse. His fame spread beyond the Alps, and Dante admired his poetry He was one of the most celebrated authors of *jeux-partis,* elaborate discussions between two interlocutors, usually on the subject of love.

His works were edited in 1851 by P. Tarbé in his *Chansonniers de Champagne*

THIBAUT, ANTON FRIEDRICH JUSTUS (1774–1840), German jurist, was born at Hameln, in Hanover, on Jan 4, 1774, the son of an officer in the Hanoverian army He studied jurisprudence at Göttingen, Konigsberg and Kiel Here in 1798 he was appointed extraordinary professor of civil law, and published his earlier works, including the important treatise (1799) *Theorie der logischen Auslegung des römischen Rechts*[1] In 1802 Thibaut was called to Jena, where he wrote his chief work, *System des Pandektenrechts* (1803) This work is, in effect, a codification of the Roman law as it then obtained in Germany, modified by canon law and the practice of the courts into a comprehensive system of Pandect law In 1805 he went to Heidelberg, where he stayed till his death on March 29, 1840. His influence was great; and, except Gustav Hugo and Savigny, no civilian of his time was so well known. In 1814 appeared his *Civilistische Abhandlungen,* of which the principal was his famous essay advocating a national code for Germany. This essay was inspired by the War of Liberation

See Baumstark, *Thibaut, Blätter der Erinnerung* (1841); Karl Hagemann, *Aus dem Leben A. F. J. Thibaut, mit Correspondenz,* in *die Preuss. Jahrbucher* (1880); Teichmann, in *Holtzendorff's Rechtslexikon;* and E Landsberg, in *Allgemeine Deutsche Biographie,* vol. 37.

THIBAW (now **HSIPAW**): *see* SHAN STATES

THIELMANN, JOHANN ADOLF, FREIHERR VON (1765–1824), Prussian cavalry soldier, was born at Dresden. Entering the Saxon cavalry in 1782, he saw service against the French in the Revolutionary Wars and in the Jena campaign, and after Jena, at the siege of Danzig and at Friedland In 1809, as colonel of a Free-Corps, he opposed the advance of the Austrians into Saxony, and was promoted major-general, becoming lieutenant-general in 1810 As commander of the Saxon Heavy Cavalry Brigade he took part in the advance on Moscow (1812), and at Borodino attracted the attention of Napoleon, who took him into his own suite. His own sovereign at the same time made him Freiherr In the war of Liberation Thielmann took a prominent part When ordered to surrender the fortress of Torgan, of which he was governor, to the French, he resigned his command and joined the allies As a Russian general he reorganized the Saxon army after Leipzig, and in 1814 he commanded the Saxon corps operating in the Low Countries. Early in 1815 he became a lieutenant-general in the Prussian service, and in command of the 3rd army corps he took part in the Waterloo campaign, in which he fought the spirited action of Wavre (June 18–19). He was later a corps commander at Münster and at Coblenz, where he died in 1824.

See von Petersdorf, *General Johann Adolf Freiherr von Thielmann* (Leipzig, 1894).

THIERRY, JACQUES NICOLAS AUGUSTIN (1795–1856), French historian, who was born at Blois on May 10, 1795. He was educated at the Blois Grammar School, and at the École normale supérieure. He embraced the ideas of the French Revolution with enthusiasm, and he became fired with Saint Simon's ideal society of the future. He became the secretary, and, as he would say himself, the "adopted son" of the famous visionary (1814–17); but, while most of Saint Simon's followers turned their attention to the affairs of life, devoting themselves to the problems, both theoretical and practical, of political economy, Thierry turned his to history. His imagination had been powerfully impressed by reading *Les Martyrs,* in which Châteaubriand had contrasted the two civilizations and the two races from which the modern world has sprung His romantic ardour was later still further nourished by the works of

Sir Walter Scott, and though he did not himself actually write romances, his conception of history fully recognized the dramatic element. His main ideas on the Germanic invasions, the Norman Conquest, the formation of the communes, the gradual ascent of the nations towards free government and parliamentary institutions are already observable in the articles contributed by him to the *Censeur européen* (1817–20), and later in his *Lettres sur l'histoire de France* (1820). From Fauriel he learnt to use the original authorities; and by the aid of the Latin chronicles and the collection, as yet very ill understood, of the Anglo-Saxon laws, he composed his *Histoire de la Conquête de l'Angleterre par les Normands* (1825) This book, the preparation of which had required several years of hard work, cost Thierry his eyesight; in 1826 he was obliged to engage secretaries and in 1830 became quite blind. Nevertheless he republished (1827) his *Lettres sur l'histoire de France*, with the addition of fifteen new ones, in which he described some of the more striking episodes in the history of the rise of the mediaeval communes.

Thierry was ardent in his applause of the July Revolution and the triumph of liberal ideas He now re-edited, under the title of *Dix ans d'études historiques*, his first essays in the *Censeur européen* and the *Courrier français* (1834), and composed his *Récits des temps mérovingiens*, in which he reproduced in a vivid and dramatic form some of the most characteristic stories of Gregory of Tours. These *Récits* appeared first in the *Revue des deux mondes;* when collected in volume form, they were preceded by long and interesting *Considérations sur l'histoire de France*. Thierry became a member of the Académie des Inscriptions et Belles Lettres; in 1841, on the motion of Villemain, the French Academy awarded him the first *Prix Gobert*, which became a kind of literary inheritance for him, being renewed in his favour fifteen years in succession. By the aid of zealous collaborators (including Bourquelot and Louandre) he compiled, in four volumes, a valuable *Recueil des monuments inédits de l'histoire du Tiers État* (1850–70), which, however, bear only on the northern part of France. He died in Paris on May 22, 1856.

THIERS, LOUIS ADOLPHE (1797–1877), French statesman and historian, was born at Marseilles on April 16, 1797. He was educated, first at the lycée of Marseilles, and then in the faculty of law at Aix. Here he began his lifelong friendship with Mignet, and was called to the bar. In 1821 Thiers went to Paris, and became a contributor to the *Constitutionnel*. Cotta, the well-known Stuttgart publisher, who was part-proprietor of the *Constitutionnel*, made over to Thiers a share of his dividends and he was thus relieved of any money anxiety.

Meanwhile Thiers became very well known in Liberal society, and he had begun the celebrated *Histoire de la révolution française* (10 vols., 1823–27), which founded his literary and helped his political fame Coming as the book did just when the reaction against the revolution was about to turn into another reaction in its favour, it was assured of success. In 1830 Thiers, with Armand Carrel, Mignet, and others started the *National*, a new opposition newspaper. Thiers himself took a leading part in the actual revolution. He ranked as one of the Radical supporters of the new dynasty. At first Thiers, though elected deputy for Aix, obtained only subordinate places in the ministry of finance. After the overthrow of his patron Laffitte, he became much less radical and, after the troubles of June 1832, was appointed to the ministry of the interior He repeatedly changed his portfolio, but remained in office for four years, became president of the council and in effect prime minister, and began his series of quarrels and jealousies with Guizot.

At the time of his resignation in 1836 Thiers was foreign minister, and, as usual, wished for a spirited policy in Spain, which he could not carry out. He travelled in Italy for some time, and it was not till 1838 that he began a regular campaign of parliamentary opposition, which in March 1840 made him president of the council and foreign minister for the second time. But he held the position barely six months, and, being unable to force on the king an anti-English and anti-Turkish policy, resigned on Oct. 29. He now worked on his *Historie du Consulat et de l'Empire*, the first volume of which appeared in 1845. Though he was still a member of the chamber he spoke rarely, till after the beginning of 1846, when he was evidently bidding once more for power. When the revolution of February broke out he and Odilon Barrot were summoned by the king; but it was too late.

Under the republic he took up the position of conservative republican The inconsistency of his conduct, especially in voting for Prince Louis Napoleon as president, was often and sharply criticized, one of the criticisms leading to a duel with a fellow-deputy, Bixio. He was arrested at the *coup d'état*, was sent to Mazas, and then escorted out of France. But in the following summer he was allowed to return. For the next decade his time was occupied for the most part on *The Consulate and the Empire*. It was not till 1863 that he re-entered political life, as deputy for a division of Paris. For the seven years following he was leader of the anti-Imperialists in the French chamber. While nominally protesting against its foreign enterprises, he perpetually harped on French loss of prestige, and so contributed more than any one to stir up the spirit which brought on the war of 1870.

After the collapse of the empire Thiers visited in the autumn the different courts of Europe in the hope of obtaining some intervention, or at least some good offices. The mission failed; but the negotiator was immediately charged with another—that of obtaining, if possible, an armistice directly from Prince Bismarck. Thiers was chosen deputy to the National Assembly by more than twenty constituencies (of which he preferred Paris), and was at once elected by the Assembly itself practically president, nominally *chef du pouvoir exécutif*. He lost no time in choosing a coalition cabinet, and then personally took up the hard task of negotiating peace. He succeeded in convincing the deputies that the peace was necessary, and it was (March 1, 1871) voted by more than five to one. Thiers held office for two years after the peace. He had at first to meet and crush at once the Paris commune, and on Aug. 30 he became president of the republic

His strong personal will and inflexible opinions had much to do with the resurrection of France; they also made it inevitable that he should excite violent opposition. His talents and his temper made him utterly indisposed to maintain the attitude supposed to be incumbent on a republican president; and his tongue was never a carefully governed one. In January 1872 he formally tendered his resignation; and, though it was refused, almost all parties disliked him, while his chief supporters—men like Rémusat, Barthélemy Saint-Hilaire and Jules Simon—were men rather of the past than of the present In 1873 regulations were proposed, and on April 13, were carried, which were intended to restrict the executive and especially the parliamentary powers of the president. The government was further weakened by a dissolution and reconstitution of the cabinet on May 19. Immediately afterwards the question was brought to a head by an interpellation moved by the duc de Broglie. The president declared that he should take this as a vote of want of confidence; a vote of this character (though on a different formal issue, and proposed by M. Ernoul) was carried by 16 votes in a house of 704. Thiers at once resigned (May 24) He survived his fall four years, continuing to sit in the Assembly, and, after 1876, the Chamber of Deputies. He died on Sept. 3, 1877.

Thiers was by far the most gifted and interesting of the group of literary statesmen which formed a unique feature in the French political history of the 19th century. There are only two who were at all comparable to him—Guizot and Lamartine; and as a statesman, he stands far above both. Nor was this eminence merely the result of his great opportunity in 1870, for Guizot might under Louis Philippe have almost made himself a French Walpole, at least a French Palmerston, and Lamartine's opportunities after 1848 were, for a man of political genius, illimitable. But both failed—Lamartine almost ludicrously—while Thiers in hard conditions made a striking if not a brilliant success. But he only showed well when he was practically supreme. Even as the minister of a constitutional monarch his intolerance of interference or joint authority, his temper at once imperious and intriguing, his inveterate inclination towards *bricolage*, that is to say, underhand rivalry and caballing for power and place, showed themselves unfavourably; and his constant tendency to inflame

the aggressive and chauvinist spirit of his country neglected fact, was not based on any just estimate of the relative power and interests of France, and led his country more than once to the verge of a great calamity. In opposition, both under Louis Philippe and under the empire, and even to some extent in the last four years of his life, his worst qualities were always manifested. But with all these drawbacks he conquered and will retain a place in what is perhaps the highest, as it is certainly the smallest, class of statesmen—the class of those to whom their country has had recourse in a great disaster, who have shown in bringing it through that disaster the utmost constancy, courage, devotion and skill, and who have been rewarded by as much success as the occasion permitted

As a man of letters Thiers was very much smaller. He had not only the fault of diffuseness, which is common to so many of the best-known historians of his century, but others as serious or more so The charge of dishonesty is one never to be lightly made against men of such distinction as his, especially when their evident confidence in their own infallibility, their faculty of ingenuous casuistry, and the strength of will which made them (unconsciously, no doubt) close and keep closed the eyes of their mind to all inconvenient facts and inferences, supply a more charitable explanation. But it is certain that from Thier's dealings with the men of the first revolution to his dealings with the battle of Waterloo, constant, angry and well-supported protests against his unfairness were not lacking.

His histories, in many different editions, and his speeches, as above, are easily accessible, his minor works and newspaper articles have not, we believe, been collected in any form. Several years after his death appeared *Deux opuscules* (1891) and *Mélanges inédites* (1892), while *Notes et souvenirs*, 1870–73, were published in 1901 by "P. D.," his sister-in-law and constant companion, Mlle. Félicie Dosne. Works on him, by M. Laya, M. de Mazade, his colleague and friend, M. Jules Simon, and others, are numerous D Halévy, *Le Courrier de M de Thiers* (1921), pp. 521; L. A Thiers, *Thiers an pouvoir*, 1871–73 (1921), pp. 357. (G. SA.; X)

THIERS, a town of central France, capital of an arrondissement in the department of Puy-de-Dôme, 24 mi. E N.E. of Clermont-Ferrand, on the railway between that town and St. Etienne Pop (1936) 12,676. Thiers was sacked about 531 by the soldiers of Thierry, son of Clovis. About the same period Gregory of Tours speaks of a wooden chapel which may have occupied the site of the present church of Le Moutier. The streets rising in steep rows contain a number of 15th-century houses. The church of St Genès was built in 575 by Aprilus, bishop of Clermont, and rebuilt in the 12th century. It has some curious mosaic work of the Merovingan period and a fine tomb of the 13th century. The church of Le Moutier, formerly part of a Benedictine monastery, dates chiefly from the 11th century. Thiers is the seat of a sub-prefect and has a tribunal of commerce, a chamber of commerce and a board of trade arbitrators. Its special industry is the manufacture of cutlery

THIETMAR (DIETMAR or **DITHMAR) OF MERSEBURG** (975–1018), German chronicler, was a son of Siegfried, count of Walbeck, and was related to the family of the emperor Otto the Great. Born on July 25, 975, he was educated at Quedlinburg and at Magdeburg and became provost of Walbeck in 1002 and bishop of Merseburg seven years later. He took some part in the political events of the time, in 994 he was a hostage in the hands of the Northmen. He died on Dec. 1, 1018.

Thietmar wrote a *Chronicon* in eight books, which deals with the period between 908 and 1018. For the earlier part he used Widukind's *Res gestae Saxonicae*, the *Annales Quedlinburgenses* and other sources; the latter part is the result of personal knowledge. It has been edited by J. M. Lappenberg in Band III of the *Monumenta Germaniae historica, Scriptores;* and by F Kurze (Hanover, 1889); and has been translated into German by J. Laurent (new ed. revised by W. Wattenbach [Leipzig, 1892]). See F Kurze, *Bischof Thietmar von Merseburg und seine Chronik* (Halle, 1880); and W. Wattenbach, *Deutschlands Geschichtsquellen*, Band II (Berlin, 1904)

THINKING, PSYCHOLOGY OF. The first sustained and systematic psychological experiments on thinking were reported during the first decade of the 20th century. In the psychology then prevalent, still new as an experimental science, thinking was conceived as essentially a conscious process, directly open to the introspection of the thinker The experimental method, therefore, was that of presenting brief, thought-provoking tasks to individuals who served as subjects, and of securing their introspections promptly as each task was completed

The results of this straightforward and apparently obvious procedure were such as to cast doubt on some of the basic presuppositions of the science of psychology as it was then widely understood Among the most thoroughgoing of the early experimental psychologists, it was commonly assumed that consciousness is a composition of elementary processes—specifically, simple sensations, images and feelings—and that it is the special task of a scientific psychology to describe consciousness exhaustively in terms of these constituents, as determined by experimentally controlled introspection.

It was precisely this assumption concerning the nature of consciousness that the data from the thought experiments called into question. The subjects' reports, to be sure, mentioned sensory, affective and imaginal contents, but they referred far more prominently to conscious events which most subjects described as unanalyzable into the expected elementary constituents. Among these were conscious attitudes like doubt, hesitation or sudden illumination, and "thoughts," noted simply as thoughts *of* or thoughts *about*, reported as having little or no sensory or imaginal content Furthermore, such contentless or relatively contentless occurrences, seemed to the subjects to mark critical turning points in their thinking, crucial stages in the solution of a problem.

These results were especially impressive because they emerged almost simultaneously from three independent sets of investigations, conducted respectively by A Binet in France, R S Woodworth in the United States and O Külpe and his co-workers in Austria. Naturally they aroused skepticism, controversy and further research. An obvious criticism, and one emphatically stated, was that the reported results might have been based on faulty introspection. But many psychologists hesitated to reject on these grounds alone an agreement on unexpected findings, independently obtained and reported by investigators of recognized competence.

But clearly the question of introspection required critical examination. Indeed, one of the most significant features of these first experiments on thinking is that if the reported introspective data are accepted as valid, they themselves point to limitations and flaws in introspection as a method of studying thinking. The occurrence of contentless or relatively contentless stretches of thought called attention to the possibility that important determinants of thought—neural "sets," perhaps, or other bodily processes—are, as a simple matter of fact, not registered in consciousness and are, therefore, outside the range of introspective observation. Besides, the reported course of conscious events themselves did not match step by step what the organism was actually doing. The evidence indicated, for example, that maximal awareness of an assigned task sometimes occurred only after the task had been performed; that the task had been initiated and correctly executed with little or no conscious awareness of its nature. In short, the indications were that the course of thought is neither completely nor faithfully mirrored in consciousness. There was evidence, too, that introspective observation is unreliable. Even among highly trained introspectionists, disagreements arose, not only concerning the interpretation of introspective data, but concerning the nature of some of the data themselves; and disagreements that could not be settled by an appeal to observed facts—here introspectively observed facts—strongly suggested that introspection is incapable of giving results sufficiently free from vagueness and ambiguity to be acceptable in scientific research. To some psychologists, it seemed necessary to discard introspection altogether, not only in studying thinking, but in all psychological research But to others, perhaps to most, the situation meant that the possibilities of introspection had been greatly overestimated; that like other modes of observation, it has limitations which must be recognized; but that within these limits, it may be useful if properly safeguarded,

especially when combined with other methods. In any event the increased warmess toward introspection created a readiness to try other approaches to the problem, and hence to entertain conceptions of thinking which would direct research into new channels.

One such conception was that suggested by the Darwinian theory. In the light of *The Origin of Species* and *The Descent of Man*, human thinking is readily interpretable as one of the modes of adaptation evolved by a particular animal species, something to be explained along with other modes of adaptation in living organisms, in terms of its ancestry, its environmental determinants and its biological utility. The problem of thinking was thus shifted from "What *is* thinking? Of what stuff is it made?" to "What does it *do*? How does it operate? How is it related to other activities of the organism?"

The Darwinian theory also suggested a new methodological approach. Emphasizing as it did the importance of interspecies comparisons, it led to methods of research applicable to subhuman animals as well as to human beings. In general, the method was that of investigating the behaviour of animals for indications of specified abilities, for example, the ability to perceive relations. C. Lloyd Morgan's interest in the relation between human and animal intelligence led him to perform informal but cautiously interpreted experiments of this sort, and his methods were developed by E. L. Thorndike into laboratory experiments in which special apparatus, such as mazes and puzzle boxes, made it possible to secure not only qualitative descriptions but also quantitative measures of the animal's behaviour under known conditions. For example, Thorndike constructed learning curves which represented in terms of times required for successive escapes from a given maze or puzzle box an animal's increasing proficiency in mastering it. On the basis of his findings, he reported that his animals—cats, dogs, chicks and monkeys—acquired correct modes of reaction through a kind of behaviour subsequently called trial and error, that they produced a succession of reactions, approximately at random, to one after another feature or aspect of the external situation and that in the course of this activity, reactions leading to failure were gradually weakened and "stamped out," those leading to success, strengthened and "stamped in." In short, he explained an animal's successful performance as the outcome, not of intelligence or thought, but of associations produced by the interplay of bodily mechanisms, aroused in the course of its initially random reactions to the environment.

Thorndike's methods were extended by H. A. Ruger to inquiries into the psychology of solving complex problems. Using human subjects, most of whom were intelligent and educated adults, and substituting complicated mechanical puzzles for Thorndike's mazes and puzzle boxes, he followed essentially the same procedures as those used by Thorndike, supplementing them, however, with introspective reports from his subjects. In presenting his findings, Ruger emphasized the large amount of typically "animal" trial and error in the activities of his subjects, not only in their acquisition of the motor skills required for manipulating the puzzles, but also in their understanding of the presented situations. He noted that many kinds of nonrational behaviour regularly occurred; *e.g.*, that unsuccessful reactions were often retained after they had proved to be useless, that successful variations in procedure often made their first appearance, not through foresight, but without even attracting the subject's notice; that a puzzle was often solved—*i.e.*, repeatedly manipulated with consistent correctness—with little or no comprehension of the principles involved. Ruger noted especially that the course of events by which a puzzle was eventually understood, was similar to that by which a motor skill is acquired; that ordinarily the understanding of a puzzle did not occur in a single flash of comprehension, but was achieved gradually through a succession of partial analyses; that the extent to which it was comprehended was itself a matter of degree; that often the situation was analyzed up to a given point and no further. But Ruger also presented data which in his opinion pointed to distinctively human as contrasted with animal procedures. Among the learning curves of his human subjects were some that showed sudden drops in performance time, and these drops, indicating marked and consistently maintained improvement, coincided in most cases with introspective reports that just here the subject had seen the point of the puzzle (insofar as he understood it)—sometimes that it had flashed upon him suddenly, sometimes that he had worked it out deliberately But even these reactions which seemed to him distinctively human, appeared in a context of typically animal trial and error, in fact seemed to grow out of it and to be conditioned by it His results suggested that the continuity between human and animal behaviour was indicated less by the presence of typically human intelligence in animals, than by the large amount of typically animal trial and error that characterized human thinking.

Both in methods and results, Ruger's study is representative of many experiments which extended research on thinking beyond the limits set by the problem as formulated in the first psychological laboratories. A further revision in method and a more drastic restatement of the problem were made by American behaviourism, a school of psychology that discarded all reference to consciousness in its account of thinking as of all psychological processes. In the early and relatively uncritical behaviourism of J. B. Watson, the chief contribution to the psychology of thinking was that of stating the problem in a thoroughly objective, though oversimplified and highly schematic form. As a part of his program of accounting for all behaviour in terms of bodily mechanisms, Watson treated thinking as essentially laryngeal behaviour, consisting of implicit or subvocal speech as contrasted with overt verbal reactions. To the question, "Is thinking merely a matter of language mechanisms?" his answer was "Yes," but he included among language mechanisms not merely verbal reactions, but equivalent reactions like the shrug of a shoulder or a visceral quiver. His basic claim was that thought is wholly explicable as bodily reactions substitutable for, and in that sense symbolic of, those by which the organism engages directly with actual objects, events and situations.

Relatively few actual experiments on thinking were contributed by the early Watsonian behaviourists, and most of these did not greatly differ in method from those illustrated by Ruger's study. The discarding of introspection was often more apparent than real, since verbal report was accepted as a form of overt behaviour, and the distinction between language as reaction and language as report was usually left obscure. The results, too, were similar to those previously reported. The experimenters usually called attention to the frequency of nonrational reactions, and they tended also to emphasize the similarities between behaviour presumably involving thought, and motor trial and error where bodily reactions are more conspicuous. Later and more sophisticated forms of behaviourism clarified the methodological problem by pointing out that those determinants of behaviour ordinarily classified as thinking, though not open to observation, may be *inferred* from behaviour under suitably arranged experimental conditions. For example, the experimenter may arrange a situation which the subject can solve if and only if he reacts to a specified relation, and on the assumption that the conditions have been suitably arranged and adequately controlled, the experimenter may infer that the relation has been reacted to, if the subject produces the solution. In this way, a behaviourist may study thinking experimentally, without resort to introspection.

The psychology of thinking has also been approached, notably by the Gestalt psychologists, through studies of perception. It is a basic contention of Gestalt psychology that the immediate data of experience are not merely sensed but perceived; that, to take visual experience as an illustration, anyone looking about him in a naïve, uncritical way is immediately aware not merely of sensory contents such as green and blue in various shades and intensities, but of organized wholes or "gestalten," such as green trees and an expanse of blue lake with a definite shore line. The gestaltists further insist that such organized wholes are immediately experienced as perceptually organized; that their organization is the outcome, not of intellectual elaboration, but of the in-

teraction of forces within the perceptual field itself, including the physiological processes involved in perceiving. Taking perception as their clue, they explain thinking as a mode of activity that tends toward organized wholes similar in organization to perceptual gestalten, a mode of activity characterized during its course by successive organizations and reorganizations of the field in which it operates, until it is stabilized in the closed, definitely articulated structure that constitutes the solution of the problem

Specifically, Gestalt psychologists emphasize the role of *insight* in thinking This term covers a wide variety of cases; and though its precise meaning is not always readily apparent, it seems clear that it refers to the grasping of a relational pattern in a manner akin to the perceptual apprehension of an organized and unitary whole. This concept of insight first aroused widespread interest when W. Koehler published his famous study on the mentality of anthropoid apes Criticizing Thorndike's procedures as placing animals in situations that artificially reduced them to trial and error, Koehler conducted his experiments in surroundings familiar to the animals and resembling their natural habitat, and confronted them with problems which depended for solution on the animal's reaction to a relational pattern. Though he reported considerable behaviour classifiable as trial and error, Koehler stressed the point that the critical moment in the animal's solution of a problem was that in which he grasped the appropriate relational pattern—when, for example, he saw a box, upon which he could climb, as a means of making a workable connection between himself and the fruit suspended beyond his farthest reach Koehler's most famous single case of animal insight is that of an ape who, confined in a cage, in the presence of visible food at some distance outside the cage, and provided with bamboo sticks too short to reach the food, eventually, after signs of considerable difficulty and frustration, inserted one stick into another, thus fashioning a tool which brought into a single relational system, the desired food, the hungry animal and a means of closing the gap between them. The concept of insight has also been applied to some of the highest reaches of human intellectual achievement. Max Wertheimer used it in giving an account of so exceptional a course of thought as that which led Albert Einstein to his theory of relativity. The account was based on a series of leisurely conversations, during which Einstein described, in response to Wertheimer's questions, the course and manner of his thinking. According to Wertheimer, the successive stages reported by Einstein—among them, his first glimmerings of the problem, his preoccupation with the Maxwell equations, his lack of surprise at the results of the Michelson experiment, his incomplete satisfaction with the Lorentz transformations—were successive configurations and reconfigurations which, being partial insights, did not give a closed relational pattern, until he conceived of treating the velocity of light as an invariant, thus achieving an insight which, when elaborated, transformed classical physics and brought all the terms of the problem into a single system.

Working in a context very different from that of Gestalt psychology, Charles Spearman also based his account of thinking on reaction to relations. He found the paradigm of all cognition in the eduction from a given relational situation of something not immediately given in that situation· either the eduction of a relation (say, similarity) from two similar terms or fundaments; or the eduction of a correlate (say, a similar term) from a presented term and a presented relation, here similarity. He explained all levels of intellectual activity in terms of this basic schema. To support his interpretation, he made extensive use of tests of intelligence. He believed that the mathematical analysis of the results of various kinds and combinations of tests gave evidence of a mode of organization among intellectual abilities that required his theory as an explanation.

Attempts have been made, too, to understand thinking by considering it in relation to other psychological processes, especially those representing the basic needs, desires and urges of the organism. The strongest single influence in making this problem focal was that exerted by Sigmund Freud. According to Freud, the function of thinking, and indeed of all cognitive processes, is to procure satisfactions for the primal organic needs, especially those represented by sexual desires which repression has rendered unconscious In his early teachings, he strongly emphasized the point that all human motives spring from these primitive desires, and that by comparison, the intellectual processes not only play a minor and subsidiary role in human life, but are so weak as to be subject, under the influence of their powerful masters, to perversions like rationalization, fantasy and other forms of wishful thinking. In his later writings, he considered the cognitive processes more directly Here he treated perception as a device which the organism develops to gain a true representation of external reality, the source of all the means to real, not merely fantasied, satisfactions; and in this connection he treated thinking as a set of elaborative operations between perception and action, occasioned by inevitable difficulties and delays in obtaining such satisfactions. As means of coping with real situations, including the desires themselves, the cognitive processes were accorded a more important role than that formerly assigned them; but Freud still regarded them as secondary in function and power to the instinctual drives. William McDougall's treatment of the intellectual processes somewhat resembles Freud's. He too regarded the instincts as the springs of all action, including intellectual action; but in admitting, as determinants of behaviour, sentiments like loyalty and self-esteem, he, too, recognized motivational structures in which instincts had undergone intellectual modification.

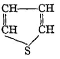
The wider context of thinking includes, not only its psychological setting, but its bodily determinants, its genetic and phylogenetic history, and the social field in which it operates. Concerning the bodily structures and functions that condition thinking, the evidence is too controversial to be considered here The status of the phylogenetic problem has already been briefly indicated; it is indeed one of the oddities of the psychology of thinking that at least as much scientific knowledge is available about the thinking of animals as about that of human beings. The genetic approach to the problem of thinking has been vigorously exploited. The extensive work of Jean Piaget may be cited as a single illustration. By systematically and expertly questioning children of different ages, Piaget and his co-workers undertook to chart the course of human intellectual development, tracing through the successive stages of childhood, characteristic changes in children's conceptions of the physical world, and also of their social world, as reflected in such conceptions as those of justice and guilt. Thinking has also been studied in its social and cultural setting. The social sciences, especially cultural anthropology, have insistently maintained that thinking is so strongly conditioned by cultural factors that very different ways of thinking develop in different cultural milieus. B. Malinowski has shown, again to take a single illustration, that a language is largely determined by the ways of life of a given culture, and it has become increasingly evident through logical, psychological and sociological investigations, that a person's language is a powerful determinant of the way in which he apprehends his physical and social environment, and hence of many of the deeply rooted, unconscious assumptions on which his thinking operates.

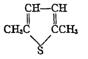
It is evident from the foregoing discussion that thinking remains one of the unsolved problems of psychology. There is, to be sure, a considerable mass of factual knowledge relevant to the problem, but this fact itself suggests that the immediate need in the psychology of thinking may be for some guiding conception of thinking, some theoretical formulation concerning its nature, which will order the available factual data and at the same time co-ordinate research. The many researches on thinking have been pursued from many different theoretical standpoints, and the various lines of investigation, though some show signs of converging, have not yet met in an explanation which accounts for all the available relevant facts in a manner acceptable to all those who are competent to judge. The psychology of thinking, then, must be presented, not as a record of achievement, but as a report of progress, or at least of persistent endeavour.

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THIONVILLE, capital of the arrondissements of Thionville-Est and Thionville-Ouest in the department of Moselle, France, 22 mi N. from Metz by rail. Pop. (1946) 17,596 Its German name is Diedenhofen. It is an ancient Frank town (Theudonevilla, Totonisvilla), in which imperial diets were held in the 8th century, was captured by Condé in 1643 and fortified by Vauban; capitulated to the Prussians, after a severe bombardment, on Nov 25, 1870, and was returned to France in 1918

THIOPHENE, an organic sulphur compound present in small quantities in coal-tar benzene, from which it is separated only with considerable difficulty, because of the close similarity of the physical and chemical properties of the two substances Thiophene is a colourless liquid with the odour of benzene; the former boils at 84° C., the latter at 80° C. Both readily undergo bromination, nitration and sulphonation. Coal-tar toluene is similarly accompanied by small amounts of α- and β-methylthiophenes and the xylenes contain traces of dimethylthiophenes. In each case the sulphur compound simulates closely the boiling point and other properties of the hydrocarbon.


I


II

Thiophene (formula I) was first recognized in coal-tar benzene and isolated from it by V Meyer (1883), who availed himself of the fact that thiophene is more readily sulphonated than benzene at the ordinary temperature. Benzene containing 0.5% of thiophene was shaken with cold, concentrated sulphuric acid, the impure thiophenesulphonic acid converted into lead salt and the latter distilled with ammonium chloride Impure thiophene was thus obtained and the process was repeated until the product after recti- [illegible] mercial importance because a convenient method of manufacture was discovered. In this process a mixture of butane (butene or butadiene) and sulphur was heated for a fraction of a second at 600° C.; a yield of about 20% to 25% of thiophene per pass through the heated zone was thus obtained. Recycling of unconsumed butane brought the total yield up to about 75%.

Thiophene is a more reactive chemical than benzene. In addition to the reactions listed above, thiophene reacts with cyanogen bromide to form bromothiophene, with acetyl chloride in the presence of titanium tetrachloride to yield acetothienone and with ethylmagnesium bromide to yield thienylmagnesium bromide. A trace of thiophene is recognizable by the blue colour of the indophenine reaction, brought about when a trace of thiophene or coal-tar benzene is added to isatin in concentrated sulphuric acid. The 1·4-diketones react in their dienolic forms on heating with phosphorus pentasulphide and yield homologues of thiophene. 2.5-dimethylthiophene (formula II) is thus obtained from acetonylacetone, CH_3 C(OH)·CH.CH C(OH) CH_3

BIBLIOGRAPHY.—V Meyer, *Der Thiophengruppe* (1888), W Steinkopf, *Die Chemie des Thiophens* (1941). (C. D. HD.)

THIRD DEGREE, originally a U S. slang or cant term, but now in common use in the United States and coming into such use in Great Britain, to designate the employment of brutal methods by police or prosecuting authorities to extort information or confessions from persons in custody The phrase is believed to have been suggested by the third masonic degree, that of master mason, which is conferred with considerable ceremony.

The phrase as often employed includes not only the use of physical violence, but also such forms of torture as depriving a prisoner of food, drink, sleep and toilet facilities and the prolonged and uninterrupted interrogation of him when exhausted, suffering and broken down by such deprivations. It is more commonly applied to those forms of physical assault (such as beating with a rubber hose) which produce pain but leave no traces

Since admissions and confessions of guilt have great probative weight when made voluntarily, it is obvious that unscrupulous officials interested in procuring convictions may be tempted to force unwilling confessions by improper means, and falsely to represent such confessions as voluntary. In several U S states, assertions that such methods are used to extort confessions or to elicit information have for some time been so common as seriously to disturb the courts Similar charges have in a few cases been made in the course of criminal trials in England. It is impossible, however, to state to what extent the practices described prevail (C. A. P.; X.)

THIRD (COMMUNIST) INTERNATIONAL: *see* INTERNATIONAL, THE

THIRD PARTY INSURANCE: *see* INSURANCE: MISCELLANEOUS.

THIRD PARTY PROCEDURE: *see* PRACTICE AND PROCEDURE.

THIRLWALL, CONNOP (1797–1875), English bishop and historian, was born at Stepney, London, on Jan. 11, 1797. He was educated at Charterhouse and at Trinity college, Cambridge In Oct 1818 he was elected to a fellowship, and went for a year's travel on the continent On his return he settled down to study law, but without much zeal, and in 1827 he definitely abandoned law, and was ordained deacon. At Rome in 1819 he had fallen in with Christian C. J Bunsen, and since that time had been interested in German literature He now joined with Julius C. Hare in translating Barthold G Niebuhr's *History of Rome* (1828). On Hare's departure from Cambridge in 1832, Thirlwall became assistant college tutor and was involved in the controversy upon the admission of Dissenters which arose in 1834 Thirlwall, in replying to objections by Thomas Turton, pointed out that no provision for theological instruction was in fact made by the colleges except compulsory attendance at chapel, and that this was mischievous After this outburst he had to resign his position as assistant-tutor. Nevertheless he received from Lord Brougham the living of Kirby-under-Dale in Yorkshire. Then he began his *History of Greece* (1835–44), which has remained a standard work.

In 1840 Thirlwall was raised by Lord Melbourne to the see of St. David's The great monument of his episcopate is the 11 famous charges in which he from time to time reviewed the position of the English Church with reference to pressing questions of the day—addresses at once judicial and statesmanlike, full of charitable wisdom and massive sense. Thirlwall was one of the four prelates who refused to inhibit Bishop John Colenso from preaching in their dioceses, and the only one who withheld his signature from the addresses calling upon Colenso to re-

sign his see He took the liberal side in the questions of Maynooth, of the admission of Jews to parliament, of the Gorham case, and of the educational conscience clause He was the only bishop who voted for the disestablishment of the Irish Church

During his latter years Thirlwall took great interest in the revision of the Authorized Version of the Bible, and was chairman of the revisers of the Old Testament He resigned his see in May 1874, and retired to Bath, where he died on July 27, 1875 He lies in Westminster Abbey in the same grave as Grote

Thirlwall's *History of Greece* (new ed 1845–52) remains a standard book *See* his *Remains, Literary and Theological*, ed J J S Perowne in three volumes (1877–80), two of which are occupied by his charges, *Letters, Literary and Theological*, with a connecting memoir, ed J J S Perowne and L Stokes (1881), and *Letters to a Friend* (Miss Johnes of Dolaucothy), ed Dean Stanley (1881) They were originally published by Dean Stanley, and there is a revised and corrected edition. For a general view of Thirlwall's life and character, *see* the *Edinburgh Review*, vol. cxliii , for a picture of him in his diocese, *Temple Bar*, vol. lxxvi

THIRSK, a market town and parish, North Riding of Yorkshire, Eng., 22 mi. north-northwest of York, on the Scottish Region railway and on the Cod Beck, a tributary of the river Swale The district is known as the Vale of Mowbray. Pop (1931) 2,651. Thirsk is first mentioned as a borough in a charter granted by Roger de Mowbray to Newburgh priory in the reign of Henry II The Perpendicular church of St. Mary with its 80-ft tower is one of the most beautiful churches in the Riding. Thirsk was steadily represented in parliament from 1552–3 until 1885.

THIRTY YEARS' WAR (1618–1648), the general name of a series of wars in Germany which began formally with the claim of Frederick, the elector palatine, to the throne of Bohemia and ended with the treaty of Westphalia. It was primarily a religious war and was waged with the bitterness characteristic of such wars, but at the same time political quarrels were interwoven with the religious question. with the consequence that the armies, considering themselves as their masters' retainers rather than champions of a cause, plundered and burned everywhere, military violence being in no way restrained by expediency.

Formation of the "Union" and the "League."—Fifty years before the outbreak of the war the Convention of Passau had compromised the burning questions of the Reformation, but had left other equally important points as to the secularization of church lands and the consecration of Protestant bishops to the future. Each such case, then, came before the normal government machine—a Diet so constituted that even though at least half of the secular princes and nine-tenths of their subjects were Protestants, the voting majority was Catholic. Moreover, the Jesuits had rallied and disciplined the forces of Catholicism, while Protestantism, however firm its hold on the peoples, had dissipated itself in doctrinal wrangles The strongest side was that which represented conservatism, peace and Catholicism. Realizing this from the preliminary mutterings of the storm, the Protestant princes formed a "Union," which was promptly answered by the Catholic League. This group was headed by the wise and able Maximilian of Bavaria and supported by his army, which he placed under a soldier of long experience and conspicuous ability, Count Tilly.

The Bohemian Movement.—The war arose in Bohemia, where the Protestant magnates refused to elect Ferdinand of Austria to the vacant throne, offering it instead to Frederick, the elector palatine. But the aggrandizement of this elector's power was entirely unacceptable to most of the Protestant princes—to John George of Saxony above all. They declared themselves neutral, and Frederick found himself an isolated rebel against the Emperor Ferdinand.

Even thus early the struggle showed itself in the double aspect of a religious and a political war. Just as the Bohemians and their nominee found themselves looked upon askance by the other Protestants, so the emperor himself was unable to call upon Maximilian's Army of the League without promising to aggrandize Bavaria Only the incoherence of the rebels saved Ferdinand They ordered taxes and levies of soldiers, but the taxes were not collected, and the soldiers, unpaid and unfed, plundered the country-side. The only coherent force was the mercenary corps of Ernst von Mansfeld, which, thrown out of employment by the termination of a war in Italy, had entered the service of Frederick. Nevertheless, the Bohemians were conspicuously successful at the outset. they won several engagements, and appeared before Vienna itself. Moravia and Silesia supported the Bohemians, and the Austrian nobles attempted, in a stormy conference, to wrest from Ferdinand not only religious liberty but also political rights that would have made Austria and Bohemia a loose confederation of powerful nobles. Ferdinand firmly refused, though the deputation threatened him to his face, and the tide ebbed as rapidly as it had flowed No sooner had Frederick accepted the crown than Maximilian let loose the Army of the League. Spanish aid arrived Spinola with 20,000 men from the Low Countries and Franche Comté invaded the Palatinate, and Tilly, with a combined army of Austrians and Bavarians crushed the Bohemians at the battle of the Weisser Berg near Prague (Nov. 8–18, 1620) With this the Bohemian war ended. Some of the nobles were executed, and Frederick, the "Winter King," was put to the ban of the empire But the emperor's revenge alarmed the Union princes. They were Protestants, and neither in religion nor in politics could they suffer an all-powerful Catholic emperor Moreover, the alternative to a powerful emperor was a powerful Bavaria, and this they liked almost as little.

Predatory Armies.—There still remained for the army of Tilly the reduction of the smaller garrisons in Bohemia, which when finally expelled rallied under Mansfeld, the last general of a lost cause Then there began the wolf-strategy that was the distinguishing mark of the Thirty Years' War An army even of ruffians could be controlled, as Tilly controlled that of the League, if it were paid. But Mansfeld, the servant of a shadow king, could not pay Therefore "he must of necessity plunder where he was. His movements would be governed neither by political nor by military considerations As soon as his men had eaten up one part of the country they must go on to another." These movements were for preference made upon hostile territory, and Mansfeld was so far successful in them that the situation in 1621 became distinctly unfavourable to the emperor. Tilly and the League Army fought warily and did not risk a decision. Thus even the proffered English mediation in the German war might have been accepted but for the fact that in the Lower Palatinate a corps of English volunteers, raised by Sir Horace Vere for the service of the English princess Elizabeth, the fair queen of Bohemia, found itself compelled, for want of pay and rations, to live, as Mansfeld lived, on the country along the Rhine. This brought about a fresh intervention of Spinola's Spaniards who had been destined to the interminable Dutch war. Moreover Mansfeld, having thoroughly eaten up the Palatinate, decamped into Alsace, where he seized Hagenau and wintered in safety.

The winter of 1621–22 passed in a series of negotiations which failed because too many interests, inside and outside Germany, were bound up with Protestantism to allow the Catholics to speak as conquerors, and because the cause of Protestantism was too much involved with the cause of the elector palatine to be taken in hand with energy by all Protestant princes But Frederick and Mansfeld found two allies One was Christian of Brunswick, the gallant young knight-errant, titular bishop of Halberstadt, queen Elizabeth's champion, and withal, though he called himself *Gottes Freund, der Pfaffen Feind*, a plunderer of peasants as well as of priests. The other was the margrave George Frederick of Baden-Durlach, reputed to be of all German princes the most skilful sequestrator of ecclesiastical lands. In April 1622, while Vere garrisoned the central fortresses of the Palatinate, Mansfeld, Christian and George Frederick took the field against Tilly, who at once demanded assistance from Spinola. The latter, though engaged with the Dutch, sent a corps under his subordinate Cordova. Mansfeld and the margrave of Baden defeated Tilly at Wiesloch (April 17–27, 1622). But soon the allies had to separate to find food. Then Cordova came up, and Tilly and the Spaniards combined defeated George Frederick at Wimpfen on the Neckar (April 26–May 6) Cordova chased Mansfeld back into Alsace, while Tilly went north to oppose Christian of Brunswick on the

Main. On June 10–20 the latter's army was almost destroyed by the League Army at Hochst Mansfeld, and with him Frederick, had already set out from Alsace to join Christian, but when that leader arrived with only a handful of beaten men, the war was practically at an end Frederick took Mansfeld and Christian back to Alsace, and after dismissing their troops, retired to Sedan. Henceforth he was a picturesque but powerless exile, and his lands and his electoral dignity, forfeited by the ban, went to the prudent Maximilian, who was created by the Emperor elector of Bavaria.

Mansfeld and Christian of Brunswick.—The next act in the drama, however, had already begun with the adventures of the outlaw army of Mansfeld and Christian. After Hochst, had it not been for them, the war might have ended in compromise James I of England was busy as always with mediation schemes. Spain, being then in close connection with him, and the Protestant princes of North Germany being neutral, a diplomatic struggle over the fate of the Palatinate might have ended in a new convention of Passau that would have regulated the present troubles and left the future to settle its own problems. The struggle would only have been deferred, it is true, but meanwhile the North German Protestants remained powerless and inactive, while Tilly's army was kept in hand to deal with the adventurers.

These, after eating up Alsace, moved on to Lorraine, whereupon the French Government "warned them off." But ere long they found a new employment The Dutch were losing ground before Spinola, who was besieging Bergen-op-Zoom, and the States-General invited Mansfeld to relieve it. The adventurers moved straight across Luxemburg and the Spanish Netherlands to the rescue. Cordova barred the route at Fleurus near the Sambre, but the desperate invaders, held together by the sheer force of character of their leaders, thrust him out of their way (Aug. 19–29, 1622) and relieved Bergen-op-Zoom. But ere long, finding Dutch discipline intolerable, they marched off to the rich country of East Friesland.

Their presence raised fresh anxieties for the neutral princes of North Germany In 1623 Mansfeld issued from his Frisian stronghold, and the threat of a visitation from his army induced many princes of the Lower Saxon Circle to join him. Christian was himself a member of the Circle, and although he resigned his bishopric, he was taken, with many of his men, into the service of his brother, the duke of Brunswick-Wolfenbüttel Around the mercenary nucleus gathered many thousands of volunteers, for the towns and the nobles' castles alike were alarmed at the progress of the Catholics, who were reclaiming Protestant bishoprics But this movement was nipped in the bud by the misconduct of the mercenaries The authorities of the Circle ordered Christian to depart. He returned to Holland, therefore, but Tilly started in pursuit and caught him at Stadtlohn, where on July 28–Aug. 6, 1623 his army was almost destroyed. Thereupon the Lower Saxon Circle, which, like the Bohemians, had ordered collectively taxes and levies of troops that the members individually furnished either not at all or unwillingly, disbanded their army to prevent brigandage. Mansfeld, too, having eaten up East Friesland, returned to Holland in 1624.

Foreign Intervention.—The only material factor was now Tilly's ever-victorious Army of the League, but for the present it was suspended inactive in the midst of a spider's web of European and German diplomacy. Spain and England had quarrelled. The latter became the ally of France, over whose policy Richelieu now ruled, and the United Provinces and (later) Denmark joined them Thus the war was extended beyond the borders of the empire, and the way opened for ceaseless foreign interventions. From the battle of Stadtlohn to the pitiful end 20 years later, the decision of German quarrels lay in the hands of foreign powers. France was concerned chiefly with Spain, whose military possessions all along her frontier suggested that a new Austrasia, more powerful than Charles the Bold's, might arise. James, in concert with France, re-equipped Mansfeld and allowed him to raise an army in England, but Richelieu was unwilling to allow Mansfeld's men to traverse France, and they ultimately went to the Low Countries, where, being raw pressed-men for the most part, and having neither pay (James having been afraid to summon parliament) nor experience in plundering, they perished in the winter of 1625. At the same time a Huguenot rising paralysed Richelieu's foreign policy Holland after the collapse of Mansfeld's expedition was anxious for her own safety owing to the steady advance of Spinola. The only member of the alliance who intervened in Germany itself was Christian IV. of Denmark, who as duke of Holstein was a member of the Lower Saxon Circle, and as king of Denmark was anxious to extend his influence over the North sea ports. Gustavus Adolphus of Sweden, judging better than any the difficulties of affronting the empire and Spain, contented himself with carrying on a war with Poland.

Intervention of Christian of Denmark.—Christian IV. raised an army in his own lands and in the Lower Saxon Circle in the spring of 1625. Tilly at once advanced to meet him. But he had only the Army of the League, the Emperor's troops being occupied in a war on Gabriel Bethlen of Transylvania. Then, like a *deus ex machina*, Wallenstein, duke of Friedland, came forward and offered to raise and maintain an army in the emperor's service. It was an army like Mansfeld's in that it lived on the country, but its exactions were systematic and the products economically used, so that it was possible to feed 50,000 men instead of 20,000 This method, the high wages which he paid, and his own princely habits and commanding personality gave it a cohesion that neither a free company nor an army of mere Lower Saxon contingents could ever hope to attain.

In 1625, Wallenstein kept his new army well away from the risks of battle until he could trust it to conquer. It was fortunate for Ferdinand that he did so. Christian IV., who had been joined by Mansfeld and Christian of Brunswick, had, in 1626, 60,000 men. Wallenstein and Tilly together had only a very slight numerical superiority, and behind them was nothing Even the hereditary provinces of Austria were threatening revolt and Gabriel Bethlen was again giving trouble. But on the other side the English subsidies failed, and the Protestant armies soon began to suffer in consequence. Tilly opposed Christian IV ; Wallenstein, Mansfeld. The latter advanced upon Wallenstein, attacked him in an entrenched position at the Bridge of Dessau and was thoroughly defeated (April 25–25, 1626). He then wandered across Germany into Silesia and joined Bethlen. Wallenstein followed up, and by taking up strong positions, compelled Mansfeld and Bethlen to choose between attacking him and starving. So, without a battle, he brought about a truce, whereby Bethlen was disarmed and Mansfeld was required to leave Hungary. Mansfeld and Christian of Brunswick died soon afterwards, the one in Hungary, the other in Westphalia. King Christian, left alone and unable without English subsidies to carry on the war methodically, took the offensive, as Mansfeld had done, in order to live on the Thuringian countryside. But Tilly, with whom Wallenstein had left a part of his army, moved as quickly as the king, brought him to action at Lutter-am-Barenberge in Brunswick and totally defeated him (Aug 27–27)

With this, armed opposition to Tilly and Wallenstein in the field practically ceased, but their armies continued to live on the country Christian of Denmark slowly gave up fortress after fortress to Tilly. Wallenstein, returning from the campaign against Gabriel Bethlen, drove Christian's army through Jutland and into the sea (1627). But Wallenstein, with his dreams of a united Germany free in conscience and absolutely obedient to the emperor, drifted farther and farther away from the League Ferdinand thought that he could fulfil the secular portion of Wallenstein's policy while giving satisfaction to the Catholics. The princes and bishops of the League continued to oppose any aggrandizement of the emperor's power at their expense and to insist upon the resumption of church lands. In this equilibrium the North German Protestant cities were strong enough to refuse to admit Wallenstein's garrisons. In 1628 Wallenstein, who had received the duchy of Mecklenburg on its rightful lord being put to the ban for his share in the Danish war, began to occupy his new towns, and also to spread along the coasts. But the Hanse towns rejected his overtures, and Stralsund, second-rate seaport though it was, absolutely refused to admit a garrison of his wild soldiery. The result was the famous siege of Stralsund (Feb. to Aug. 1628), in which the

citizens compelled the hitherto unconquered Wallenstein army to retire. The siege was, as the result proved, a turning-point in German history The emperor's policy of restoring order had practically universal support. But the instrument of the restoration was a plundering army. Even this might have been borne had Wallenstein been able to give Germany, as he wished, not only peace but religious freedom When the Edict of Restitution (1629) gave back 150 northern ecclesiastical foundations to the Catholics, men were convinced that one ruler meant one religion.

Gustavus Adolphus of Sweden.—Rather than endure this the North Germans called in Gustavus Adolphus of Sweden and, just as Gustavus landed, the resentment of the princes of the League against Wallenstein's policy and Wallenstein's soldiers came to a head, and the emperor was forced to dismiss him. His soldiers were taken over by Tilly, and for the moment he disappeared from the scene On Gustavus's side, a thoroughly trained army, recruited from good yeomen and stout soldiers of fortune, paid good wages, and led by a great captain, was a novelty in war that more than compensated for Tilly's numerical superiority Gustavus, however, after landing at Peenemunde in June, spent the rest of the year in establishing himself firmly in Mecklenburg and Pomerania, in order to secure the active support of the more important Protestant princes, so as to appear as an auxiliary rather than a principal in the German conflict First the old duke Bogislav of Pomerania, then George William of Brandenburg joined him, very unwillingly. He was soon afterwards allied with France, by the treaty of Bärwalde (Jan. 1631) John George of Saxony, still attempting to stifle the war by a policy of neutrality, sent a last appeal to Vienna, praying for the revocation of the Edict of Restitution. Meanwhile Tilly had marched into north-eastern Germany, where his lieutenant Pappenheim was besieging Magdeburg This city had twice defied Wallenstein's attempts to introduce a garrison, and it was now in arms against the League. Gustavus, as yet without active allies, thought it impossible to go forward alone, and could only hope that his sudden and brilliant storm (April 3–13) of Frankfurt-on-Oder would distract Tilly from the siege.

Sack of Magdeburg.—But the hope was vain and when, realizing this, he moved directly to Magdeburg's relief, his passage through the territories of the Electors of Brandenburg and Saxony was delayed by the objections of the Protestant princes While he was negotiating with them in turn, Magdeburg, although the citizens fought desperately, was stormed, sacked and burned on the night of May 10, 1631, amidst horrors that neither of the imperialist generals was able to check. The Catholics rejoiced as though for another St. Bartholomew's day, the Protestants were paralysed, and Gustavus, accused on all hands of having allowed the Magdeburgers to perish, sorrowfully withdrew into Pomerania. But Tilly, in spite of Pappenheim's remonstrances, turned westward against Hesse-Cassel and other minor principalities whose rulers had declared for Gustavus The king of Sweden, thereupon, advanced to Werben (at the junction of the Elbe and the Havel), where his army entrenched itself, and, in spite of sickness and famine, stoically awaited the attack. The desired result was achieved. At the end of July Tilly, returning from the west, made his appearance and was twice repulsed (July 13–23 and 18–28), losing 6,000 men out of 22,000. Thereupon, turning away from Gustavus's entrenchments, Tilly invaded Saxony, being reinforced *en route* by 20,000 men from Italy. The elector John George at once made an alliance with the Swedes.

Battle of Breitenfeld.—Then Gustavus advanced in earnest. He crossed the Elbe at Wittenberg. 16,000 Saxons joined his 26,000 Swedes at Düben, and some of the western Germans had already come in. Tilly had just captured Leipzig, and outside that place, carried away by Pappenheim's enthusiasm, he gave battle on Sept. 7–17 to the now superior allies. The first battle of Breitenfeld (*q.v.*) was a triumphant success for Gustavus and for the new Swedish system of war. Though the raw Saxons were routed at the outset by Tilly's men, the Swedes on the other wing drove the veterans of the League off the field in disorder, leaving 6,000 dead. Tilly himself was thrice wounded and barely escaped.

All Protestant Germany hailed Gustavus as the liberator. John George, the Swedish general Horn and the Swedish chancellor Oxenstierna united in advising Gustavus to march straight upon Vienna. Richelieu was of the same mind But Gustavus deliberately chose to move into South Germany, there to organize the cities and the princes in a new and stronger Protestant Union, the *Corpus Evangelicorum*, and to place himself in a country full of resources whence he could strike out against the emperor, Tilly and the Rhine Spaniards in turn. The Swedish army pushed on to Mainz, where it wintered in luxury. The Palatinate was reorganized under Swedish officials and the reformed religion established again In March 1632 the campaign was resumed. Nuremberg and Donauworth welcomed Gustavus. Tilly's army, reorganized for the defence of Bavaria, stood to fight on the Lech, but the passage was forced (April 4–14) and Tilly himself was mortally wounded. Augsburg, Munich and all the country south of the Danube were occupied without resistance. At the same time John George's Saxons, advancing into Bohemia, entered Prague without firing a shot.

Wallenstein Returns.—The emperor had now either to submit or to reinstate Wallenstein Wallenstein demanded as the price of his services the reversal of the Edict, and power to dethrone every prince who adhered to the Swedes. His terms were accepted, and in April 1632 he took the field as the emperor's *alter ego* with a new army that his recruiters had gathered in a few weeks He soon expelled the Saxons from Bohemia and offered John George amnesty and the rescinding of the Edict as the basis of peace. The elector, bound by his alliance with Gustavus, informed the Swedish king of this offer, and a series of negotiations began between the three leaders. But John George had too much in common with each to follow either Wallenstein or Gustavus unreservedly, and the war recommenced. The Swedish king had now to meet Wallenstein's new army of 60,000, composed of the men immortalized by Schiller's play, excellent in war and in plundering, destitute of all home and national ties, and owning allegiance to its general alone. While Gustavus in Franconia was endeavouring with little success to consolidate his *Corpus Evangelicorum* Wallenstein came upon the scene Gustavus offered him battle. But as in 1625 Wallenstein would risk no battle until his army had gained confidence. He entrenched himself near Fürth, while Gustavus camped his army about Nuremberg and a contest of endurance ensued. Wallenstein, aided by his superiority in irregular cavalry, was able to starve for three days longer than the king, and at last Gustavus furiously attacked the entrenchments (battle of the Alte Veste, Aug. 24–Sept. 3, 1632) and was repulsed with heavy losses. Thereupon he retired, endeavouring in vain to tempt Wallenstein out of his stronghold by making his retreat openly and within striking distance of the imperialists. Wallenstein had other views than simple military success. Instead of following Gustavus he marched into Saxony, his army plundering and burning even more thoroughly than usual in order to force the Saxons into peace. Gustavus followed with the swiftness that was peculiar to the Swedish system, and concentrated at Erfurt when Wallenstein had scarcely mastered Leipzig. But it was now late in the season, and Wallenstein hoped to spin out the few remaining weeks of the campaign in an entrenched position. Gustavus, without waiting for Arnim's Saxons to join him, suddenly moved forward, and on Nov. 6–16 the battle of Lützen (*q.v.*) was fought, a battle as fierce even as Breitenfeld. Gustavus was slain, but Wallenstein's army was driven from the field.

The League of Heilbronn.—The fall of Gustavus practically determined the intervention of France, for Richelieu supported all electors, Catholic or Protestant, against the central power at Vienna as part of his anti-Spanish policy, and French assistance was now indispensable to the Protestants. For although Lützen was a victory and the Protestant circles formed the League of Heilbronn in April 1633, the emperor was really in the ascendant. John George of Saxony needed but little inducement to make peace But the tragedy of Lützen was soon to be followed by the tragedy of Eger Wallenstein, gradually forming the resolve of forcing peace on Germany with his army, relaxed his pressure on Saxony, and flung himself upon the Swedish garrisons in Silesia.

Winning a victory at Steinau (Oct. 11, 1633) and capturing one town after another, he penetrated almost to the Baltic But he was recalled to the south-west before his operations had had any effect. The Swedish army, now under Bernhard of Saxe-Weimar, Horn and Banér, had returned to the South, and took Regensburg from Maximilian's army But it was now late in the year and Wallenstein was intent upon peace. With this object he endeavoured to secure the higher officers of the army, but these were gradually won over by Spanish emissaries; the emperor, having decided to continue the war in alliance with Spain, dismissed his general for the second time. Wallenstein then openly attempted to unite the Swedish, Saxon and other Protestant armies with his own, so as to compel all parties to make peace. But his officers would not follow, the *coup d'état* failed, and Wallenstein was murdered at Eger by his own lieutenants, with the full sanction of the Emperor (Feb. 15–25, 1634).

All idea of German unity died with him, and for the next 14 years Germany was simply the battle-ground of French, Spanish, Austrian and Swedish armies, which, having learned the impunity and advantages of plunder in the school of Mansfeld and Wallenstein, reduced the country to a state of misery that no historian has been able to describe, save by detailing the horrors of one or other village among the thousands that were ruined Germany remained for a century in the stillness of exhaustion

Battle of Nordlingen.—Success was for the present with the emperor and Spain Under the leadership nominally of the king of Hungary, Ferdinand's heir, but really of Gallas, the army recaptured Regensburg and Donauwörth, and when the Spanish Cardinal Infante joined them with 15,000 men on his way from Italy to the Netherlands, they were invincible Bernhard of Weimar and the Swedes attacked them in an entrenched position at Nordlingen (Aug. 27/Sept. 6, 1634) and was beaten with absolutely ruinous loss. The model army of Gustavus perished there, and for the rest of the war a Swedish army, except for some advantages of organization and technical form, was intrinsically no better than another John George, having obtained from Ferdinand a compromise on the question of the Edict, agreed to the peace of Prague (May 20–30, 1635), wherein all that was Protestant in 1627 was to remain so, or if since resumed by the Roman Church to be returned to the Lutherans. A certain number of princes followed John George's example on the same terms. There was now no ideal, no objective, common even to two or three parties Gustavus's *Corpus Evangelicorum* as a German institution was moribund since Nördlingen, and Richelieu and the Spaniards stepped forward as the protagonists.

The Policy of Richelieu.—The centre of gravity was now the Rhine valley, the highroad between Spanish Italy and the Spanish Netherlands Richelieu had, as the price of his assistance after Nördlingen, taken over the Alsatian fortresses held by the Swedes, and in May, just before the treaty of Prague was signed, he declared war on Spain. The French army numbered 130,000 men in 1635, and 200,000 in the year after One army assembled in Upper Alsace for the attack of the Spaniards in Franche Comté; another occupied Lorraine, which had been conquered in 1633; a corps under Henri de Rohan was despatched from the same quarter across Switzerland, to expel the enemy from the Valtelline, Another force, co-operating with the duke of Savoy, was to attack the Milanese Bernhard was to operate in the Rhine and Main country. Having thus arranged to isolate the Spanish Netherlands, Richelieu sent his main army, about 30,000 strong, thither to join Frederick Henry of Orange and so to crush the Cardinal Infante. This was strategy on a scale hitherto unknown in the war. Richelieu had unified France under the single authority of the king, and his strategy, like his policy, was masterful and clear. But the event proved that his scheme was too comprehensive Richelieu proposed to strike at each of the two halves of his enemy's power at the same time as he separated them. His forces were not sufficient for these tasks and he was therefore compelled to eke them out, both in Italy and the Netherlands, by working with allies whose interests were not his. Popular outbreaks among the Brabanters and Flemings led Frederick Henry to withdraw to his own country and in 1636 the French northern army had to face the whole of the Cardinal Infante's forces In Italy the Franco-Piedmontese army achieved practically nothing In Alsace and Lorraine neither side was strong enough to prevail Bernhard waged a desultory campaign in Germany, and later, when supplies gave out he and his army were taken into the French service. In eastern Germany the consequences of the peace of Prague were that Saxony, Brandenburg and other States, signatories to the treaty, were *ipso facto* the enemies of those who continued the war. Thus John George turned his arms against the Swedes in his neighbourhood But their commander Banér was as superior in generalship as he was inferior in numbers, and held the field until a truce between Sweden and Poland set free a fresh Swedish corps that had been held ready for eventualities in that country. This corps, under Torstensson, joined Banér in October, and on Nov. 1 they won an action at Domitz on the Elbe.

Thus Richelieu's great scheme was only very partially executed. The only important military events of the year took place outside Germany; within Germany men were chiefly occupied in considering whether to accept the terms of the peace of Prague. But the land had no rest, for the armies were not disbanded. In 1636 the movements foreshadowed in 1635 were carried out with energy. John George, aided by an imperialist army, threatened to interpose between Banér and the Baltic. But Banér was too quick for them. Before the Brandenburg contingent could join John George, he brought on a general action at Wittstock (Sept. 24–Oct 4, 1636). The elector had 30,000 men against 22,000 and sought to attack both in front and rear. But while his entrenchments defied the frontal attack Banér threw most of his army upon the enveloping force and crushed it. The Swedes lost 5,000 killed and wounded, the combined army 11,000 killed and wounded and 8,000 prisoners The prestige of so brilliant a victory repaired even Nördlingen, and many North German princes who were about to make peace took fresh heart.

Invasion of France.—In the west, though there were no such battles as Wittstock, the campaign of 1636 was one of the most remarkable of the whole war The Cardinal Infante was not only relieved by the retreat of the Dutch, but also reinforced by a fresh army[1] under a famous cavalry officer, Johann von Weerd. He prepared, therefore, to invade France from the north-west. The French were too much scattered to offer an effective resistance, and the Cardinal Infante's generals took Corbie, passed the Somme and advanced on Compiègne. For a moment Paris was terror-stricken, but the Cardinal Infante missed his opportunity. Louis XIII. and Richelieu turned the Parisians from panic to enthusiasm The burghers armed and drilled, money, too, was willingly given, and some 12,000 volunteers went to Compiègne, where all levies and reinforcements were concentrated Thus the army at Compiègne was soon 50,000 strong. It was only half mobile owing to its rawness and its "trained-band" character, but the Spaniards and Bavarians retired unmolested to oppose Frederick Henry in the Low Countries

During the episode before Compiègne another storm burst on the eastern frontier of France This was the inroad into Burgundy of Gallas with the main imperialist army He took a few small towns, but Dijon and the entrenchments of Bernhard's army there defied him, and his offensive dwindled down to an attempt, soon abandoned, to establish his army in winter quarters in Burgundy.

War in Italy.—In Italy the duke of Savoy with his own army and a French corps under Créqui advanced to the Ticino, and an action in which both sides lost several thousand men was fought at Tornavento, a few miles from the future battlefield of Magenta, to which in its details this affair bears a singular resemblance (June 22, 1636). But the victory of the French was nullified by the refusal of Victor Amadeus, for political reasons, to advance on Milan.

The campaign of 1637, on the French and Spanish side, was not productive of any marked advantage to either party. From Catalonia a Spanish army invaded Languedoc, but was brought to a standstill in front of the rocky fortress of Leucate and defeated with heavy losses by the French relieving army under Schom-

[1] Composed partly of Bavarians, partly of Cologne troops.

berg. On the Low Countries frontier the cardinal de La Valette captured Câteau Cambrésis, Landrecies and Maubeuge.

War on the Rhine.—On the Rhine and in the adjacent countries Johann von Weert, returning from Belgium with his Bavarians, captured Ehrenbreitstein, the citadel of Coblenz, and expelled small French detachments from the electorate of Trier, whose ruler, the archbishop, had been put to the ban by the emperor. Then, passing into the Main valley, he took Hanau. The main imperialist army, still under Gallas, had departed from Alsace to the east in order to repair the disaster of Wittstock, and Charles of Lorraine was defeated by Bernhard on the Saône in June, after which Bernhard advanced vigorously against Piccolomini, the imperialist commander in Alsace But soon Piccolomini was joined by Johann von Weert, and Bernhard retired again

In the north-east the effect of Wittstock proved but transient In 1638 Banér found himself the target of several opponents The Saxons did no more than defend their own country, but the imperialists and Bavarians uniting under Gen Geleen manoeuvred Banér out of his strongholds on the Elbe He retreated on the Oder, but there found, not the expected assistance of Wrangel's Pomeranian army, but Gallas with the main imperial army which had hurried over from the west Banér escaped only by a stratagem. Deluding Gallas with an appearance of retreat into Poland, he slipped northwards, joined Wrangel, and established himself for a time in Pomerania Gallas ruined his army by exposing it to an open winter in this desolate country, and at last retired to the Elbe.

Fighting in the Netherlands and Alsace.—In 1638 the French operations in Italy, Belgium and Spain were in the main unsuccessful. In Italy the Spanish advanced to the Sesia and took Vercelli. In the Low Countries Prince Thomas and Piccolomini repulsed in turn the Dutch and the French In the south the Prince of Condé led from Bayonne an invading army that was to dictate terms at Madrid, but failed ignominiously before the small frontier fortress of Fontarabia But the case was different in Alsace. There Richelieu was more than ever determined to strike at the Spanish power, and there too was Bernhard, who hoped that Alsace was to be his future principality, with the survivors of Breitenfeld and Nördlingen, now in French pay under the name of the "Weimar Army." Bernhard had wintered about Basle, and began operations by taking a few towns in the Black Forest. Johann von Weert, however, fell upon him by surprise and drove him away (Feb. 28). But Bernhard reassembled his adventurers and invited them to return and beat the imperialists at once. The outcome was the battle of Rheinfelden, in which the redoubtable Weert, who had terrified Paris in 1636, was taken prisoner and his army dissipated (March 3). Bernhard later invested Breisach and received its surrender when the garrison had eaten the cats, dogs and rats in the place, on Dec. 17.

In the course of 1638 peace negotiations were carried on at Cologne and Hamburg, but the war still dragged on. In the east, 1639 began with Banér's pursuit of the retreating Gallas Thanks to his skill the Swedish star was again in the ascendant. Banér crossed the Elbe, inflicted a severe defeat on the imperialists at Chemnitz (April 14, 1638), and then after overrunning western Saxony advanced into Bohemia. But he contented himself, after an unsuccessful attempt upon Prague, with thoroughly eating up the country and, as winter came on, he retired into the Saxon mountains.

France and Spain.—In 1639, as before, Richelieu's attacks on Spain, other than those directed upon Alsace and Baden, were unsuccessful. In the north the French devoted this year, as they had devoted 1637 and 1638, to a methodical conquest of walled towns in view of a future *frontière de fer*. The two objectives selected, Hesdin and Thionville, were far apart, and Piccolomini, by a forced march from Liège and Huy through the Ardennes, flung himself upon the besiegers of Thionville before their "circumvallation" was completed, and being greatly superior in numbers he almost annihilated them (June 7, 1639). But on the Flemish flank Hesdin was driven to surrender. On the side of the Pyrenees Condé as usual showed himself both unlucky and incapable. In Italy Cardinal de La Valette died after allowing Prince Thomas to win over Savoy to the emperor's side and seeing almost every French post lost

His successor was the duc d'Harcourt, called by his men "Cadet-la-Perle" on account of his earrings, but a bold and exceedingly competent soldier Under him served Turenne, hitherto known only as a younger brother of the duke of Bouillon Harcourt successfully revictualled Casale, and beat the Savoyards and Imperialists in the Route de Quers (Nov 29).

In Alsace Bernhard was carried off by a fever just as he was preparing to fight his way to a junction with Banér. Nevertheless he was fortunate in the opportunity of his death, for his dream of a duchy of Alsace had already brought him into conflict with Richelieu, and their conflict could only have ended in one way. Another event of importance in this year was the episode of the Spanish fleet in the Downs. Now that the land route was imperilled the sea communications of Spain and Belgium were brought into use. A squadron sailed from Spain for the Netherlands, and, though it evaded the now powerful French navy, it was driven into English territorial waters by the Dutch. Charles I. of England offered France free access to the victim if France would restore the Elector Palatine, offered Spain protection if she would furnish him with funds for his army But the Dutch, contemptuous of his neutrality, sailed in and destroyed the fleet at anchor.

In 1640 the French still kept up their four wars in Belgium, Germany, Italy and Spain But the Belgian and Spanish frontiers were no longer directly attacked. The Catalans turned their arms against the old enemy Castile and Portugal declared herself independent under a king of the house of Braganza. In the Low Countries Louis XIII himself presided over the siege of the important fortress of Arras, which surrendered on Aug 8

Casale and Turin.—In Italy, however, Cadet-la-Perle kept the moral ascendancy he had won in the brave action of the *Route de Quers*. In April with 10,000 men he advanced from Carignan against the 20,000 Spaniards who were besieging Casale and attacked their line of circumvallation boldly and openly on April 29. Half of Leganez's army was killed or captured. After this, Harcourt promptly turned upon Prince Thomas, and then followed one of the most curious episodes in military history. Thomas, himself defending Turin, was besieging the French who still held the citadel. while Harcourt, at once besieging the town and attempting to relieve the citadel, had, externally, to protect himself against Leganez's army which was reorganized and reinforced from Naples and the Papal States. Harcourt's courage and the disunion of his opponents settled the problem Their general attack of July 11 on the French lines was made not simultaneously but successively, and Harcourt repulsed each in turn with heavy losses Soon afterwards the French received fresh troops: the citadel was relieved and the town surrendered. Leganez retired to Milan.

In Germany Banér's course was temporarily checked and when at last Bernhard's old army, under the duc de Longueville, crossed the Rhine and joined Banér in Thuringia, the country could not support the combined army The Weimar army retired to the Rhine valley and Banér to Waldeck. A fresh opportunity came to Banér in the winter months of 1640–41. Negotiations for peace were constantly in progress, but no result seemed to come out of them. The Diet was assembled at Regensburg. Banér suddenly moved south to surprise the Diet, for the defence of which all available troops were hurried up by the emperor. The Weimar army under Guébriant joined the Swedes *en route*, and the combined army reached the objective But a thaw hindered them and gave the emperor time to concentrate his forces, and the raid failed. On May 20 Banér, worn out by fatigue, died, and Torstensson succeeded to the command The war had now receded far from Alsace, which was firmly held by France, but Harcourt's continued success in Piedmont and the trouble to Spain caused by the Catalan and Portuguese insurrection was partly balanced by France's own difficulties in the abortive conspiracy against Richelieu.

In Dec. 1641 there began at Münster and Osnabruck in Westphalia the peace negotiations which, after eight more years of spasmodic fighting, were to close this ruinous war. In 1642 Tors-

tensson crossed the Elbe and besieged Leipzig. The imperialist army, which was joined by the Saxons when their country was again the theatre of war, marched to the rescue. But Torstensson defeated them with enormous loss in the second battle of Breitenfeld (Nov 2, 1642) But, although the Austrians feared an advance on Vienna itself, the victors waited for the fall of Leipzig and then took up winter quarters. The Bavarians had advanced into the lower Rhine region in order to support, in concert with the Belgian army of Spain, a fresh outbreak in France (Cinq-Mars' conspiracy). But the Spanish were attacked and defeated before the Bavarians came up, at Holzkirchen (Jan. 17), whereupon the Bavarians took shelter under the guns of the fortress of Julich.

On the northern frontier of France, Harcourt, the brilliant commander of the Italian army, failed to prevent the Spaniards from capturing Lens and La Bassée, and another army was defeated and routed at Honnecourt (May 26) The Spaniards in the Milanese lost fresh ground. Louis XIII. himself conquered Roussillon. Richelieu crushed the conspiracy of Cinq-Mars by executing its leaders, and Marshal de la Motte-Houdencourt held Catalonia and defeated Leganez at Lerida (Oct. 7th)

The Duc d'Enghien.—Before the next campaign opened, Louis and Richelieu were dead. One of the last acts of the king was to designate the young duc d'Enghien, son of the incapable Condé, general of his northern army It was no small matter to put in command a youth of 21, who might prove not merely inexperienced but also incompetent. But Enghien's victory was destined to be the beginning for the French army of a long hegemony of military Europe. Mello, the Spanish general, had selected the Meuse route for his advance on Paris On it he would meet only the places of Rocroi and Rethel. The young duke learned at the same moment that Louis XIII was dead and that the Spaniards had invested Rocroi With the resolution and swiftness which was to mark his whole career, he marched at once to offer them battle, though all the generals of the old school were for delay. The battle took place on May 19, 1643, in a plain before Rocroi. Mello's cavalry was routed, and nearly all the infantry, the best regiments in the Spanish army, stood their ground and were annihilated.

But even Rocroi, under the existing conditions of warfare, was decisive only in so far as, by the destruction of Spain's superiority in Belgium, it saved France from further danger from the north. The thorough establishment of the French on the Rhine and the need of co-operating with the Swedes were considered by the young general to be more important than fighting Mello in front of Brussels, and in spite of the protests of the Regent and Mazarin, he decided to attack Thionville. Taking a leaf out of Mello's book, he threatened Brussels in order to draw all the defenders thither, and then suddenly turned eastward Enghien arrived on June 18, and on Aug 8, Thionville surrendered.

Beyond the Rhine Guébriant was mortally wounded in the siege of Rottweil, and Rantzau, taking over the command, allowed himself to be surprised in the act of dispersing into winter-quarters, and was defeated at Tuttlingen on the headwaters of the Danube (Nov. 24).

In the East the campaign had as usual turned more upon subsistence than upon military operations. Torstensson swept through Bohemia and Moravia, his steps dogged through the devastated country by Gallas, until he reached Brünn. Thence, however, he suddenly retreated to the shores of the Baltic. For Christian of Denmark had declared war on Sweden, and threatened to isolate the Swedish forces in Germany. Torstensson, therefore, wintered in Holstein. In Italy and Spain there was no event of any importance

In 1644 Gaston of Orleans began the conquest of the Dunkirk region in July, and Mello, having no army to oppose him, remained inactive. In Italy there happened nothing serious, while in Spain La Motte-Houdencourt lost Lerida, and was imprisoned by Mazarin in consequence. But the Rhine campaign is memorable for the first appearance of Turenne at the head of an army and for the terrible battle of Freiburg.

Freiburg.—In Suabia Mercy's Bavarians were left to oppose Turenne, who spent the first months of the year in restoring discipline and confidence in the shaken Weimar army But Mercy was still considerably superior in strength, and, repulsing Turenne's first inroad into the Black Forest, besieged Freiburg. Turenne made one cautious attempt at relief, then waited for reinforcements. These came in the shape of Enghien's army, and Enghien as a prince of the blood took over the supreme command But both armies together numbered hardly 17,000 men when Enghien and Turenne united at Breisach on Aug 2 On the 3rd they crossed the Rhine and attacked Mercy's position, which was of great natural and artificial strength, in front and flank Three separate battles, which cost the Bavarians one-third of their force and the French no less than half of theirs, ended in Mercy's retreat (*see* FREIBURG IM BREISGAU) on Aug. 10. Enghien did not follow him into the mountains, but proceeded to the methodical conquest of the middle Rhine fortresses, leaving Turenne and the Weimar army at Spire

In the east, or rather in the north, a desultory campaign was carried on during 1644 between Torstensson and the younger Wrangel, on the one side, the Danes and Gallas on the other, and in the end Gallas retreated to Austrian territory, so completely demoralized that his army dwindled on the way from 20,000 men to 2,000. Torstensson followed him, having little to fear from the Danes. Meanwhile the prince of Transylvania, George Rakóczy, playing the part of Gabriel Bethlen his predecessor, made war upon the emperor, who not being able on that account to send fresh troops against Torstensson called for help to Maximilian of Bavaria The Elector sent most of his own troops under Weert on the same errand—hence Mercy's defeat at Freiburg. But Torstensson pressed on towards Vienna, and on Feb. 24–March 6, 1645 he inflicted a crushing defeat on the Bavarians and Imperialists at Jankau near Tabor. In his extremity Ferdinand offered part of Bohemia and Silesia to Maximilian in return for soldiers But the Bavarian ruler had no more soldiers to give, for Turenne was advancing again from the Rhine.

At the end of March the Weimar army marched to Heilbronn, and Rothenburg-on-Tauber, when Turenne resolved to go northward in search of supplies and recruits in the territories of his ally and cousin the landgravine of Hesse-Cassel. But at this point the army, headed by Bernhard's old colonels, demanded to be put into rest-quarters, and Turenne allowing them to disperse as they wished, was surprised by Mercy and Weert—who brought his courage, if nothing else, back from the field of Jankau—and lost two-thirds of his forces. But Turenne, instead of retreating to the Rhine, installed himself in the landgravine's country, while Enghien hurried up from the Moselle to his aid. The "Army of Weimar" and the "Army of France" joined forces, as in 1644, almost under the eyes of the enemy. Enghien at once pushed forward from Ladenburg, by Heidelberg and Dinkelsbuhl, and found the Austro-Bavarians under Mercy entrenched in a strong position at Allerheim near Nördlingen, directly barring the way to the Danube. The second battle of Nördlingen (Aug. 3, 1645) was as desperately fought as the first, and had not Mercy been killed at the crisis of the day Enghien would probably have been disastrously defeated. As it was, the young duke was victorious, but he had only 1,500 infantry left in rank and file out of 7,000 at the end. Soon afterwards Enghien fell ill, and his army returned to France. Turenne, left with a few thousand men, attempted in vain to hold his ground in Germany and had to make a hasty retreat to Philippsburg on the Rhine, almost the only remaining conquest of these two brilliant but costly campaigns. In Flanders Gaston of Orleans conquered a number of fortresses, and his army united with that of the Dutch. But the allies separated again almost at once, each to undertake the sieges which suited its own purposes best.

From Silesia Wrangel, who had succeeded Torstensson, passed into Bohemia, where he remained until the forces employed against Rakóczy and Turenne could send help to the imperialists opposed to him. He then drew away into Hesse, the Archduke Leopold and the Bavarians following suit.

Turenne's Strategy.—The campaign of 1646 in Hesse up to August was as usual uneventful, each army being chiefly concerned

with its food. But at last the archduke retired a little, leaving Turenne and Wrangel free to join their forces. Turenne had no intention of repeating the experiences of Freiburg and Nördlingen. It was more profitable to attain the small objects that were sought by manœuvre than by battle, and the choice of means practically lay between manœuvring the enemy's army into poor districts and so breaking it up by starvation, and pushing one's own army into rich districts regardless of the enemy's army The usual practice was the first method Turenne chose the second.

Delayed at the opening of the year by orders from Mazarin —Turenne found it impossible to reach Hesse by the short and direct route, and he therefore made a rapid and secret march down the Rhine as far as Wesel, whence, crossing unopposed, he joined Wrangel on the upper Lahn (Aug 10). The united armies were only 19,000 strong But the imperialists, fearing to be hemmed in and starved between Turenne and the Rhine, fell back to Fulda, leaving the Munich road clear The interior of Bavaria had not been fought over for 11 years, and was thus almost the only prosperous land in desolated Germany. Turenne and Wrangel marched straight forward on a broad front, and for the rest of the year they devastated the country about Munich in order to force Maximilian to make terms. An armistice was concluded in the winter, Maximilian having been finally brought to consent by an ill-judged attempt of the emperor to seduce his army. The French and Swedes wintered in southern Wurttemberg

In Flanders, Gaston of Orleans and Enghien took Dunkirk and other fortresses In Italy, where the Tuscan fortresses were attacked, the French were completely checked at first, until Mazarin sent a fresh corps thither and restored the balance. In Catalonia Harcourt underwent a serious reverse in front of Lerida at the hands of his old opponent Leganez, and Mazarin sent Enghien, now prince of Condé, to replace him.

1647 was a barren year. In the Low Countries the war dissipated itself in sieges. In Italy Plessis-Praslin won an unprofitable victory over the viceroy of the Milanese on the Oglio (July 4). In Spain Condé, resuming the siege of Lerida, was repulsed and had to retire. In Germany Turenne and Wrangel parted company. The latter returned to Hesse, whence he raided into Bohemia, but was driven back by the imperialists. As the few obtainable supply areas gave out one by one, the Swedes gradually retired almost to the coast, but the imperialists did not follow, swerving into Hesse instead. Turenne meanwhile had had to send all his French troops to Luxemburg to help in the defence of northern France against the Spaniards. The Weimar army had refused to follow him to the Meuse, and mutined for its arrears of pay. Turenne, however, promptly seized the ringleaders and after a sharp fight disarmed the rest. Thus ignominiously Bernhard's old army vanished from the scene.

In the autumn the elector of Bavaria was reconciled to the emperor and his army re-entered the field. Turenne was therefore sent back to Germany to assist the Swedes. But winter came on before any further inroads could be made into south Germany

The campaign of 1648 brought the decision at last Turenne and Wrangel, having refitted their forces and united in Hesse as in 1646, steadily drove back the imperialists and Bavarians, whose 30,000 combatants were accompanied by a horde of nearly 130,000 hangers-on—men, women and children—to the Danube At Zusmarshausen (May 17) catching the enemy in the act of manœuvring, they destroyed his rear-guard The victors advanced as far as the Inn, but Piccolomini, reorganizing the débris of the Austro-Bavarian army checked their further progress and even drove them back to the line of the Isar Meantime, however, the Swedish general Königsmarck, had entered Bohemia and was besieging Prague This caused the recall of Piccolomini's army, and Turenne and Wrangel invested Munich. But Mazarin ordered the French to retire into Suabia so as not to compromise the peace negotiations at the critical moment, and Wrangel followed suit. Before Königsmarck was in a position to assault Prague news came of peace. Meanwhile in Artois Condé had repulsed the Spanish invasion by his brilliant victory of Lens (Aug. 5), which was a second Rocroi. After the thanksgiving service for the victory at Nôtre Dame, Mazarin arrested the leaders of the *parlement* of Paris, and in a few hours the streets were barricaded and a civil war was in progress This was the Fronde (*q v.*), which went on for another 11 years

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(C. F. A.; X)

THISTLE, a name, as generally employed, of vague application, being given to almost any herbaceous plant that has spines. More strictly, it is applied to certain herbs possessing very spiny leaves, and similar bracts surrounding a head of purplish-white, tubular, five-parted flowers seated on a pitted and hairy receptacle, belonging to the Compositae family. The fruit is surmounted by a tuft of silky hairs. The species, chiefly natives of Europe, western Asia and North America, are numerous, and some are of great beauty, though, not unnaturally, looked on with disfavour by the farmer The blessed thistle is *Cnicus benedictus;* lady's thistle, the leaves of which are spotted with white, is *Silybum marianus.* The common bull thistle, *Cirsium lanceolatum,* seems to be the most suitable prototype for the Scots thistle, though that honour is also conferred on *Onopordon acanthium,* the cotton thistle, remarkable for its covering of white down, a doubtful native of Great Britain, and on other species. The great objection to thistles from an agricultural point of view resides in the freedom with which their seeds are spread, and in the vigour of their underground growth, which makes their eradication difficult. Among the so-called thistles the following, all introduced from Eurasia, are well known weeds of farmlands in the northern United States and Canada. The blue thistle (*Echium vulgare*), is a biennial member of the Borage family The Russian thistle (*Salsola kali*), so common on the great plains of western North America, is an introduced annual tumble-weed belonging to the pigweed family. The perennial sow thistle (*Sonchus arvensis*), a milky-juiced member of the family Compositae, because of its freely creeping root system, is one of the most persistent weeds of arable lands. (*See* CANADA THISTLE.) (W. C. M.)

THISTLEWOOD, ARTHUR (1770–1820), principal instigator of the Cato Street conspiracy, a plot to murder the British cabinet in 1820. A son of William Thistlewood, and born at Tupholme in Lincolnshire, young Thistlewood became a soldier and visited France and America He developed republican sympathies and joined the Spencean society, a revolutionary body; associated himself with James Watson (d. 1838) and other agitators; and in Dec. 1816 helped to arrange a meeting in Spa Fields, London, which was to be followed by the seizure of the Tower of London and the Bank of England, and by a general revolution. The proposed rising failed, but the Habeas Corpus act was suspended and Thistlewood and Watson were tried but acquitted. Thistlewood was sentenced to a year's imprisonment for challenging the home secretary, Lord Sidmouth, to a duel After his release in May 1819 he prepared a new and comprehensive plot. On Feb. 23, 1820, at a time of great distress and unrest caused by the death of George III, the cabinet ministers had arranged to dine at the earl of Harrowby's house in Grosvenor Square With some associates Thistlewood hired a room in the neighbouring Cato street, collected arms and made ready to fall upon Harrowby's guests. The authorities had been informed of the plot, probably by a conspirator named George Edwards; officers appeared and arrested some of the conspirators, and although Thistlewood escaped he was seized the following day Tried for high treason, Thistlewood and four others were sentenced to death, and were hanged May 1, 1820.

See Sir S. Walpole, *History of England* (1890), vol. i.

THÖKÖLY, IMRE (EMERICH), Prince (1657–1705), Hungarian statesman, was born at Késmark on the 25th of September 1657. He lost both parents while still a child. In 1670, fleeing from the dangers of Upper Hungary, where the Protestants and Imperialists were constantly in arms against each other, he took

refuge with his kinsman Michael Teleki, the chief minister of Michael Apafy, prince of Transylvania. Here he came into contact with the Magyar refugees, who had great hopes of the high-born, high-gifted youth who was also a fellow sufferer, a large portion of his immense estates having been confiscated by the emperor The discontent reached its height when Leopold (Feb 27, 1673) suspended the Hungarian constitution, appointed Johan Gaspar Ampringen dictator, deprived 450 Protestant clergy of their livings and condemned 67 more to the galleys Encouraged by promises of help from Louis XIV., the Magyars now rose *pro libertate et justitia*, and chose the youthful Thököly as their leader The war began in 1679. Upper Hungary and the mining towns were soon in Thököly's possession In 1681, reinforced by 10.000 Transylvanians and a Turkish army under the pasha of Nagyvárad, he compelled the emperor to grant an armistice Thököly's distrust of the emperor induced him to turn for help to the sultan. In the same year Thököly captured fortress after fortress from the emperor and extended his dominions to the Waag. He refused the title of king offered to him by the Turks He was buried at Nicomedia but in 1906 his relics were transferred to Hungary.

See *Correspondence of Thokoly* (Hung), ed by Kálmán Thaly (Budapest, 1896), V Fraknói, *Papst Innocenz XI und Ungarn's Befreiung von der Turkenherrschaft* (Freiburg, 1902); *Memoirs of Emeric Count Teckely* (London, 1693); *Correspondence of Michael Teleki* (Hung), ed. by S. Gergely (Budapest, 1905–06).

THOLOS, in Greek architecture, a circular building, with or without a peristyle; the earliest examples are the beehive tombs at Mycenae and in other parts of Greece, which were covered by domes built in horizontal courses of masonry The Tholos at Epidaurus, built by Polycleitus (*c.* 400 B.C.), and the Tholos at Olympia, known as the Philippeion, are the most remarkable examples, and in both cases were covered with a sloping roof and not with a dome.

THOLUCK, FRIEDRICH AUGUST GOTTREU (1799–1877), German Protestant divine, was born at Breslau, on March 30, 1799. He studied at Breslau and at Berlin, where he was received into the house of the Orientalist Heinrich Friedrich von Diez (1750–1817) He came under the influence of the pietist Baron Ernst von Kottwitz (1757–1843), who became his "spiritual father," and of the historian Neander. In 1821 he was *Privatdozent* and in 1823 became professor extraordinarius of theology in Berlin. *Die wahre Weihe des Zweiflers* (1823; 9th ed, with the title *Die Lehre von der Sünde und dem Versöhner*, 1870), the outcome of his own religious history, secured his commanding position as the Pietistic apologist of Evangelical Christianity In 1825, with the aid of the Prussian government, he visited the libraries of England and Holland, and on his return was appointed (in 1826) professor ordinarius of theology at Halle, the centre of German rationalism, where he afterwards became preacher and member of the supreme consistorial council. Here he sought to combine in a higher unity the learning and to some extent the rationalism of J. S. Semler with the devout and active pietism of A. H. Francke; and, in spite of the opposition of the theological faculty of the university, he succeeded in changing the character of its theology Tholuck was also one of the prominent members of the Evangelical Alliance, and few men were more widely known or more beloved throughout the Protestant world than he. As a preacher he ranked among the foremost of his time. He died at Halle on June 10, 1877

After his commentaries (on Romans, the Gospel of John, the Sermon on the Mount and the Epistle to the Hebrews) and several volumes of sermons, his best-known books are *Stunden christlicher Andacht* (1839, 8th ed., 1870), intended to take the place of J. H. D. Zschokke's standard rationalistic work with the same title, and his reply to David Strauss's *Life of Jesus* (*Glaubwurdigkeit der evangelischen Geschichte*, 1837). He published at various times valuable contributions towards a history of rationalism—*Vorgeschichte des Rationalismus* (1853–62), *Geschichte des Rationalismus* (1865), i. and a number of essays connected with the history of theology and especially of apologetics His views on inspiration were indicated in his work *Die Propheten und ihre Weissagungen* (1860), in his essay on the "Alte Inspirationslehre," in *Deutsche Zeitschrift fur christliche Wissenschaft* (1850), and in his *Gespräche über die vornehmsten Glaubensfragen der Zeit* (1846; 2nd ed., 1867).

See *Das Leben Tholucks*, by L. Witte (2 vols., 1884–86).

THOMA, HANS (1839–1924), German painter, was born at Bernau in the Black Forest Having started life as a painter of clock faces, he entered in 1859 the Karlsruhe academy, where he studied under Schirmer and Des Coudres. He subsequently studied and worked, with but indifferent success, in Dusseldorf, Paris, Italy, Munich and Frankfurt, until his reputation became firmly established as the result of an exhibition of some 30 of his paintings in Munich. In spite of his studies under various masters, his art has little in common with modern ideas and was formed partly by his early impressions of the simple idyllic life of his native district, partly by his sympathy with the early German masters, particularly with Altdorfer and Cranach. In his love of the details of nature, in his precise, though by no means faultless, drawing of outline, and in his predilection for local colouring, he has distinct affinities with the pre-Raphaelites. His works hang chiefly in museums in Breslau, Munich, Dresden and Frankfurt and consist of landscapes, portraits and historical and biblical subjects He died at Karlsruhe in 1924

THOMAR: *see* TOMAR.

THOMAS, ST., one of the twelve apostles. The name means "twin" in Aramaic, as is recognized in John xi. 16 ("called Didymus"). Eusebius (*H E* iii. 1, 1) says Thomas was the evangelist of "Parthia," probably because Edessa (*q.v.*), where some of his bones were preserved, is sometimes called "Edessa of the Parthians" These bones were reputed to have been brought to Edessa from India, and a work known as the *Acts of Thomas* relates his missionary labours and martyrdom there This work was originally composed in Syriac; it is indeed one of the oldest and most idiomatic monuments of Syriac literature, though many have doubted whether it is based on any historical facts. In the 4th century it was translated into Greek, and thence into Latin, almost certainly as part of the Manichaean propaganda. The Manichaean taint was soon recognised (*e g.*, by Augustine) and the *Acta Thomae* in their original form branded as heretical. The view taken was that the framework, recounting the journeyings of the apostle, was historical, while the speeches and sermons contained the heresy. In consequence most mss, both Greek and Latin, contain very little of the speeches while retaining the framework Even Wright's Syriac ms. has been occasionally conventionalized, and the original form is only to be found in the ancient (4th or 5th century) palimpsest fragments at Sinai

The *Acts of Thomas* is a leading authority for the earliest Christianity in the countries east of the Euphrates. it was ascetic, marriage being discountenanced and all preoccupation with the things of this world discouraged. In the Acts Eucharistic prayers are given, but (according to the Sinai fragments and the best Greek) only bread and water were used. The Lord's Prayer is quoted in full. A curious feature is that the name of the apostle is given as Judas Thomas, and it is expressly set forth that he was the twin of Jesus Christ. As a tale the *Acts of Thomas* is remarkable for the real religious emotion that pervades it and for careful delineation of character, but above all for the hymn chanted by the apostle when in prison. This, commonly known as the "Hymn of the Soul" (Wright, pp. 238–245), is a metrical Syriac poem describing, under the parabolic form of the journey of a prince from his Eastern home to Egypt, the descent to earth and the return to its heavenly home of the soul. It is often supposed to be an independent composition inserted into the *Acts*, but for this there is no real evidence. In any case it is the great gem of Syriac literature.

"Christians of St Thomas" is a name often applied to the ancient Christian churches of southern India; the view taken of their history is so intimately connected with the historicity of the *Acts of Thomas* that it is convenient to treat of them here. According to the tradition, St. Thomas founded the Christian churches in Malabar (south-west coast), and then crossed to Mylapur, now a suburb of Madras, where the shrine of his martyrdom, rebuilt by the Portuguese in 1547, still stands on Mt. St. Thomas, where a cross is shown with a Pahlavi inscription which may be as old as the 7th century. We know from Cosmas Indicopleustes that there were Christians of Persian (East Syrian) origin, and doubtless of Nestorian creed, in Ceylon, in Malabar,

and at Caliana (north of Bombay) before 550. In 1490 they sent to the Nestorian patriarch Simeon, who gave them fresh bishops (Assemani, *Bib Or* iii, 1.590-f , *J. Theol Stud* xxix, 155). Hard pressed by the Moslems they welcomed the Portuguese and,' after much controversy, a formal union with Rome was carried through in the Synod of Diamper (1599). Syriac was to remain the ecclesiastical language, but the service books were "purified from error."

Dom R. H. Connolly proved in 1914 that this revision was slight in extent, and that the Malabar liturgy remained essentially a form of the Nestorian rite After a century and a half of union with Rome a schism took place in 1653, those who thus became independent of Rome organizing themselves under Jacobite (Monophysite) influence. (The ms of the whole Syriac Bible and the Clementine literature [12th century] then sent to Malabar from Mesopotamia was brought to Europe by Claudius Buchanan [1811] and is now in the Cambridge university library) Both this Church and the Roman obedience still flourish in Malabar.

From what has been said, the ancient Christian communities of southern India would be naturally regarded as a surviving branch of the extensive Nestorian missions, parallel to those which once flourished in Turkestan and China But many of the Christians in India in fact regard St. Thomas as their founder and appeal to tradition and to the *Acts of Thomas*, in support. They claim that the *Acts* are historical, and that they refer in part to the apostle's activity in southern India. There are, indeed, objections to this view, such as the absence of compelhngly clear allusions to specifically southern usages As to the meeting of St Thomas and the Indian King Gundaphar (the historical Gondophares, contemporary with the apostle and ruler in Gandhara, the northwest borderland of India), while a rigorously scientific proof is impossible, yet the substantial agreement of the *Acts* (the sole literary document which mentions this king) with all that is known from other sources, is best explained on the supposition that the *Acts* contain a kernel of historical truth. As to the southern journey and the martyrdom in Mylapur, it should be remarked that the agreement of the south Indian tradition with that of the Church of Edessa lends a high degree of probability to the claim that St. Thomas preached in southern India, suffered martyrdom there, and was there first buried But difficulties remain, and no strict certainty is claimed for their conclusions by temperate investigators.

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(N. J. T.)

THOMAS, surnamed MAGISTER (*i e.*, officiorum)[1], also known as a monk by the name Theodulos Monachos, a native of Thessalonica, Byzantine scholar and grammarian and confidential adviser of Andronicus II. (1282–1328) His chief work, 'Εκλογὴ 'Ονομάτων καὶ Ῥημάτων Ἀττικῶν, is a collection of selected Attic words and phrases, partly arranged in alphabetical order, compiled as a help to Greek composition from the works of Phrynichus, Ammonius, Herodian and Moeris. He also wrote scholia on Aeschylus, Sophocles, Euripides (with life), and three of the comedies of Aristophanes; the scholia on Pindar, attributed to him in two mss., are now assigned to Demetrius Triclinius. His speeches and letters deal with contemporary events.

Editions of the 'Εκλογ , by F. Ritschl (1832), C. Jacobitz (1833) and C. D Beck (1836); other works in J. P. Migne, *Patrologia graeca*, cxlv ; *see* also C Krumbacher, *Geschichte der byzantinischen Literatur* (1897)

THOMAS (d 1100), archbishop of York, a native of Bayeux, is usually called Thomas of Bayeux His father was a priest named Osbert, and Samson, bishop of Worcester (1086–1112), was his brother Owing largely to the generosity of Odo, bishop of Bayeux, Thomas studied in France, Germany and Spain and then became one of Bishop Odo's officials and after 1066 one of William the Conqueror's chaplains, or secretaries In 1070 he succeeded Aldred as archbishop of York, but declining to promise obedience to the archbishop of Canterbury, Lanfranc refused to consecrate him King William, however, induced him to submit and he was consecrated, but his profession of obedience was to Lanfranc personally and not to the archbishops of Canterbury.

In 1071 both archbishops travelled to Rome for their palls and while there Thomas wished Pope Alexander II. to decree the equality of the sees of Canterbury and York The pope, however, referred the dispute to a council of Enghsh prelates which met at Windsor at Whitsuntide in 1072. It was then decided that the archbishop of Canterbury was the superior of the archbishop of York, who had no rights south of Humber, but whose province included Scotland This decision did not end the dispute which broke out again in 1092 and 1093 when Thomas protested against what he thought infringements of his archiepiscopal rights. The first of these occasions was over the dedication of the cathedral built by Remigius at Lincoln and the second was over the consecration of St. Anselm to the archbishopric of Canterbury. He died at York on Nov. 18, 1100.

THOMAS, ALBERT (1878–1932), French statesman, was born on June 16, 1878, at Champigny-sur-Marne, near Paris His father was a baker who by great sacrifices enabled his son to receive a college and university education Scholarships enabled him to travel in Russia and Germany. A sequel to this was his book *Le syndicalisme allemand* (1903) in which his socialist faith was propounded for the first time

When, in 1904, Jean Jaurès launched *l'Humanité* he appointed Thomas assistant editor. Thomas played an important part as a right-wing leader in the General Confederation of Labour (C.G T.). He published in 1908 a volume on the Second Empire in Jaurès' great *Histoire socialiste*.

He was elected to the Chamber for his native city in May 1910 and again in 1914, becoming one of the most active and prominent Socialist members.

He joined his regiment in 1914. After he had seen a few weeks of war service, the Government summoned Thomas and two other Socialists, Jules Guesde and Marcel Sembat, to organize the production of munitions. In May 1915 he entered the cabinet as under-secretary for armaments and also joined the Briand Ministry which followed at the end of the year. Towards the end of 1916 he became minister of munitions, retaining this post in the Ribot Ministry which followed. In April 1917 he was sent to Russia, where he remained for several months and succeeded in persuading Kerensky to undertake the ineffectual "great offensive" against the Central Powers

Meanwhile in France the struggle was becoming very bitter between the majority (pro-war) and the minority (internationalist) sections of the French Socialist party, culminating in the Stockholm Conference Leader, with Renaudel and Sembat, of the majority party, Albert Thomas was also a strong advocate of the independence of Czechoslovakia and Poland and the creation of a "Great Serbia" and a "Great Rumania." Since this "majority wing" policy was opposed by many Socialists, particularly in the Paris district, Thomas decided not to stand again in the Paris suburbs and resigned the mayoralty of Champigny. At the elections of Nov. 16, 1919, he was returned as a Socialist in the Tarn, Jaurès' former constituency.

During the first session of the International Labour Conference, held at Washington at the end of the year, Thomas was provisionally appointed director of the International Labour Office (League of Nations) by its governing body; the appointment was confirmed at the governing body's second meeting held in Paris in Jan 1920. Apart from the organization and conduct

[1]For the duties of this important office, *see* J. B. Bury (*Later Roman Empire*) (1889), i. 45.

of the administration and scientific work of the Office, he secured many national ratifications of conventions adopted by the International Labour Conference. In 1921 the claims of his work at Geneva led him to resign his seat in the Chamber of Deputies.

THOMAS, (CHARLES LOUIS) AMBROISE (1811–1896), French composer, was born at Metz Aug. 5, 1811. After studying under his father, a musician, he entered the Paris conservatory in 1828 and four years later won the Prix de Rome with *Herman et Ketty*, a cantata. He was professor of harmony and composition at the conservatory thereafter and in 1871 was named director. He was elected a member of the Académe des Beaux Arts in 1851. Among his compositions are ballets, cantatas and songs; his best known operas are *Mignon* (1866), *Hamlet* (1868) and *Françoise de Rimini* (1882). He died at Paris Feb. 12, 1896.

THOMAS, ARTHUR GORING (1850–1892), English composer, was born at Ratton Park, Sussex, on Nov. 20, 1850, and educated at Hailey bury College. He studied music in Paris under Durand and at the Royal Academy of Music under Ebenezer Prout and Arthur Sullivan; also under Max Bruch. The performance at the Royal Academy of a selection from *The Light of the Harem* (libretto by Clifford Harrison), induced Carl Rosa to commission him to write *Esmeralda* (libretto by T. Marzials and A. Randegger), which was successfully produced at Drury Lane on March 26, 1883. On April 16, 1885 Rosa produced at Drury Lane Thomas's fourth and best opera, *Nadeshda* (libretto by Julian Sturgis), a German version of which was given at Breslau in 1890. Besides his dramatic works Thomas's chief compositions were a psalm, "Out of the Deep," for soprano solo and chorus (London, 1878), a choral ode, "The Sun Worshippers" (Norwich, 1881), and a suite de ballet for orchestra (Cambridge, 1887). His music, which shows traces of his early French training, reveals a great talent for dramatic composition and a real gift of refined and beautiful melody. He died on March 20, 1892.

THOMAS, AUGUSTUS (1857–1934), American playwright, was born in St. Louis (Mo.), Jan. 8, 1857. He was educated in the public schools, served as a page boy in the Missouri Legislature and in Congress, for several years worked in railway freight offices, and, after serving as writer and illustrator for various newspapers, became in 1886 part editor and proprietor of the Kansas City (Mo.) *Mirror*.

The success in New York and on the road of *The Burglar* (1889), an elaboration of the earlier one-act piece, and of *A Man of the World* (1883) used by Maurice Barrymore, induced A. M. Palmer of the Madison Square Theatre to offer the young playwright the post left vacant by the retirement of Dion Boucicault, and under Palmer's management *Alabama* (1891) was produced, a play which contributed to the removal of sectional prejudice resulting from the Civil War. Thenceforth Thomas was one of the most prolific and successful of American playwrights. Other dramatic successes by him which made use of native materials were *In Mizzoura* (1893), *The Hoosier Doctor* (1898), *Arizona* (1868), and *The Copperhead* (1917). Other outstanding plays, chiefly in the vein of light comedy or romance, were *Oliver Goldsmith* (1900), *The Earl of Pawtucket* (1903), *Mrs. Leffingwell's Boots* (1905) and *The Witching Hour* (1907). An autobiographical volume *The Print of My Remembrance* appeared in 1922.

THOMAS, GEORGE (*c* 1756–1802), British military adventurer in India. Thomas was born of poor parentage in Ireland in 1756, deserted from the British Navy in Madras, and made his way north to Delhi, where he took service under the begum Samru of Sardhana. He then served Appa Rao, a Mahratta chieftain, and subsequently set up an independent kingdom of his own in Hariana with his capital at Hansi He dreamed of conquering the Punjab, and fought one of his best campaigns against the Sikh chiefs; but he was finally defeated and captured by Sindhia's army under General Perron. He died on his way down the Ganges on Aug. 22, 1802.

See Francklin, *Military Memoirs of Mr. George Thomas* (1803); Compton, *Military Adventurers of Hindustan* (1893).

THOMAS, GEORGE HENRY (1816–1870), American general, was born in Southampton county (Va), on July 31, 1816. He graduated at West Point in 1840, served as an artillery subaltern in the war against the Seminole Indians in Florida (1841), and in the Mexican War at the battles of Fort Brown, Resaca de la Palma, Monterey and Buena Vista, receiving three brevets for distinguished gallantry in action. From 1851 to 1854 he was an instructor at West Point In 1855 he was appointed by Jefferson Davis, then secretary of war, a major of the 2nd cavalry. His regimental superiors were A S Johnston, R E. Lee and Hardee. All three resigned at the outbreak of the Civil War. Thomas finally decided to adhere to the United States. He was promoted in rapid succession to be lieutenant colonel, colonel in the regular army, and brigadier general of volunteers.

In command of an independent force in eastern Kentucky, on January 19, 1862, he attacked the Confederate Gen Zollicoffer at Mill Springs, and gained the first important Union victory in the west. He served under Buell and was offered, but refused, the chief command in the anxious days before the battle of Perryville. Under Rosecrans he was engaged at Stone River and was in charge of the most important part of the manoeuvring from Decherd to Chattanooga At the battle of Chickamauga (*q.v.*) Sept. 19, 1863, he gained the name of "The Rock of Chickamauga," because of his firmness He succeeded Rosecrans in command of the Army of the Cumberland shortly before the great victory of Chattanooga (*q.v.*), in which Thomas and his army played a most conspicuous part, his divisions under Sheridan, Wood and Baird carrying Missionary Ridge in superb style. When J. B Hood broke away from Atlanta in the autumn of 1864, menaced Sherman's long line of communications and endeavoured to force Sherman to follow him, Sherman left to Thomas the difficult task of dealing with Hood. At the battle of Franklin, Nov. 30, 1864, Thomas's force, under Gen Schofield, checked Hood long enough to cover the concentration at Nashville (*q.v.*). Thomas attacked (Dec. 15–16, 1864) and inflicted on Hood the worst defeat sustained in the open field by any army on either side during the war For this Thomas was made a major-general in the regular army and received the thanks of Congress. After the Civil War he commanded military departments in Kentucky and Tennessee until 1869, when he was placed over the division of the Pacific with headquarters at San Francisco. He died there on March 28, 1870.

See G. Bradford, "Union Portraits," *Atlantic Monthly*, Aug. 1914; *Sketch of General G H. Thomas*; R W. Johnson, *Memoir of Major-General George H. Thomas*; Van Horne, *The Life of Major-General George H. Thomas*

THOMAS, ISAIAH (1749–1831), American printer, was born in Boston, Mass., on Jan. 19, 1749. He was apprenticed in 1756 to Zechariah Fowle, a Boston printer, with whom, after working as a printer in Halifax, N S., Portsmouth, N H., and Charleston, S.C., he formed a partnership in 1770. He issued in Boston the *Massachusetts Spy* three times each week, then (under his sole ownership) as a semi-weekly, and beginning in 1771, as a weekly which soon espoused the Whig cause and which the government tried to suppress. On April 16, 1775 (three days before the battle of Concord, in which he took part) he took his presses and types from Boston and set them up at Worcester, where he was postmaster for a time; here he published and sold books and built a paper-mill and bindery, and continued the paper until about 1802 except in 1776–78 and in 1786–88. The *Spy* supported Washington and the Federalist party. In Boston Thomas published, in 1774, the *Royal American Magazine*, which was continued for a short time by Joseph Greenleaf, and which contained many engravings by Paul Revere; and in 1775–1803 the *New England Almanac*, continued until 1819 by his son He set up printing houses and book stores in various parts of the country, and in Boston, with Ebenezer T. Andrews, published the *Massachusetts Magazine*, a monthly, from 1789 to 1793. At Walpole, N H , he published the *Farmer's Museum*. About 1802 he gave over to his son, Isaiah Thomas, Jr, his business at Worcester including the control of the *Spy*. Thomas founded in 1812 the American Antiquarian Society. He died in Worcester on April 4, 1831.

His *History of Printing in America, with a Biography of Printers,*

and an Account of Newspapers (1810, 2nd ed., 1874, with a memoir by his grandson B F Thomas) is an important work, accurate and thorough *See* also "Diary of Isaiah Thomas, 1805–28" in *Transactions of the American Antiquarian Society*, vol. IX and X (1909), and C L Nichols, "Isaiah Thomas and his Worcester Imprints" in *Proceedings of the American Antiquarian Society*, New Series, vol XIII. (1900).

THOMAS, JAMES HENRY (1874–1949), British Labour leader, was born at Newport, Mon., on Oct 3, 1874. He started work as an errand boy at the age of 9 and was later employed by the Great Western railway as an engine cleaner, he rose rapidly and soon became a power in Swindon (the G.W.R headquarters) both as a trade unionist and in local government By 1910 he had become president of the Amalgamated Society of Railway Servants and played a leading part in its reorganization as the National Union of Railwaymen of which he was appointed general secretary after the great railway strike of 1911. Under him the N U R became the leader in the policy of "industrial" or "all grades" as against "craft" trade unionism

Thomas was elected member for Derby in 1910 and appointed to the privy council in 1917. He refused to enter the Coalition government. He was president and chairman of the parliamentary committee of the Trades Union Congress (1920–21) and president of the International Federation of Trade Unions (1920–24).

In the Labour government of 1924 Thomas was secretary for the colonies; and in that of 1929 was, first, lord privy seal and minister of employment, and in 1930 secretary of state for the Dominions. He retained this office in the National government of 1931, and consequently resigned his office in the N.U.R. In Nov. 1935 he became Colonial secretary. In 1936 it was found that Thomas had been, to some extent at least, responsible for a serious leakage of information concerning the budget before the date of its publication; and in consequence he resigned from the cabinet and from the house of commons on May 22 and June 11 respectively, 1936. He died Jan. 21, 1949, in London.

THOMAS, PHILIP EDWARD (1878–1917), British author and poet, was born on March 3, 1878, and educated at St. Paul's School and at Lincoln college, Oxford. His first book was a volume of nature studies, *The Woodland Life* (1897), followed by *Horae Solitariae* (1902), and numerous other works. Among a good many miscellaneous works should be noted his critical studies of *George Borrow* (1912); *Swinburne* (1912); and *Walter Pater* (1913), and a volume of stories, *Four-and-Twenty Blackbirds* (1915) But his prose work, though its quality is undoubted, was done to order, and shows signs of constraint as to subject and time. A collection of his prose fragments appeared in 1928, under the title of *The Last Sheaf;* some of these were written under less exacting conditions, and allow more scope to his leisurely and precise genius. It was not till middle age that, under the influence of Robert Frost, the American poet, Thomas discovered himself as a poet, and soon after came the War. Thomas enlisted in 1915, and with freedom from routine literary work became extremely fluent. His verse was first written under the name of "Edward Eastaway" and a volume of *Poems* under his own name appeared in 1917. He was killed in France on April 9, 1917. His poetry is not sharply distinguished from his prose; the rhythms are quiet and unstressed Pre-eminently a poet of the country, when he was killed, as De la Mare has said "there was shattered a mirror of England."

THOMAS, SIDNEY GILCHRIST (1850–1885), British inventor, was born on April 16, 1850, at Canonbury, London. As a police court clerk he found time to study chemistry at the Birkbeck Institute. He set himself to solve the problem of separating phosphorus from iron in the Bessemer converter, and by the end of 1875 he was convinced that he had discovered a method. The method was tested by his cousin, P. C. Gilchrist, at the Blaenavon works, and found effective. In March 1878 the first public announcement of the discovery was made at the meeting of the Iron and Steel Institute; and a paper was written by Thomas and Gilchrist on the "Elimination of Phosphorus in the Bessemer Converter" for the autumn meeting of this institute, but was not read till May 1879. Thomas, however, interested E. W. Richards, the manager of Bolckow, Vaughan & Co.'s works at Cleveland, Yorkshire, whom he interested in the process, and from this time the success of the invention was assured and domestic and foreign patents were taken out The "basic process" invented by Thomas was especially valuable on the continent of Europe, where the proportion of phosphoric iron is much larger than in England, and both in Belgium and in Germany the name of the inventor became more widely known than in his own country. Thomas died in Paris on Feb. 1, 1885

See *Memoirs and Letters of Sidney Gilchrist Thomas* (1891), ed. by R. W. Burnie.

THOMAS, THEODORE (1835–1905), American musician, was born in Essens, Germany, on Oct 11, 1835. His first public appearance as a violinist was made at the age of five He was taken to America by his parents in 1845, and became first violin in the orchestra that accompanied Jenny Lind (1850), Sontag (1852) and Grisi and Mario (1854) In 1862 he began to organize his own orchestra, and in 1864 he inaugurated the series of Irving Hall symphony concerts, which for 14 years were regarded as one of the great musical institutions of New York city. To Theodore Thomas is largely due the popularization of Wagner's works in America, and it was he who founded the Wagner Union in 1872. In 1891, Thomas organized the Chicago Symphony orchestra which has continued to be one of the foremost organizations of its class in the world. In 1928 this orchestra possessed a liberal endowment and its own hall. He died Jan 4, 1905, in Chicago

See biography by George P. Upton, Charles Edward Russell, *The American Orchestra and Theodore Thomas* (1927).

THOMAS À KEMPIS (*c.* 1380–1471), the name by which the Augustinian canon and writer Thomas Hammerken (Hammerchen, Malleolus) is commonly known. He was born in 1379 or 1380 in the town of Kempen, near Dusseldorf, in one of the many patches of territory between the Meuse and the Rhine belonging to the archiepiscopal principality of Cologne. "Ego Thomas Kempis," he says in his chronicle of the monastery of Mount St Agnes, "scholaris Daventriensis, ex diocesi Coloniensi natus." His father was a poor hard-worked peasant; his mother "ad custodiam rei domesticae attenta, in opere alacris, in victu sobria, in potu absternia, in verbo pauca, in factis pudica," as her son fondly says, kept a dame's school for the younger children of the town John and Gertrude Hammerken had two sons, John and Thomas, both of whom found their way to Deventer, and thence to Zwolle and to the convent of Mount St. Agnes. Thomas reached Deventer when he was barely twelve years old, was taught by a dame the beginnings of his learning, and in a few months to his great joy entered the classes of Florentius Radewyn. After the fashion of the time he was called Thomas from Kempen, and the school title, as was often the case then, pushed aside the family name. Thomas Hammerken was forgotten; Thomas à Kempis has become known to the whole Christian world.

The school at Deventer had become famous long before Thomas à Kempis was admitted to its classes. It had been founded by Gerhard Groot (*q.v.*), a wealthy burgher who had been won to pious living mainly through the influence of Ruysbroeck, the Flemish mystic At Deventer, in the midst of this mystical theology and hearty practical benevolence, Thomas à Kempis was trained. Gerhard Groot was his saintly ideal. Florentius Radewyn and Gerhard's other early disciples were his heroes; their presence was his atmosphere, the measure of their lives his horizon. But he was not like them; he was not an educational reformer like Radewyn, nor a man of affairs like Gerhard He liked books and quiet corners all his days, he says; and so, when conviction of sin and visions of God's grace came to him in the mediaeval fashion of a dream of the anger and forgiveness of the Virgin, Florentius told him that a monk's life would suit him best, advised him to join the Augustinian order, and sent him to Zwolle to the new convent of Mount St. Agnes, where his brother John was prior. Thomas was received there in 1399, professed the vows in 1407, received priest's orders in 1413, became sub-prior in 1425 and died on Aug. 8, 1471, at the age of ninety-one.

Works.—The convent of Mount St. Agnes was poor, and most of the monks had to earn money to support their household by copying MSS Thomas was a most laborious copyist; missals, books of devotion and a famous MS. Bible were written by him.

He also wrote a large number of original writings, most of them relating to the convent life, which was the only life he knew. He wrote a chronicle of the monastery and several biographies—the life of Gerhard Groot, of Florentius Radewyn, of a Flemish lady St Louise, of Groot's original disciples; a number of tracts on the monastic life—*The Monk's Alphabet*, *The Discipline of Cloisters*, *A Dialogue of Novices*, *The Life of the Good Monk*, *The Monk's Epitaph*, *Sermons to Novices*, *Sermons to Monks*, *The Solitary Life*, *On Silence*, *On Poverty*, *Humility and Patience*; two tracts for young people—*A Manual of Doctrine for the Young*, and *A Manual for Children*, and books for edification—*On True Compunction*, *The Garden of Roses*, *The Valley of Lilies*, *The Consolation of the Poor and the Sick*, *The Faithful Dispenser*, *The Soul's Soliloquy*, *The Hospital of the Poor* He also left behind him three collections of sermons, a number of letters, some hymns and the famous *Imitatio Christi* (though his authorship of this has been disputed)

Character.—These writings help us to see the man and his surroundings, and contemporary pious records make him something more than a shadow. We see a real man, but a man helpless anywhere save in the study or in the convent—a little fresh-coloured man, with soft brown eyes, who had a habit of stealing away to his cubiculum whenever the conversation became too lively; somewhat bent, for it is on record that he stood upright when the psalms were chanted, and even rose on his tiptoes with his face turned upwards; genial, if shy, and occasionally given to punning, as when he said that he preferred Psalmi to Salmones; a man who perhaps led the most placid uneventful life of all men who ever wrote a book or scribbled letters. His brethren made him oeconomiae prefectus, but he was too "simple in worldly affairs" and too absent-minded for the post, and so they deposed him and made him sub-prior once more. And yet it is this placid kindly fresh-coloured old man who has come down to us as the author of that book the *Imitation of Christ*, which has been translated into more languages than any other book save the Bible, and which has moved the hearts of so many men.

On the controversy as to the author of the *Imitatio*, *see* the article IMITATION OF CHRIST. *See* also James Williams, *Thomas of Kempen* (1910). The classical edition of the works of Thomas à Kempis by Sommalius—*Thomas Malleoli à Kempis opera omnia* (3 vols. in 1, 1607)—has been many times reprinted A critical edition in 8 vols. by M J Pohl has also been undertaken. The best accounts in English of Thomas à Kempis are those by S. Kettlewell (1882) and F. R. Cruise (1887), written from the Protestant and the Catholic standpoints respectively. A penny tract by F. R. Cruise, entitled *Outline of the Life of Thomas à Kempis* (1904), contains substantially all that is known concerning him. (T. M. Ll.)

THOMASIUS, CHRISTIAN (1655–1728), German jurist and publicist, was born at Leipzig on Jan. 1, 1655, and was educated by his father, Jakob Thomasius (1622–1684), at that time head master of the Thomasschule. Through his father's lectures Christian came under the influence of the political philosophy of Hugo Grotius and Samuel Pufendorf, and continued the study of law at Frankfort-on-Oder. In 1684 he commenced the career of professor of natural law at Leipzig, and soon attracted attention by his abilities, but particularly by his daring attack upon traditional prejudices, in theology and jurisprudence. In 1687 he made the daring innovation of lecturing in German instead of Latin, and in the following year published a monthly periodical (*Schershafte und ernsthafte, vernünftige und einfältige Gedanken über allerhand lustige und nutzliche Bucher und Fragen*) taking the side of the Pietists in their controversy with the orthodox, and defending mixed marriages of Lutherans and Calvinists. In consequence of these and other views, he was denounced from the pulpits, forbidden to lecture or to write (May 20, 1690), and his arrest was ordered. The latter he escaped by flight to Berlin, and the elector Frederick III. offered him a refuge in Halle, with a salary of 500 talers and the permission to lecture. He took part in founding the university of Halle (1694), where he became second and then first professor of law and rector of the university. He died on Sept 23, 1728. In theology Thomasius was a believer in the necessity of revealed religion for salvation.

Thomasius's most popular and influential German publications were his periodical already referred to (1688–89); *Einleitung zur Vernunftlehre* (1691, 5th ed. 1719); *Vernunftige Gedanken uber allerhand ausserlesene und juristische Handel* (1720–21), *Historie der Weisheit und Torheit* (3 vols, 1693); *Kurze Lehrsatze von dem Laster der Zauberei mit dem Hexenprocess* (1704), *Weitere Erlauterungen der neueren Wissenschaft anderer Gedanken kennen zu lernen* (1711).

See Luden, *Christian Thomasius nach seinen Schicksalen und Schriften* (1805); H Dernburg, *Thomasius und die Stiftung der Universitat Halle* (1865), B A Wagner, *Thomasius, ein Beitrag ur Wurdigung seiner Verdienste* (1872); Nicoladoni, *Christian Thomasius. Ein Beitrag zur Geschichte der Aufklarung* (Berlin, 1888); and E. Landsberg, *Zur Biographie von Christian Thomasius* (1894).

THOMAS OF CELANO, Franciscan friar and disciple and biographer of St. Francis of Assisi. Born at Celano in the Abruzzi, he joined St. Francis probably about 1214, and he appears to have been one of the first band of friars who went into Germany. He was commissioned by Gregory IX. to write the Life of St. Francis, and in 1229 he completed the *First Legend*; in 1247 at the command of the minister general he composed the *Second Legend*, and a few years later the *Tract on the Miracles of St Francis*. He also composed in 1255 the *Legend of St. Clare*; and he is one of those to whom the sequence *Dies irae* is attributed.

Thomas of Celano's writings on St Francis have been critically edited by E. d'Alençon in 1906. An English translation (*The Lives of S. Francis of Assisi by Brother Thomas of Celano*) by A G. Ferrers Howell appeared in 1908 *See* FRANCIS OF ASSISI (E. C. B.)

THOMAS OF ERCELDOUNE, called also THE RHYMER, and sometimes given the surname of LEARMONT (*fl.* ? 1220–? 1297), poet and prophet in the legendary literature of Scotland. The historical person of that name figures in two charters of the 13th century, and from these it appears that he owned lands in Erceldoune (now Earlstoun), in Berwickshire, which were made over by his son and heir on Nov. 2, 1294, to the foundation of the Holy Trinity at Soltra (or Soutra) on the borders of the same county This would imply that Thomas the Rhymer was already dead, but J. A. H. Murray, who edited *The Romance and Prophecies* (E E.T.S , 1875), thinks that he was living three years later in a Cluniac priory in Ayrshire. He figures in the works of Barbour and Harry the Minstrel as the sympathizing contemporary of their heroes, and Walter Bower, who continued the *Scotichronicon* of Fordun, tells how he prophesied the death of Alexander III. in 1285.

In the folk-lore of Scotland his name is associated with numerous fragments of verse of a gnomic and prophetic character. The romance of Thomas and the elf-queen was attributed to Erceldoune by Robert Mannyng de Brunne, but the earliest text, in the Auchinleck ms. in the Advocates' library, Edinburgh, is in a dialect showing southern forms, and dates from the beginning of the 14th century. It may be based on a genuine work of Thomas, a version by him of the widely diffused Tristan Saga. The most widely accepted opinion is that it is a translation of a French original

See J. A. H. Murray's edition of *The Romance and Prophecies* (E.E.T.S, 1875); Brandl's *Thomas of Erceldoune* (Berlin, 1880), and Kölbing's *Die nordische und die englische Version der Tristransage* (Heilbronn, 1882); also McNeill's *Sir Tristrem* (S.T.S, 1886); Lumby's *Early Scottish Prophecies* (E.E.T.S., 1870), and the reprint of the *Whole Prophesie of Scotland* (1603) by the Bannatyne Club (1833); J. Geddie, *Thomas the Rymour and his Rhymes* (Edinburgh, 1920).

THOMAS OF MARGÂ, a Nestorian bishop and author of an important monastic history in Syriac, who flourished in the 9th century AD. He was born early in the century, probably of Persian parents, in the region of Salakh to the north-east of Mosul. As a young man he became in 832 a monk of the famous Nestorian monastery of Beth 'Abhê, about 25 m. due east of Mosul when he acted as secretary to Abraham, who had been abbot of Beth 'Abhê, and was catholicus (patriarch) of the Nestorians from 837 to 850. Thomas was promoted by Abraham to be bishop of Margâ, and afterwards to be a metropolitan of Beth Garmai. It was during the period of his life at Beth 'Abhê and his bishopric that he composed *The Book of Governors*, which is in the main a history of his own monastery, but includes lives of holy men in other parts of Mesopotamia and elsewhere.

The Book of Governors has been edited with an English translation and a copious introduction by E. W. Budge, (2 vols., London, 1893).

There is a later edition by P. Bedjan (Paris, 1901).

THOMASON, GEORGE (d. 1666), English book and tract collector, was a London bookseller, who is famous for having brought together a great collection of books and tracts published during the time of the Civil War and the Commonwealth; this was formerly called the "King's Pamphlets," but is now known as the "Thomason Collection." He possessed nearly 23,000 separate publications in 1662, and having arranged these in chronological order he had them bound in 1,983 volumes The collection was bought in 1761 from his descendants by George III, who presented it to the British Museum He died in April 1666

THOMASVILLE, a city of south-western Georgia, U.S.A., the county seat of Thomas county; 12 mi. from the Florida state line, on federal highways 84, 19 and 319, and served by the Atlantic Coast Line railway. Pop. (1950) 14,424, 12,683 in 1940 by federal census, 47% Negroes The city is on a ridge 273 ft above sea level, in the yellow-pine belt of the state, and has a mild and equable climate. It is famous for its rose gardens, and its "big oak" has a spread of 151 ft. 3 in. An annual rose festival is held in April Thomasville is one of the oldest winter resorts in the south. It was settled about 1825, incorporated as a town in 1831 and chartered as a city in 1889.

THOMOND, EARL AND MARQUESS OF, Irish titles borne by the great family of O'Brien, the earldom from 1543 to 1741 and the marquessate from 1800 to 1855 Thomond, or Tuaidh-Muin, was one of the three principalities of Munster, forming the northern part of the province. Its earls were descended from Turlough O'Brien (*c.* 1009–1086), king of Munster, and through him from the celebrated king of Ireland, Brian Boroimhe. Turlough's descendants, Conchobhar O'Brien (d. 1267) and Brian Ruadh O'Brien (d 1276), kings of Thomond, were both typical Irish chieftains Conchobhar's tomb and effigy with a crown are still to be seen in the ruined abbey of Corcomroe, Co Clare. His descendant Conor O'Brien (d. 1539), prince of Thomond, took part in the feud between the great families of Fitzgerald and Butler and was the last independent prince of Thomond Conor's brother, Murrough O'Brien (d. 1551), prince of Thomond, the succeeding chief of the race, gave up his "captainship, title, superiority and country" to Henry VIII. in 1543, when he was created earl of Thomond. By special arrangement the earldom descended, not to his son Dermod, but to his nephew, Donough, who became the 2nd earl. Dermod, however, inherited the barony of Inchiquin, which was conferred upon his father at the same time as the earldom

Conor O'Brien, the 3rd earl (*c* 1534–*c.* 1582), was for some years at the outset of his career, harassed by the attacks of his discontented kinsmen. Then in his turn he rose against the English, but was defeated and fled to France; in 1571, however, he was pardoned and formally surrendered his lands.

Donough O'Brien, the 4th earl (d. 1624), called the "great earl," was the son and successor of the 3rd earl. He served England well in her warfare with the rebellious Irish during the closing year of Elizabeth's reign and was made president of Munster in 1605. The 8th earl, Henry (1688–1741), was created an English peer as Viscount Tadcaster. When he died the earldom of Thomond became extinct.

The estates of the earldom descended to the last earl's nephew, Percy Wyndham (*c.* 1713–1774), a younger son of Sir William Wyndham, Bart. He took the additional name of O'Brien and was created earl of Thomond in 1756 When he died unmarried the title again became extinct

In 1800 Murrough O'Brien, 5th earl of Inchiquin (*c.* 1724–1808), was created marquess of Thomond. His brother James, the 3rd marquess (*c.* 1768–1855), was an officer in the navy and became an admiral in 1853. When he died the marquessate became extinct.

See John O'Donoghue, *Historical Memoirs of the O'Briens* (Dublin, 1860).

THOMPSON, FRANCIS (1859–1907), English poet, born at Preston on Dec. 18, 1859, was the son of Charles Thompson, a doctor, and the nephew of Edward Healy Thompson, the friend of Manning and professor of English literature at Dublin. His father becoming a convert to Roman Catholicism, Francis was educated in the Catholic faith at Ushaw college, and in 1866 he proceeded to Owen's college, Manchester, to study medicine He took little interest in the work however, and having thrice failed in his examinations, he went to London in Nov 1885, to seek his fortune. There he fell into great destitution, ill health compelled him to take to opium, and after five years of misery, he obtained some light employment in the shop of a London bootmaker, where he found sufficient leisure to write his first poems. These he despatched to Wilfrid Meynell, then editor of *Merrie England,* who, struck with their great merit, arranged for immediate publication At the same time the Meynells sought out the young author, whom they found on the verge of starvation, and after persuading him to enter a hospital, they aided him throughout his long convalescence, and procured the publication of his first volume of poems in 1893 The volume quickly attracted the attention of sympathetic critics, notably Coventry Patmore, who praised it in the *Fortnightly Review* (Jan 1894)

Much of Francis Thompson's verse is reminiscent of Crashaw's, but the beauty and splendid inventiveness of his diction were immediately recognized as giving him a unique place among his contemporaries. Persistent ill health limited his output, but *Sister Songs* (1895) and *New Poems* (1897) confirmed the opinion formed of his genius. The former, dedicated to the children of Mrs Meynell, was devoted mainly to descriptions of the days when he was an outcast; the latter, which contains some of his finest verse, indicates the influence of the older mystical poets. From 1893–97, Thompson lived, with short intervals, near the Franciscan monastery in Pantasaph, North Wales, and later he spent much time at the Capuchin monastery, Tanlasapt He died in London on Nov. 13, 1907, and was buried at Kensal Green He gave evidence of great power as a prose writer in his contributions to the *Academy* and the *Athenaeum,* and in his treatise *Health and Holiness* (1905), but it is mainly as a poet that he is remembered

Among his work there is much that may justly be termed eccentric, especially the use of poetically compounded neologisms; but nothing can be more simply beautiful than "The Daisy," nothing more intimate or reverent than his poems about children, or more magnificent than "The Hound of Heaven."

Apart from the works above mentioned Thompson wrote: *Life of Ignatius Loyola* (1909); *Life of John Baptist de la Salle* (1911) and *Essay on Shelley* (1909)

See also the *Athenaeum,* obit by Wilfrid Meynell, since reprinted in Thompson's *Selected Poems* (1908), Wilfrid Blunt in the *Academy,* Nov 23, 1907; the *Dublin Review,* cxli, art by Alice Meynell; E. V. Lucas, *One Day and Another* ("A Rhapsodist at Lords") (1909); Floris Delattre in *Revue Germanique,* July–Aug. 1909; K Rooker, *Francis Thompson* (1912); G. A. Beacock, *F. Thompson* (1912); J. Thompson (1923) pp. 159; and the authoritative biography, E. Meynell, *The Life of Francis Thompson* (1926), pp. 360.

THOMPSON, SIR HENRY (1820–1904), English surgeon, was born at Framlingham, Suffolk, on Aug 6, 1820. He graduated in medicine at University college, London, in 1851, and subsequently became assistant surgeon (1853), full surgeon (1863), professor of clinical surgery (1866), and consulting surgeon (1874) to University College hospital. In 1884 he became professor of surgery and pathology in the Royal College of Surgeons, which in 1852 awarded him the Jacksonian prize for his *Pathology and Treatment of Stricture of the Urethra,* and again in 1860 for his *Health and Morbid Anatomy of the Prostate Gland.* Specializing in the surgery of the genito-urinary tract, he acquired a high reputation He performed the operation of lithotomy with success on the king of the Belgians in 1863. Ten years later he carried out a similar operation on the emperor Napoleon

In 1874, he helped to found the Cremation Society of England, of which he was the first president. In 1892 he was instrumental in procuring the appointment of a committee to enquire into the methods of death certification. Thompson was a man of many interests, an amateur painter, a collector of China and a novelist. Thompson was knighted in 1867, and received a baronetcy in 1899. He died on April 18, 1904.

Of his more important works, *Clinical Lectures on Diseases of*

the Urinary Organs (1868) passed through eight editions. *The Diseases of the Prostate* through six, *Cremation* (1874) through four, and *Food and Feeding* through twelve.

THOMPSON, SIR JOHN SPARROW (1844–1894), Canadian jurist and statesman, was born at Halifax, Nova Scotia, on Nov. 10, 1844, of Irish descent In 1877 he was elected to the local legislature for Antigonish as a Conservative, and in 1878 became attorney-general. In May 1882 he became premier, but in June was defeated at the general election, though retaining his own seat, and in July was made a judge of the provincial supreme court. In Sept 1885, he was appointed minister of justice in the federal cabinet, and soon after was elected member for Antigonish. In 1886 he successfully defended in the federal parliament the hanging of Louis Riel (*q v*), which had greatly angered the French Roman Catholics; in 1887–88, together with Mr. Joseph Chamberlain and Sir Charles Tupper, he arranged a Fisheries treaty with the U S commissioners, which was afterward thrown out by the United States senate. During the following years he defended the government with great skill in various politico-religious disputes, and in Nov. 1892 he became premier of Canada. He died suddenly on Dec. 12, 1894, at Windsor castle, a few minutes after having been sworn in by Queen Victoria as a member of the privy council.

His *Life* has been written by J. C. Hopkins (Toronto, 1895).

THOMPSON, LAUNT (1833–1894), U.S. sculptor, was born at Abbeyleix, Ireland, on Feb 8, 1833. In 1847 he emigrated to the United States and settled with his mother at Albany, N Y After studying anatomy in the office of a physician, Dr. Armsby, he spent nine years in the studio of the sculptor, E D. Palmer. In 1857 he opened a studio in New York, and in 1862 became a national academician. He visited Rome in 1868–69, and from 1875–87 was again in Italy, living for most of the time at Florence He died at Middleton (N.Y) on Sept. 26, 1894. Among his important works are: "Napoleon the First," at the Metropolitan Museum of Art, New York; "Abraham Pierson," first president of Yale university, New Haven (Conn.); an equestrian statue of Gen. A. E. Burnside, Providence (R I); "General Winfield Scott," Soldiers' Home, Washington (D.C.); "Admiral S F. Du Pont," Washington (D.C.); "General John Sedgwick," West Point (N.Y.).

THOMSEN, (HANS PETER JÖRGEN) JULIUS (1826–1909), Danish chemist, was born in Copenhagen on Feb. 16, 1826, and spent his life in that city. From 1847 to 1856 he was engaged in teaching chemistry at the Polytechnique, of which from 1883 to 1892 he acted as director. From 1856 to 1866 he was on the staff of the military high school. He and his brother August founded the important *Journal of Chemistry and Physics*, one of the principal scientific periodicals in Denmark. He was editor from 1862–78. In 1866 he was appointed professor of chemistry at the university, and retained that chair until 1891 when he retired. He was awarded the Davy medal in 1883 and elected a foreign member of the Royal society in 1902. He was a member of the municipal council for about 35 years, and the gas, water and sewage systems of Copenhagen were largely the results of his civic activity. He died on Feb. 13, 1909.

His name is famous for his researches in thermochemistry, a subject to which he was attracted as early as 1852, as his first published paper, entitled "Contributions to a thermochemical system," shows. But his comprehensive work in this subject was not started until some years later. The results first appeared in 1869, and were published from time to time until 1882 They were collected in *Thermochemische Untersuchungen* (Leipzig, 1882–88; 4 vols), and a summary in Danish, entitled *Thermokemisker Resultater* appeared in 1905; the latter was translated into English as *Thermochemistry* by Katherine Burke.

In the course of his thermochemical work Thomsen made about 3,500 calorimetric measurements and he determined the heat evolved or absorbed in a very large number of chemical reactions. Incidentally he verified Kirchoff's equation connecting the change of heat of a reaction with temperature and the specific heats of the reactants and resultants, and also used his measurements to confirm Guldberg and Waage's theory of mass action (1867). Thomsen introduced the term "avidity" to indicate the tendency of an acid to unite with a base and used his results to draw up the first table of relative strengths of acids He also worked on selenic acid, platinum compounds and hydrogen peroxide. He made accurate determinations of the atomic weights of oxygen and aluminium. In 1853 Thomsen devised a process for manufacturing soda from cryolite, and this was first worked on a large scale in 1857. The process proved quite successful, and as a result Thomsen died a rich man His polarization battery received many awards at international exhibitions and was used in the Denmark telegraphic service In 1895 he predicted the existence of a group of inactive gases.

BIBLIOGRAPHY —See obituary notice, *Proceedings of the Royal Society* (1910–11); E Thorpe, Thomsen Memorial Lecture, *Journal of the Chemical Society* (London, 1910), E. Thorpe, *Essays in Historical Chemistry* (1923); M. Bjerrum, *Berichte der deutschen chemischen Gesellschaft* (1909).

THOMSEN, VILHELM LUDVIG PETER (1842–1927), Danish philologist, was born on Jan 25, 1842, at Copenhagen. He took his doctor's degree in 1869 and in 1871 became a lecturer at the University of Copenhagen, where from 1887–1916 he was professor of comparative philology. In 1876 he visited England and lectured at Oxford university. Thomsen came to be known as one of the most prominent linguists of modern times, and possessed an extensive and thorough knowledge of the various classes of languages. In Romance philology he solved the problem of softened consonants (1856); he was the first to ascertain the palatal law in the phonic system of the Indo-European languages. In 1894 he deciphered the Orkhon inscriptions from Mongolia, and made in 1899 important interpretations of Etruscan and Lycian texts. In *Turcica* (1916) he treated Ancient Turkic. He became president of the Royal Danish Scientific society in 1909 Thomsen died on May 13, 1927.

His publications include:—*Den gotiske Sprogklasses Indflydelse paa den finske* (1869); *The Relations between Ancient Russia and Scandinavia and the Origin of the Russian State* (1877); *Beroringer mellen de finske og de baltiske Sprog* (1890); *Samlede Afhandlinger* (Christiania, 1919).

THOMSON, SIR CHARLES WYVILLE (1830–1882), Scottish naturalist, director of the scientific staff in the Challenger expedition, was born at Bonsyde, Linlithgowshire, on March 5, 1830, and was educated at Edinburgh university. He held professional appointments at Aberdeen and in Ireland, and finally (1870–79) was professor of natural history at Edinburgh. He died at Bonsyde on March 10, 1882. He will be specially remembered as a student of the biological conditions of the depths of the sea. His interest in crinoids was stimulated by the results of the dredgings of Michael Sars (1805–69) in the deep sea off the Norwegian coasts, and he succeeded, with Dr. W. B. Carpenter, in obtaining the loan of H.M.S. "Lightning" and "Porcupine," for successive deep-sea dredging expeditions in 1868 and 1869 These operations showed that animal life exists in abundance down to depths of 650 fathoms, that all invertebrate groups are represented (largely by Tertiary forms previously believed to be extinct), and, moreover, that deep-sea temperatures are by no means so constant as was supposed, but vary considerably, and indicate an oceanic circulation. The results of these expeditions were described in *The Depths of the Sea* (1873). The government realised the value of the work and provided H.M S. "Challenger" for a circumnavigatmg expedition. Thomson sailed at the end of 1872 as director of the scientific staff, the cruise lasting three and a half years. (*See* CHALLENGER EXPEDITION) On his return he received many academic honours, and was knighted. In 1877 he published two volumes (*The Voyage of the Challenger in the Atlantic*) of a preliminary account of the voyage.

See obituary notice in *Proc. Soc Edin.* (1883); also Thomson and Murray, *Reports of the Voyage of H.M.S. "Challenger"* (Edinburgh, 1885).

THOMSON, CHRISTOPHER BIRDWOOD, 1ST BARON, cr. 1924 (1875–1930), British soldier and statesman, was born on April 13, 1875. Educated at Cheltenham and the Royal Military academy, Woolwich, he served in the Mashonaland campaign

and in the South African War From 1902–05 he was instructor at the military engineering school at Chatham. In 1909 he passed on to the Staff college and in 1911 to the war office During World War I he served as military attaché and chief of the British military mission in Rumania (1915–16), and in Palestine (1917) and was on the supreme war council in 1918 Having attained the rank of brigadier-general, he resigned from the service in 1920 as a protest against Allied intervention in Russia. He joined the Labour party, and accompanied, as military expert, the commissions of enquiry dispatched by that body to Ireland and to the Ruhr, later. he visited Russia In 1922, and again in 1923, he stood for parliament in the Labour interest, but was unsuccessful. In 1924, he was appointed air minister in the first Labour government, with a seat in the cabinet, and raised to the peerage. A graceful and effective speaker, Lord Thomson also possessed marked literary gifts and published various writings including *Old Europe's Suicide* (1922); *Victors and Vanquished* (1924). He was killed in the crash of the airship R-101 in 1930.

THOMSON, ELIHU (1853–1937), U.S. inventor, was born in Manchester, England, March 29, 1853, but moved to Philadelphia, Pa., with his parents in 1858. He received a public school education and in 1876–80 was professor of chemistry and mechanics at the Central high school in Philadelphia. In 1880 he went to New Britain, Conn., as electrician for the American Electric company and two years later he united with Edward J Houston to found the Thomson-Houston Electric company in Lynn, Mass In 1892 a merger took place between this company and the Edison General Electric company to form the General Electric company, the largest manufacturer of electrical equipment in the world Thomson remained as director of the large laboratory in Lynn, renamed after him the Thomson laboratory. Thomson made the first important research into the nature of the laws governing the electric arc, disclosing the fact that the resistance of the arc varies inversely with the current. He invented and constructed an arc light dynamo with a spherical (three-coil armature, and the first with an automatic regulator, which went into commercial use in 1880 He was the first to utilize a magnetic field to move an electric arc, a principle which found many uses, notably in the construction of the magnetic blowout switches In his notable discovery of the so-called alternating current repulsion phenomena he laid the basis for successful alternating current motors. He made the first high-frequency dynamo in 1890 and shortly afterward the first high frequency transformer, and was a pioneer in the development of other high frequency apparatus. In 1886 he invented the art of electric welding by the incandescent method which was simpler and less expensive than previous methods and applicable to a wider range of metals. He also invented the electric watt-hour meter, while the arc lamp, incandescent lamp, alternator, alternating current transformers and railway motors found improvement at his hands. He made many contributions to the field of radiology and was the first to make stereoscopic X-ray pictures. He published many articles in scientific journals, held over 700 patents, and received the Rumford, John Fritz, Kelvin and Faraday medals as well as other honours

THOMSON, JAMES (1700–1748), English poet, author of *The Seasons*, was born at Ednam, in Roxburghshire, on Sept 11, 1700—the third son and fourth child of Thomas Thomson, minister of that place. About 1701 Thomas Thomson removed to Southdean near Jedburgh. Here James was educated at first by Robert Riccaltoun, to whose verses on winter he owed the idea of his own poem, and then at a school at Jedburgh In 1715 he went to Edinburgh university. He became a divinity student, and it was partly to make a reputation as a preacher that he went to London in March 1725 He had already friends in London in Lady Grizel Baillie and Duncan Forbes of Culloden, and he was introduced by them to literary society in London, where he supported himself partly by acting as tutor.

The Seasons.—Thomson's *Winter* appeared in March 1726. It was dedicated to Sir Spencer Compton, the speaker, who rewarded the poet, to his great disgust, with a bare 20 guineas. *Summer* appeared in 1727, dedicated to Bubb Dodington. In the same year Thomson published his *Poem to the Memory of Sir Isaac Newton* *Spring* appeared in 1728, published by Andrew Millar. In 1729 he produced *Sophonisba*, a tragedy now only remembered by the line "O Sophonisba, Sophonisba, O," and the parody "O Jemmy Thomson, Jemmy Thomson, O." A poem, anonymous but unquestionably Thomson's, to the memory of Congreve appeared in the same year. In 1730 *Autumn* was first published in a collected edition of *The Seasons* It was dedicated to the speaker, Onslow. In this year, he accompanied the son of Sir Charles Talbot, solicitor-general, upon his travels. In the course of these he projected his *Liberty* as "a poetical landscape of countries, mixed with moral observations on their government and people" In Dec. 1731 he returned with his pupil to London. His pupil died soon after, and Talbot, who became chancellor, gave Thomson a sinecure in chancery. The first part of *Liberty* appeared in 1734–35, and it was completed in five parts in 1736. The poem was a failure; its execution did not correspond with its design; in a sense indeed it is a survey of countries and might have anticipated Goldsmith's *Traveller*. The truth is that Thomson's poetical gift was for many years perverted by the zeal of partisanship.

His patron died in Feb. 1737 and he lost his sinecure. His tragedy *Agamemnon* appeared in April 1738, not before he had been arrested for a debt of £70, from which, according to a story which has been discredited on quite insufficient grounds, Quin relieved him in the most generous and tactful manner. The incident took place probably a little before the production of *Agamemnon*, in which Quin played the leading part. The play is of course modelled upon Aeschylus and owes whatever of dignity it possesses to that fact; the part of Cassandra, for instance, retains something of its original force. But most of the other characters exist only for the purpose of political innuendo. Agamemnon is George, absent in Germany; Aegisthus is Walpole, and so on. As a result his next tragedy, *Edward and Eleanora*, was banned. This event sufficiently accounts for the poet's next experiment, a preface to Milton's *Areopagitica*. He joined Mallet in composing the masque of *Alfred*, represented at Clieveden on the Thames before the prince of Wales, on Aug. 1, 1740. There can be little question that "Rule Britannia," a song in this drama, was the production of Thomson. The music of the song, as of the whole masque, was composed by Arne. In 1744 Thomson was appointed surveyor-general of the Leeward Islands by Lyttelton with an income of £300 a year; this improved his circumstances considerably, and whilst completing at his leisure *The Castle of Indolence*, he produced *Tancred and Sigismunda* at Drury Lane in 1745.

Eventually *The Castle of Indolence*, after a gestation of 15 years, appeared in May 1748. It is in the Spenserian stanza with the Spenserian archaism, and is the first and last long effort of Thomson in rhyme. The great and varied interest of the poem might well rescue it from the neglect into which even *The Seasons* has fallen. It was worthy of an age which was fertile in character-sketches, and excels in the lifelike presentation of a noteworthy circle. It is the last work by Thomson which appeared in his lifetime. In walking from London to his house at Richmond he became heated and took a boat at Hammersmith; he thus caught a chill and died on Aug. 27, 1748. He was buried in Richmond churchyard. His tragedy *Coriolanus* was acted for the first time in Jan. 1749. In itself a feeble performance, it is noteworthy for the prologue which his friend Lyttelton wrote, two lines of which—

> He loved his friends—forgive the gushing tear!
> Alas! I feel I am no actor here—

were recited by Quin with no simulated emotion.

Precursor of Romanticism.—It may be questioned whether Thomson himself ever quite realized the distinctive significance of his own achievement in *The Seasons*, or the place which criticism assigns him as the pioneer of a special literary movement and the precursor of Cowper and Wordsworth. His avowed preference was for great and worthy themes of which the world of nature was but one, but fortunately his readers were wiser than himself. And though he recalled the minds of his contemporaries from the town to the country, in his feeling for nature, he is a true man of his age; his descriptions are general, and purely objective. There is no hint yet of the emotional reactions of the Romantic school. He

has many audacities and many felicities of expression, and enriched the vocabulary even of the poets who have disparaged him. Yet it is difficult to believe that he was not the better for that training in refinement of style which he partly owed to Pope.

The first collected editions of *The Seasons* bear dates 1730, 1738, 1744. 1746 Lyttelton tampered both with *The Seasons* and with *Liberty* in editions after his friend's death Among the numerous lives of the poet may be mentioned those by his friend Patrick Murdoch, by Dr Johnson in *Lives of the Poets*, by Sir Harris Nicolas (Ald. ed., 1860), by M. Morel, *James Thomson, sa vie et ses oeuvres* (Paris, 1895), and *James Thomson*, in the English Men of Letters Series, by G C. Macaulay (1908). See also Dr G Schmeding's *Jacob Thomson, ein vergessener Dichter des achtzehnten Jahrhunderts;* the life prefixed to the Aldine edition of his works in 1897; and an excellent edition of *The Seasons* in the Clarendon Press Series by J Logie Robertson Also A H. Thompson in *Cambridge History of English Literature*, vol. 10 (1913). (D C. To.; X.)

THOMSON, JAMES (1834–1882), British poet, best known by his signature "B.V.", was born at Port-Glasgow, in Renfrewshire, on Nov. 23, 1834, the eldest child of a mate in the merchant shipping service His mother was a deeply religious woman of the Irvingite sect. On her death, James, then in his seventh year, was procured admission into the Caledonian Orphan asylum. In 1850 he entered the model school of the Military asylum, Chelsea. As assistant army schoolmaster at Ballincollig, near Cork, he encountered the one brief happiness of his life· he fell passionately in love with, and was in turn as ardently loved by, the daughter of the armourer-sergeant of a regiment in the garrison, a girl of very exceptional beauty and cultivated mind. Two years later he suddenly received news of her fatal illness and death. The blow prostrated him in mind and body Henceforth his life was one of gloom, misery and poverty, rarely alleviated.

While in Ireland he had made the acquaintance of Charles Bradlaugh, then a soldier stationed at Ballincollig. In 1860 was established the paper with which Bradlaugh was so long identified, the *National Reformer*, in which, among other productions by James Thomson, there appeared (1861) the powerful and sonorous verses "To our Ladies of Death," and (1874) his chief work, the sombre and imaginative *City of Dreadful Night*. In Oct 1862 Thomson was dismissed from the army, in company with other teachers, for some slight breach of discipline Through Bradlaugh, with whom he lived for some years, he gained employment as a solicitor's clerk. From 1866 to the end of his life, except for two short absences from England, Thomson lived in a single room, first in Pimlico and then in Bloomsbury. He was intemperate in his habits, and made few friends. In 1869 his long poem, "Sunday up the River," appeared in *Fraser's Magazine*. In 1872 Thomson went to the western states of the U.S , as the agent of the shareholders in what he ascertained to be a fraudulent silver mine; and in 1873 he received a commission from the New York *World* to go to Spain as its special correspondent.

On his return to England he continued to write in the *Secularist* and the *National Reformer*, under the initials "B.V."[1] In 1875 he severed his connection with the *National Reformer*, owing to a disagreement with its editor; henceforth his chief source of income (1875–81) was from the monthly periodical known as *Cope's Tobacco Plant*. Chiefly through the exertions of his friend and admirer, Bertram Dobell, Thomson's best-known book, *The City of Dreadful Night, and other Poems*, was published in April 1880, and at once attracted attention; it was succeeded in the autumn by *Vane's Story, and other Poems*, and in the following year by *Essays and Phantasies*. All his best work was produced between 1855 and 1875 ("The Doom of a City," 1857; "To our Ladies of Death," 1861; *Weddah and Om-el-Bonain*, "The Naked Goddess," 1866–67; *The City of Dreadful Night*, 1870–74). He died at University College Hospital, in Gower Street, London, on June 3, 1882, and was buried at Highgate cemetery, in the same grave, in unconsecrated ground, as his friend Austin Holyoake.

To the productions of James Thomson already mentioned may be added the posthumous volume entitled *A Voice from the Nile, and other Poems* (1884), to which was prefixed a memoir by Bertram Dobell. If James Thomson has distinct affinity to any writer it is to De Quincey. The merits of Thomson's poetry are its imaginative power, its sombre intensity, its sonorous music; to these characteristics may be added, in his lighter pieces, a Heine-like admixture of strange gaiety, pathos and caustic irony. The same may be said of his best prose His faults are a monotony of epithet, the not infrequent use of mere rhetoric and verbiage See the *Life*, by H S. Salt (1905 edition).

THOMSON, SIR JOHN ARTHUR (1861–1933), British naturalist, was born at East Lothian on July 8, 1861, and was educated at the universities of Edinburgh, Jena and Berlin. He was, for a time, lecturer on zoology and biology at the school of medicine in Edinburgh, and in 1899 he became regius professor of natural history at Aberdeen university Apart from his purely zoological work, chiefly on alcyonarians, Professor Thomson did much, both by his lectures and his numerous attractive books and writings, to popularize biological science, and he was indefatigable in his efforts to correlate science and religion. He was knighted in 1930 and died Feb. 12, 1933.

His publications include: *Outlines of Zoology*, 7th ed. (1920); *Introduction to Science* (1911); *The Wonder of Life* (1914); *Secrets of Animal Life* (1919), *The System of Animate Nature*, Gifford Lectures (1920), *Science, Old and New* (1924); *The New Natural History* (1925); *Science and Religion* (1925); *Towards Health* (1927).

THOMSON, JOSEPH (1858–1895), Scottish explorer in Africa, was born on Feb 14, 1858 at Penpont, Dumfriesshire, being the fifth son of William Thomson, originally a working stonemason, who had attained the position of a master builder In 1868 his father removed to Gatelawbridge, where he rented a farm and a quarry. Joseph Thomson worked in his father's quarry before he went up to Edinburgh university After completing his course in 1878 he was appointed geologist and naturalist to the Royal Geographical society's expedition to East Central Africa under Keith Johnston. The latter died at Behobeho, between the coast and the north end of Lake Nyasa, in June 1879, and Thomson then took command. He successfully conducted the expedition across the desolate region of Uhehe and Ubena to the north end of Lake Nyasa, and then by a hitherto unexplored track to Lake Tanganyika, where he investigated the Lukuga outlet From Tanganyika he started to reach the Congo, but troubles with his carriers, who dreaded the warlike Warua, obliged him to retrace his steps. Going round the south end of Tanganyika he discovered Lake Rukwa, and marched via Tabora to the coast at Bagamoyo, reaching London in Aug. 1880.

About this time the sultan of Zanzibar asked Thomson to report on certain supposed coal-beds on the river Rovuma, but the coal proved to be merely bituminous shale.

For a considerable time the explorer had directed his attention to Masailand, through which ran the shortest route from the sea to the headwaters of the Nile. In 1882 the Royal Geographical society requested Thomson to report on the practicability of taking a caravan through the Masai country He succeeded in crossing the Njiri desert and exploring the eastern rift-valley Thence he went with a picked company through Laikipia to Mt Kenya and Lake Baringo, afterwards traversing the unknown region lying between Baringo and Victoria Nyanza, reached on Dec. 10, 1883.

In 1885 he undertook an expedition to Sokoto for the National African (afterward the Royal Niger) company, and obtained the signatures of the sultans of Sokoto and Gando to treaties with which he had been entrusted by the company. In 1888 he travelled for pleasure through southern Morocco and explored a portion of the Atlas range.

In 1890 he entered the service of the British South Africa company and starting from Quilhmane he traversed the region between lakes Nyasa and Bangweulu and the Zambezi. It was a period of tension between the Portuguese and the British, and Thomson's party on leaving the Portuguese frontier was fired on by the Portuguese who, too late, realized that they had allowed a treaty-making envoy to pass through their territory in the guise of a peaceful trader. Thomson concluded treaties with native potentates which gave to the chartered company political, trading and mining rights over a large part of the district since known

[1] Byssbe Vanolis: "Byssbe," as the commonly used Christian name of Shelley, Thomson's favourite writer; and "Vanolis," an anagram of Novalis (F. von Hardenberg)

as North-East Rhodesia. This journey, in which he covered nearly 1,000 m. of hitherto unexplored country, proved disastrous to his constitution In 1893 he visited South Africa in search of health, but unavailingly. He died in London on Aug 2, 1895. The accounts of his travels not recorded in the books mentioned were published in magazines or in the *Proceedings of the Royal Geographical Society*. Thomson was the last, as he was one of the most successful, of the great geographical pioneers in Africa. He had an extraordinarily keen topographical instinct which enabled him to comprehend at a glance the natural features of the countries he traversed. To undaunted courage and promptness of decision he added a forbearing and patient disposition.

Thomson wrote accounts of his travels under the titles *To the Central African Lakes and Back* (1881); *Through Maasland* (1884); *Travels in the Atlas and Southern Morocco* (1889); also some articles in the *Proceedings of the Royal Geographical Society* He also wrote, in collaboration with Miss E Harris Smith, *Ulu* (1888), a novel based on his insight into the working of the African mind, *Mungo Park and the Niger* (1890), a sound critical biography and many magazine articles on African politics.

See *Joseph Thomson, African Explorer* (1896), a biography by his brother, the Rev J B Thomson, which contains a list of the published writings of the explorer.

THOMSON, SIR JOSEPH JOHN (1856–1940), British physicist, was born at Cheetham Hill, near Manchester, on Dec. 18, 1856 His father was a bookseller and a publisher, of Scottish descent. At the early age of 14, he enrolled at Owens college, Manchester, where he came under the personal instruction of such productive scholars as Balfour Stewart and Osborne Reynolds. There he also made the acquaintance of fellow students, such as John H. Poynting and Arthur Schuster, who remained his life-long friends.

In 1876, Thomson went to Cambridge, entered Trinity as a Minor scholar and remained a member of this college, in one capacity after another, during the rest of his life. Among his teachers here were James Glaisher, George G. Stokes, John C. Adams and Arthur Cayley; but he coached with Edward J. Routh who was probably the most successful tutor in the history of Cambridge university. In the mathematical Tripos, 1880, Thomson was second only to J. Larmor (later Sir Joseph Larmor) who was senior wrangler.

At the age of 27, he was elected to a fellowship in the Royal society; and upon the resignation of Lord Rayleigh, in 1884, was chosen as his successor in the Cavendish professorship. His marriage to Rose Paget, daughter of Sir George and Lady Paget, was celebrated on Jan. 2, 1890 The essay on *Vortex Rings*, which won him the Adams prize and which may be taken as an indication of his early interest in atomic structure, appeared in 1883. Ten years later, in 1893, his *Recent Researches in Electricity and Magnetism* appeared. This book covers results obtained after the appearance of Maxwell's great *Treatise* in 1873; and is often alluded to as "the third volume of Maxwell." *A Textbook of Physics*, in four volumes, was the joint work of Thomson and Poynting These books had a wide use; so also did Thomson's *Elements of the Mathematical Theory of Electricity and Magnetism*.

In 1896, "J.J." (as he was affectionately called on both sides of the Atlantic) gave a course of four lectures at Princeton university. These summarized his researches on the *Discharge of Electricity through Gases*. Several years later, at Yale university, he gave a series of six lectures on *Electricity and Matter* in which some keen suggestions, looking toward atomic structure are offered. It was, however, between these two series of U S. lectures that he accomplished the most brilliant work of his life. This was the highly original study of cathode rays, in which he measured the ratio $\frac{m}{e}$ (where m is mass and e the charge of an ion) and discovered that its value is nearly 1,000 times less than in the electrolysis of liquids. He immediately proceeded to measure the charge of electricity, e, carried by various negative ions and found it to be the same in the gaseous discharge as in electrolysis. In this manner the fact was established that the particles which constitute cath de rays are much smaller than the smallest atoms known. They are the particles now called "electrons." This discovery of a body smaller than the hydrogen atom was first announced in his Friday evening lecture at the Royal institution on April 30, 1897.

In 1903 his most remarkable book appeared—*Conduction of Electricity through Gases*—described by Lord Rayleigh as a summary of "the work of Thomson's great days at the Cavendish laboratory." It was for his achievements along this line that the Nobel prize was awarded him in 1906. A later edition of this book, in two volumes, was published in collaboration with his son, George P. Thomson.

His later researches in the second decade of the 20th century led to an exceedingly important discovery, namely, a new method of separating different kinds of atoms and molecules This consists in the use of "positive rays," the deflection of which in a magnetic or electric field varies, *ceteris paribus*, with the atomic weight This is the idea which, in the hands of Francis W Aston, A. J. Dempster and others, has led to the discovery of many isotopes.

The British Association for the Advancement of Science came to Winnipeg for its 1909 meeting Thomson was the president of the association, the leading spirit of this brilliant group and the life of the party that made the excursion to the Pacific coast at the close of the meeting. His last trip across the Atlantic was made in 1923 for the purpose of giving five lectures upon "The Electron in Chemistry" before the Franklin institute.

The end of his scientific career is marked by his acceptance of the mastership of Trinity college in 1918. This post is one of the highest honours open to any Englishman or, indeed, to any European In the following year he resigned the Cavendish professorship, and lived the remainder of his life in the master's lodge at Trinity college, where he died on Aug. 30, 1940 His rare human and personal qualities endeared him to a long list of devoted and productive students, while his unaffected modesty, his breadth of interests and his readiness to employ "theory as a policy and not as creed" give him a unique place among men of science.

BIBLIOGRAPHY.—For a complete chronological list of Thomson's 231 scientific papers and of his 13 books, *see Obituary Notices of Fellows of the Royal Society*, vol. 3, pp 598–609 (1941); *see* also Thomson's own *Recollections and Reflections*, (1937); Lord Rayleigh's *Life of Sir J. J. Thomson* (Cambridge University Press, 1942). (H. Cw.)

THONGA, a group of Bantu-speaking peoples inhabiting the southern half of Portuguese East Africa and the neighbouring regions. It comprises a number of independent tribes, each governed by a chief assisted by councillors. The people live in small household groups, which are scattered irregularly over the tribal territory. They keep cattle and goats, and also raise crops of millet and maize. They are organized into exogamous patrilineal clans, and have a classificatory system of relationship Marriage is polygamous, and involves the payment of a bride-price Their religion is mainly ancestor-worship.

See H. A. Junod, *The Life of a South African Tribe* (1927).

THOR, one of the chief deities of the heathen Scandinavians, is represented as a middle-aged man of enormous strength, an implacable foe to the harmful race of giants (demons), but benevolent towards mankind His figure is somewhat secondary to that of Odin, represented as his father. But in Iceland and indeed, perhaps, in all northern countries except among the royal families, he was apparently worshipped more than any other god. There is evidence that a corresponding deity named Thunor or Thonar was worshipped in England and on the continent, but little is known about him beyond his identification with the Roman Jupiter. His name is the Teutonic word for thunder. Outside the Teutonic area he has close affinities with Jupiter or Zeus, and still more with the Lithuanian god Perkunas, whose name (which likewise means "thunder") appears to be connected with that of Thor's mother (Fiörgyn). (H. M. C.)

THORAX, the anatomical term for the chest, that part of the body which contains the heart and lungs (*see* ANATOMY: *Superficial and Artistic*, and also SKELETON) For the surgery of the thorax reference may be made to the heading HEART AND LUNG, SURGERY OF.

THORBECKE, JAN RUDOLF (1798–1872), Dutch statesman, was born at Zwolle, in the province of Overijssel, on Jan. 14, 1798. He studied at Leyden, and, on the completion of his course, visited the principal German universities. At Giessen he lectured as an extraordinary professor, and at Göttingen, in 1824, published his treatise, *Ueber das Wesen der Geschichte*. After his return to Amsterdam in 1824 Thorbecke wrote his *Bedenkingen aangaande het Recht en den Staat* ("Objections anent Law and the State"), which procured him in 1825 a chair as professor in Ghent university. The Belgian revolt of that year drove him from Ghent to Leyden, where he became professor of jurisprudence and political science. His standard work, *Aanteekeningen op de Grondwet* ("Annotations on the Constitution," 1839; and ed., Amsterdam, 1841–43), became the textbook and the groundwork for the new reform party in Holland, as whose leader Thorbecke was definitely recognized Thorbecke's political career until his death, which occurred at The Hague on June 4, 1872, is sketched under HOLLAND: *History*.

See biographies by Buys (Tiel, 1876) and J. A Levy (The Hague, 1876). There are two collections of his *Speeches* (6 vols., 1867–70, Deventer; and Gromngen, 1900) His *Correspondence with Groen van Prinsterer* appeared in 1873.

THOREAU, HENRY DAVID (1817–1862), American recluse, naturalist and writer, was born at Concord (Mass.), July 12, 1817 To Thoreau this Concord country contained all of beauty and even grandeur that was necessary to the worshipper of nature; he once journeyed to Canada, he went west on one occasion; he sailed and explored a few rivers; for the rest, he haunted Concord and its neighbourhood as faithfully as the stork its ancestral nest

As a boy, Henry drove his mother's cow to the pastures, and thus early became enamoured of certain aspects of nature and of certain delights of solitude. At school and at Harvard University he in nowise distinguished himself, though he was an intelligently receptive student and read widely. He was, however, proficient enough in Greek, Latin, and the more general acquirements to enable him to act for a time as a teacher But long before this he had become apprenticed to the learning of nature: when only 12 he had made collections for Agassiz, who had then just arrived in America. Thoreau gave up teaching and became a lecturer and author, though it was the labour of his hands which mainly supported him through many years' professionally he was a surveyor

He had arrived at the conviction that the less labour a man did, over and above the positive demands of necessity, the better for him and for the community at large, he would have had the order of the week reversed—six days of rest for one of labour In 1845 he made the famous experiment of Walden. Desirous of proving to himself and others that man could be as independent of his kind as the nest-building bird, Thoreau retired to a hut of his own construction on the pine slope over against the shores of Walden pond —a hut which he built, furnished and kept in order entirely by the labour of his own hands During his two years in Walden woods he lived by the exercise of a little surveying, a little job-work and the tillage of a few acres of ground which produced him his beans and potatoes He read considerably, wrote abundantly, thought actively if not widely, and came to know beasts, birds and fishes with an intimacy more extraordinary than was the case with St. Francis of Assisi Birds came at his call, and forgot their hereditary fear of man; beasts lipped and caressed him; the very fish in lake and stream would glide, unfearful, between his hands. His *Walden* (1854), the record of this fascinating two years' experience, must always remain a production of great interest.

Some years before Thoreau took to Walden woods he made the chief friendship of his life, that with Emerson He became one of the famous circle of the transcendentalists, always keenly preserving his own individuality amongst such more or less potent natures as Emerson, Hawthorne and Margaret Fuller. From Emerson he gained more than from any man, alive or dead; and, though the older philosopher both enjoyed and learned from the association with the younger, it cannot be said that the gain was equal. There was nothing electrical in Thoreau's intercourse with his fellow men; although he absorbed intensely he gave off no spiritual sparks. With children he was affectionate and gentle, with old people and strangers considerate. He loved his kind as animals, but did not seem to find them as interesting as those furred and feathered. In 1847 Thoreau left Walden lake abruptly, and for a time occupied himself with lead-pencil making, the parental trade He never married, thus further fulfilling his policy of what one of his essayist-biographers has termed "indulgence in fine renouncements." At the comparatively early age of 45 he died, May 6, 1862. His grave is in the Sleepy Hollow cemetery at Concord.

Thoreau's fame will rest on *Walden; or, Life in the Woods* (Boston, 1854) and the *Excursions* (Boston, 1863), though he wrote nothing which is not deserving of notice. Up to his 30th year he dabbled in verse, but he had little ear for metrical music, and he lacked the spiritual impulsiveness of the true poet. His weakness as a philosopher is his tendency to base the laws of the universe on the experience-born, thought-produced convictions of one man—himself. His weakness as a writer is the too frequent striving after antithesis and paradox. If he had had all his own originality without the itch of appearing original, he would have made his fascination irresistible. As it is, Thoreau holds a unique place He was a naturalist, but absolutely devoid of the pedantry of science; a keen observer, but no retailer of disjointed facts. He thus holds sway over two domains: he had the adherence of the lovers of fact and of the children of fancy. He must always be read, whether lovingly or intercestedly, for he has all the variable charm, the strange saturninity, the contradictions, austerities and delightful surprises of Nature herself.

The standard editions of his works are *The Writings of Henry David Thoreau*, Riverside ed. (11 vol, Boston, 1894–95), and Manuscript ed. (20 vol., 1906).

See also W E Channing, *Thoreau: The Poet Naturalist* (enlarged and edited by F B. Sanborn, 1902); R. W. Emerson, an introductory note to *Excursions* (Boston, 1863); F. B Sanborn, *Henry David Thoreau* (Boston, 1882), in the "American Men of Letters" series; H. S Salt, *Life of Henry David Thoreau* (1890, rev. ed 1896), *Some Unpublished Letters of H D. and Sophia E Thoreau* (Jamaica, New York, 1899); J Russell Lowell, *My Study Windows*; R L. Stevenson, *Familiar Studies of Men and Books*; F. H. Allen, *Bibliography of H. D. Thoreau* (Boston, 1908), *The Heart of Thoreau's Journals* (ed. by Odell Shepard, Boston, 1927), Brooks Atkinson, *Henry Thoreau, The Cosmic Yankee* (1927). (W. S.; X.)

THORFINN KARLSEFNI or KARLSEFNE (*fl.* 1002–1007), Scandinavian explorer, leader of the chief mediaeval expedition for American colonization Thorfinn belonged to a leading Icelandic family. In 1002 he came to Greenland, married Gudrid, widow of Red Eric's son Thorstein, and put himself at the head of a great expedition now undertaken from Ericsfiord for the further exploration and settlement of the western Vinland (south Nova Scotia?) lately discovered by Leif Ericsson (*q.v.*). Three vessels took part in the venture, with 160 men and some women, including Gudrid, and Freydis, a natural daughter of Red Eric. They first sailed north-west to the Vesterbygd or "Western Settlement" of Greenland, thence to Bear island, and thence away to the south till they reached a country they named *Helluland* (some part of Labrador?) from its great flat slabs of stone (*hellur*). Two days' sail farther southward brought them to a thickly-wooded land they called *Markland* (*i.e.*, Woodland, our Newfoundland?) Two days after this they sighted land to the right hand, and came to a cape, where they found the keel of a ship—perhaps a relic of some earlier, possibly Scandinavian explorer—and which they called therefore *Kialames* (Keelness; Cape Breton, or some adjacent point?), the long bleak sandy shores of this coast they called the *Wonderstrands* (on the east coast of Cape Breton island?) After passing the *Wonderstrands* and reaching a coast indented with bays, Thorfinn put two fleet Gael runners ashore, with orders to explore southwards (*see* LEIF ERICSSON); they returned with grapes and wild wheat, proofs that the Northmen were not far from Vinland.

The fleet now stood in to a bay called by the explorers *Streamfiord* or Firth of Currents, and wintered there (1003–04), suffering some privations, and apparently getting no more news of the fruitful country desired. Thorfinn's son Snorri was born this first autumn in the new world. Next spring nine of the party, headed by the chief malcontent Thorhall, Red Eric's huntsman, sailed off northward, intending to come to Vinland by rounding Keelness and thence working round west (and south). Adverse weather drove them to Ireland, where they were enslaved. Meanwhile Thorfinn, with the rest of the venturers, sailed south "for a long time," till they reached a spot they called *Hop*, at the mouth of a river which flows from a lake into the sea.

Here they found the "self-sown" wheatfields and vines of Leif's Vinland, and here accordingly they settled and built their huts above the lake (1004–05). After a fortnight natives, swarthy and ill-looking, with ugly hair, great eyes and broad cheeks (Beothuk or Micmac Indians?) appeared with many skin canoes; in the spring following these *Skraelings* came back and bartered with their visitors. Terrified by a bull belonging to the latter they fled, and after three weeks returned to fight. They were beaten off, but two of the Northmen were slain. The colony at Hop was therefore abandoned and the whole force returned to Streamfiord. Thence Thorfinn revisited Hop, staying two months; and also made a voyage northward in search of Thorhall, rounding Keelness and sailing westward (along the north coast of Cape Breton island?), and apparently southward also, till they came to the

mouth of a river flowing from east to west. Here Thorvald Ericsson was killed by a (Skraelng?) arrow, and the expedition came back to Streamfiord where they passed the next winter (1005-06) Internal dissensions broke out, mainly about the women of the colony, and in the summer of 1006 the entire project of Vinland settlement was abandoned and the fleet sailed to Markland Two Skraeling children were captured here and the expedition divided, Thorfinn making Greenland and Ericsfiord in safety with his own vessel, while the other was lost in the Irish sea, only half the crew escaping to Ireland in the ship's boat. (C. R. B)

On *Flatey Book, Red Eric Saga* and the whole bibliography for the Vinland voyages, including that of Thorfinn, *see* LEIF ERICSSON and AMERICA: *Pre-Columbian Discoveries* The six Vinland voyages of *Flatey*, we may repeat, *Red Eric* reduces to three, wholly omitting the alleged voyage of Biarni Heriulfsson, and grouping those of Thorvald Ericsson and *Freydis* with *Thorfinn Karlsefni's in one great* colonizing venture.

THORIANITE, a rare mineral found in the gem-gravels of Ceylon as small, heavy, black, cubic crystals, usually much water-worn. It was so named on account of its high percentage of thorium (59–79% ThO_2); it also contains the oxides of uranium (11–13%), and the formula $(Th,U)O_2$ is similar to that of uraninite, but with thorium predominating over uranium Helium is present, and the mineral is slightly less radio-active than pitchblende. A few isolated crystals of the mineral have been found in Transbaikalia, Siberia and in Madagascar Thorianite contains a higher percentage of thoria than any other known mineral, and it has been employed to a limited extent as a source of thoria for use in incandescent gas-mantles.

THORITE, a rare mineral consisting of thorium silicate, crystallizing in the tetragonal system and isomorphous with zircon. The theoretical formula, $ThSiO_4$, requires 81·5% of thoria, but analyses show only 50–70%, there being also some uranium, cerium, etc. The mineral is almost always altered by hydration and is then optically isotropic and amorphous. Owing to differences in composition and to alteration, the specific gravity varies from 4·4 to 5·4. The colour is usually light brown, but in the variety known as "orangite" it is orange-yellow. The mineral occurs as isolated crystals and small masses in the augite-syenite near Brevik in south Norway, also at Arendal, and in the gem-gravels of Ceylon. If found in larger amount it would be an important source of thoria for incandescent gas-mantles. (L. J. S.)

THORIUM, a chemical element belonging to a group of metals contained in the oxides known as the rare earths (symbol Th, atomic number 90, atomic weight 232·2). In 1828, Berzelius gave the name thoria (after the god, Thor) to the basic oxide extracted from the thorite of Lövön (Norway). Thorium is present as the main constituent in thorite and orangite, which are thorium silicates, $ThSiO_4$, auerlite, calciothorite, freyalite, mackintoshite and thorianite (ThO_2, 60–78%, with oxides of uranium), but the only commercial source is monazite sand, a complex phosphate of the rare (cerite) earths containing 2 to 10% of thoria. This sand is found in Brazil, Travancore, North and South Carolina, Idaho, Australia and the Malay Archipelago The first two sources are the most important commercially, the Travancore deposits furnishing three-fourths of the world's supply. Thoria is extensively used in the construction of incandescent gas mantles (*see* LIGHTING AND ARTIFICIAL ILLUMINATION) this being the main industrial application of thorium.

Metallic Thorium.—Owing to its intense chemical reactivity towards hydrogen, nitrogen, oxygen, carbon and the metals, thorium is isolated only with considerable difficulty. Anhydrous thorium chloride when heated with sodium *in vacuo* furnishes a pure product. Thorium is also obtained (i.) by passing the vapour of its iodide over heated tungsten filaments, (ii.) by the action of calcium on thoria, (iii.) by passing thorium acetylacetone and sodium vapours through a red hot tube. It is a leaden-grey metal of specific gravity 12·16, resembling platinum in hardness and ductility. Its melting point is 1,845° C. Thorium ribbon when heated to red heat continues to burn in air, giving a shower of sparks. At 450° C the metal combines with the halogens and with sulphur, and at 650° C with hydrogen and nitrogen. Thorium is dissolved by strong hydrochloric acid or aqua regia but other acids attack it only slowly. It is not affected by alkalis but alloys with aluminium, copper and nickel; the thorium-tungsten alloy is of industrial use for making filaments for incandescent electric lamps Tungsten containing 0·5 to 10% of thorium, when used as the cathode of an electric discharge apparatus, gives at 1,030° C an electron emission equal to that furnished by pure tungsten at 1,700° C Thorium is strongly radioactive.

Extraction of Thoria.—Thorite and thorianite are dissolved in mineral acid and the solution evaporated down to render silica insoluble Ammonium sulphide is added to the aqueous extract to precipitate such common metals as iron and lead. The thoria remaining in solution is separated through its carbonate, sulphate or oxalate.

Monazite is broken up with strong sulphuric acid, the solution diluted and partially neutralised with alkali (ammonia, caustic soda or magnesia), when thorium phosphate is precipitated This phosphate is dissolved in hydrochloric or sulphuric acid and the thorium reprecipitated as oxalate Further purification may be effected by means of (i.) thorium carbonate, which is more soluble than other rare-earth carbonates in sodium carbonate; (ii) ammonium thorium oxalate which is soluble; or (iii) fractional crystallisation of thorium sulphate, Th $(SO_4)_2.8H_2O$. Finally, the purified thoria is converted into thorium nitrate, the salt employed in the mantle industry. The world's annual consumption of monazite is about 3,000 tons, and of this, 200 tons are worked up in Great Britain, ilmenite (*see* TITANIUM) and mesothorium being useful by-products Each kilogram of monazite on acid treatment evolves one litre of helium, also obtainable by heating the mineral to redness.

Gas Mantles.—Incandescent mantles are manufactured by impregnating a woven stocking of combustible fabric (cotton or ramie) with the nitrates of thorium and cerium. The impregnated stocking is ignited to convert these nitrates into oxides, the mixture of nitrates being adjusted so that the mixed oxides consist of 99% of thoria, and 1% of ceria, this mixture giving optimum luminosity at comparatively low temperatures. About 300 millions of incandescent gas mantles are consumed annually, of which the United States takes approximately 80 millions.

Thorium Compounds.—Thorium in combination is uniformly quadrivalent. Thoria (thorium dioxide), ThO_2, a white powder of specific gravity 10·20, is obtained by heating thorium salts of volatile acids or by igniting the hydroxide, $Th(OH)_4$, a heavy white powder precipitated by alkali from thorium solutions Thoria is a refractory material utilisable in making cupels and crucibles. Thorium tetrachloride is obtained in colourless prisms melting at 820° C by heating thoria in the vapour of carbon tetrachloride or sulphur chloride. Thorium sulphate, $Th(SO_4)_2$, crystallises with 4, 8 and 9 molecules of water, and the nitrate with 5, 6 and 12 H_2O Commercial thorium nitrate should contain a minimum of 48% ThO_2.

Thorium acetylacetone, $Th[CH(CO\,CH_3)_2]_4$, a white crystalline product melting at 172° C and soluble in alcohol or chloroform, is distillable *in vacuo* without decomposition. Thorium salts of organic acids have been employed medicinally for skin trouble and in cholera and dysentery on account of their radioactive character. Thoria is used as a catalyst in organic syntheses (ketones from acids). Inhalations of thorium emanation (thoron) are stated to be efficacious in diseases of the respiratory organs.

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THORN or, better, **TORUN,** a town of Poland, in the province of Pomorze, situated on the right bank of the Vistula, 85 m. by rail N.E. of Poznan, and 92 m S. of Danzig. Pop (1939), 54,000. Torun has always been an important town owing to its position between Pomerania, Poland Proper and East Prussia, and its strategical importance as a bridge head commanding the passage of the Vistula. The old town and the new town, founded in the 13th century, were united in the 15th, and both retain a number of interesting buildings dating from the 14th, 15th and 16th centuries, when Torun was a flourishing

member of the Hanseatic league. The ruined castle of the Teutonic knights, part of the old walls, the town hall, the churches of St John, of the Virgin and of St. James are the most interesting edifices. There is a monument to Kopernik (Copernicus), who was born in Torun The old wooden bridge has been succeeded by a massive iron railway viaduct 3,300 ft. long Torun carries on trade in grain, timber and foodstuffs and has ironworks, sawmills and other manufactures. Torun was founded in 1231 by the Teutonic Order, which was given land and invited to help the Poles against the heathen Prussians. It became a subject city of the order and an important member of the Hanseatic league, but political and commercial interests bound it to Poland. In 1454 the city revolted against the order and was annexed to Poland in 1466 at the peace concluded there. A religious riot in 1724, terminating in a brutal execution, made a great stir in Europe. The town was seized by Prussia at the second partition, was returned to the grand duchy of Warszawa, and again granted, in 1815, to Prussia, in which it remained until 1918. Germany seized Torun in 1939; it was returned to Poland in 1945.

THORN, in botany, a hard pointed structure, also termed a "spine," generally representing a small branch, as in hawthorn, where a normal branch arising in the axil of a leaf is replaced by a sharply pointed thorn; accessory buds on each side of the thorn and developed in the same leaf-axil will grow in the next season into ordinary branches. The similarly developed thorns of the honey-locust (*Gleditsia*) are branched. In other cases, as the sloe or the wild pear, branches become spiny at the apex tapering into a stiff leafless point. On a cultivated tree these branches disappear owing to their more vigorous growth. Leaves may be modified into spines, as in barberry, the leaves of which show every gradation between a leaf with a spiny-toothed edge and those which have been reduced to simple or multiple spines In some species of *Astragalus* the petiole of the pinnately compound leaf persists after the fall of the leaflets as a sharp spine. In the false acacia (*Robinia*) the stipules are represented by spines.

THORNABY-ON-TEES, a municipal borough in the North Riding of Yorkshire, England, 3 mi. S.W. of Middlesbrough by road, in the Middlesbrough West parliamentary division. Pop. (1951) 23,413. Area 3.11 sq.mi It lies on the Tees river, opposite Stockton-on-Tees, with which it is connected by a bridge. In the 8th century the Danes called it Thormodby; in Domesday Book it appears as Tormozby. The parish church on the village green is Norman. Thornaby's industrial development dates from the 19th century. It was incorporated as a separate borough in 1892. The population is employed chiefly in bridge building, heavy engineering, foundries, wire ropemaking, shipbreaking, flour milling, the production of sugar and preserves

THORNDIKE, EDWARD LEE (1874–1949), U.S. psychologist and educator, was born at Williamsburg, Mass., on Aug 31, 1874. Working at Teachers college, Columbia university, from 1899 to his retirement in 1941, he opened up the then new field of educational psychology. He did pioneer experimental work on animal learning, educational and psychological tests, the study of individual differences, the psychology of the school subjects, the psychology of the adult, and the psychology of language and communication.

Through the more than 500 books and articles which he wrote and through his influence upon the many students from Teachers college who went out to assume positions of leadership in education in the United States, he exerted a major influence upon educational thought and practice during the first half of the 20th century. The influence was in the direction of: basing educational practices upon testing and investigation rather than speculation; teaching each child what he will actually need to use; and providing the most opportunity for each child to succeed and for awareness of that success to serve as the basis for his further learning.

He died Aug. 9, 1949, at Montrose, N.Y. (R. L. Te.)

THORNDIKE, DAME SYBIL (1882–), British actress born at Gainsborough, Lincolnshire, was educated at the high school, Rochester, when her father, Rev. A. J. W. Thorndike was a canon of the cathedral. From 1903–07 she toured the U.S. in Shakespearian repertory with Ben Greet. Returning to England she became a member of Miss Horniman's company at the Gaiety theatre, Manchester, 1908–09. In 1914, she became attached to the "Old Vic" company in London She remained there until 1918, and acted in many principal Shakespearian parts. In 1919 she appeared in a series of matinées at the Holborn Empire, in which she played the parts of Hecuba in *The Trojan Women* and of Candida, in Bernard Shaw's play of that name. Henceforward her success was assured

She toured in Egypt, Palestine and Australia, 1932–33, and in 1934 she gave poetry recitals in Scotland. Her later parts include Mrs Linden in *The Linden Tree*, 1947–48, and Lady Douglas in *Douglas*, Edinburgh festival, 1950 She married Sir Lewis Casson in 1908. She was created a D.B.E. in 1931.

THORNE, a market town and rural district in the Goole parliamentary division of the West Riding of Yorkshire, England, 10 mi. N.E. of Doncaster by road. Pop. of rural district (1951) 32,159. Area 60 sq.mi. It lies near the right bank of the Don river in a low, flat district formerly a marshy waste. Hatfield chase was partly drained by the Dutch engineer Cornelius Vermuyden in the 17th century; today the "levels," as the surrounding district is generally named, is drained by numerous canals, and the town has water communication with Goole and the Humber estuary. This latter fact, together with the remarkable fertility of the "levels" and the existence of two collieries in the district, contributes to the importance of Thorne as an agricultural and coal mining centre.

Hatfield chase was the scene of the battle at which in A.D. 632 King Edwin of Northumbria fell before Cadwallon, king of Gwynedd, and Penda of Mercia.

THORNHILL, SIR JAMES (1676–1734), British painter, knighted in 1720, was born at Wollands, Dorset He became the history painter and sergeant painter to George I and George II master of the Painters' company in 1720, fellow of the Royal society in 1723, and member of parliament from 1722 to 1734 Apprenticed to Thomas Highmore in 1689, Thornhill was the first Englishman to excell in history painting, then considered more important than portraiture. The eight scenes in the dome of Saint Paul's cathedral (1715–1719) and the allegories in the Painted hall, Greenwich hospital, (1708–1727) are his two most considerable works. His paintings were largely executed on the ceilings and stairs of such country houses and palaces as Hampton Court, Blenheim, and Chatsworth. Among Thornhill's few canvases are the altar piece for Saint Mary's parish church, Weymouth, and a group portrait of the members of the house of commons in which he was assisted by Wm Hogarth, his son-in-law. Thornhill also did portraits, book illustrations, theatre scenery and the rose window of the north transept of Westminster abbey (1721).

Thornhill went abroad twice—in 1711 to the Lowlands, and in 1717 to Paris. One of the original directors of Kneller's Academy of Painting in 1711, he became governor in 1716. When this closed, and he had failed to establish a "royal academy," he opened his own drawing school off Covent Garden in 1724. In 1729 he made several copies of the Raphael cartoons; one set remained in the Royal academy. He repurchased a former seat of his family, Thornhill Park, near Stalbridge Dorset, where he died in May 1734 (Wm. O.)

THORNHILL, village in the civil parish of Morton, Nithsdale, Dumfriesshire, Scotland, 14 mi. N.N.W. of Dumfries by rail. Pop. (1931), 1,044. It lies among tree-clad hills and is watered by the Nith and such streams as the Carron, Cample and Crichope. Morton parish church lies in the village. There is a natural history museum with a statue of Richard Cameron, the covenanter (1680) in the grounds. There are weekly sales of livestock, and an agricultural show is held every September. Near the town are freestone quarries, and a bacon factory. Three miles N.N.W. stands Drumlanrig castle, a seat of the duke of Buccleuch, begun in 1679. The fourth duke of Queensberry, "Old Q," incurred the wrath of Robert Burns and Wordsworth by his wanton destruction of the magnificent woods. On the death of "Old Q." without issue in 1810, Henry, third duke of Buccleuch, succeeded to the dukedom of Queensberry, and the property has since been adequately cared for. The gardens and park are very fine. The

ruins of Tibber's castle, dismantled in 1311 by Robert Bruce, stand in the grounds, about 1 m from the mansion.

THORNYCROFT, SIR JOHN ISAAC (1843–1928), British naval architect, brother of Sir Hamo Thornycroft (*q.v.*), was born in Rome, on Feb 1, 1843, and educated privately and at Glasgow university. In 1866 he established shipbuilding works at Chiswick, which later became known for the production of high-speed launches and torpedo craft In his yards was built the first British naval torpedo-boat, the "Lightning" (1877). The growing size of the torpedo-boats necessitated the removal of the works to Woolston, Southampton, in 1906. In 1916 Thornycroft built a large number of high-speed torpedo boats, constructed to skim the water, which proved very successful. He was elected F.R.S. in 1893, and was knighted in 1902. He died on June 28, 1928, at Bembridge, Isle of Wight

THORNYCROFT, SIR WILLIAM HAMO (1850–1925), British sculptor. He assisted his father, Thomas Thornycroft in carrying out the fountain in Park lane, London, and modelled the figures of Shakespeare, Fame and Clio. in 1871 In 1872 he exhibited at the Royal Academy, "Professor Sharpley" in marble, for the memorial in University college. His "Warrior Bearing a Wounded Youth from the Field of Battle" gained the gold medal at the Royal Academy schools in 1875. In this and in "Lot's Wife" in marble (1878) and "Artemis" (1880) Thornycroft turned towards the Greek school. In 1880 he was elected A.R.A , and R.A in 1888. He was awarded a medal of honour at the Paris exhibition in 1900. He was knighted in 1917, and died in 1925

Thornycroft's sculptures include "The Mower" (1884), "Teucer" (1881), a bronze figure now in the Tate gallery, London; statues of "General Charles Gordon" (1885), in Trafalgar square; "Oliver Cromwell," at Westminster (1899), and the "Gladstone Monument," in the Strand, London. *See* M H. Spielmann, *British Sculpture and Sculptors of To-day.*

THÓRODDSEN, THORVALDUR (1855–1921), Icelandic geographer, was born on the island of Flatey, in Breidfjörðr, Iceland, on June 6, 1855, the son of Jón Thóroddsen He was educated at Reykjavik and at the university of Copenhagen, where he studied natural science and geography. In 1876 he was sent to Iceland by the Danish government with Professor Johnstrup to investigate the causes of the eruption which had occurred in 1875 at Askja in Dyngjufjoli, and this was the beginning of a long series of Icelandic explorations In 1880 he was appointed master at the school of Möðruvellir in northern Iceland, and in 1882–84 made extensive explorations into the interior. He travelled in England and on the Continent from 1884 until 1886 when he was appointed schoolmaster at Reykjavik. Until 1898 he made a journey of exploration nearly every year, the later expeditions being undertaken from Copenhagen, where he settled in 1895.

His works include several volumes on the Volcanoes of Iceland, the last being *Die Geschichte der islandischen Vulkane* (1905); other works are *Land fraedssaga Island* (1892); *Geschichte der islandischen Geographie* (2 vols, 1898); and *Island Grundriss der Geographie and Geologie* (1905)

THORPE, SIR THOMAS EDWARD (1845–1925), British chemist, was born at Harpurhey, Manchester, on Dec. 8, 1845; he studied at Owen's college and then under Bunsen at Heidelberg. In 1870 he became professor of chemistry at Anderson's college, Glasgow, and four years later at the Yorkshire college, Leeds. In 1885 he obtained the chair at the Normal School of Science (now the Imperial College of Science), London, and remained there until appointed director of the Government laboratories in 1894. On his retirement, in 1909, he returned to the Imperial college for a period of three years He was elected to the Royal Society in 1876, was made a C.B. in 1900 and knighted in 1909. He died on Feb. 23, 1925

Thorpe is perhaps best known for his work as an organizer in connection with the Government laboratories, and as a brilliant lecturer and writer. His *Essays in Historical Chemistry* is an attractive and interesting work. He also brought out, with the co-operation of a number of specialists, the well-known *Dictionary of Applied Chemistry*, a new edition of which was completed in 1927 (1st ed., 1890) His contributions to chemical knowledge include a very accurate series of measurements of the specific volumes of chemical substances of related composition. With A E H. Tutton, he studied the oxides of phosphorous (*q.v.*) (1886 *et seq.*); they discovered P_2O_4 and investigated this and P_4O_6. From 1884 to 1886 he made a long series of measurements (with J. W. Rodger) of the viscosities of organic substances, and attempted to correlate fluidity and composition. With Sir A. Rücker, he carried out a magnetic survey of the British Isles.

See Proc. Roy. Soc (1925).

THORWALDSEN, BERTEL (1770–1844), Danish sculptor, the son of an Icelander who had settled in Denmark, and there carried on the trade of a wood-carver, was born in Copenhagen on Nov. 19, 1770. He entered the Copenhagen school of art, and in 1792 won the highest prize, the travelling studentship. In 1797 he went to Rome, where Canova was at the height of his popularity. Thorwaldsen's first success was the model for a statue of Jason, highly praised by Canova, which he was commissioned to execute in marble by Thomas Hope, a wealthy English art-patron From that time Thorwaldsen's success was assured, and he did not leave Italy for twenty-three years. In 1819 he returned to Denmark, where he was commissioned to make the colossal series of statues of Christ and the twelve apostles which are now in the Fruenkirche in Copenhagen. These were executed after his return to Rome, and were not completed till 1838, when Thorwaldsen again returned to Denmark He died suddenly on March 24, 1844, bequeathing a great part of his fortune for the building and endowment of a museum in Copenhagen His collection of works of art and the models for all his sculpture went to furnish the museum, in the courtyard of which he is buried under a bed of roses, by his own special wish.

On the whole Thorwaldsen was the most successful of all the imitators of classical sculpture, and many of his statues of pagan deities are modelled with much of the antique feeling for breadth and purity of design. For Christian sculpture he had no real feeling, and the tomb of Pius VII. in St. Peter's and the "Christ and Apostles" at Copenhagen are less successful. One of his best-known works is his statue of a lion, at Lucerne, Switz. Thorwaldsen worked sometimes with feverish eagerness; at other times he was idle for many months together.

See Eugène Plon, *Thorwaldsen, sa vie*, etc. (Paris, 1880); Andersen, *B Thorwaldsen* (Berlin, 1845); Killerup, *Thorwaldsen's Arbeiten*, etc. (Copenhagen, 1852), Thiele, *Thorwaldsen's Leben* (Leipzig, 1852–1856); C. A. Rosenberg, *Thorwaldsen . . . mit 146 Abbildungen* (1896, "Kunstlermonographien," No. 16); S. Trier, *Thorvaldsen* (1903); A. Wilde, *Erindringer om Jerichau og Thorvaldsen* (1884); F. Oppermann, *Thorwaldsen, hans Barndom og Ungdom* (1924).

THOTH, the Greek name of the Egyptian god of letters, invention and wisdom, the mouthpiece and recorder of the gods, and arbiter of their disputes Thoth is found on the earliest monuments symbolized by an ibis (*Ibis aethiopica*, still not uncommon in Nubia), which bird was sacred to him.

See E A. W. Budge, *The Gods of the Egyptians.*

THOU, JACQUES AUGUSTE DE [THUANUS] (1553–1617), French historian, was the grandson of Augustin de Thou, president of the parlement of Paris (d. 1544). He studied law at Orleans and at Bourges, where he made the acquaintance of Hotman, and finally at Valence, where he had Cujas for his master and Scaliger as a friend He was at first intended for the Church, he received the minor orders, and on the appointment of his uncle Nicolas to the episcopate succeeded him as a canon of Notre-Dame. As *conseiller d'état* he served faithfully both the effeminate, bigoted and cruel Henry III and Henry IV, a sceptic and given to love-intrigues, because they were both the representatives of legitimate authority. He succeeded his uncle Augustin as *président à mortier* (1595), and used his new authority in the interests of religious peace, negotiating, on the one hand, the Edict of Nantes with the Protestants, while in the name of the principals of the Gallican Church he opposed the recognition of the Council of Trent. This attitude exposed him to the animosity of the League party and of the Holy See, and to their persecution when the first edition of his history appeared.

This history was the work of his whole life. His materials

for writing it were drawn from his rich library, which he established in the Rue des Poitevins in the year 1587, with the two brothers, Pierre and Jacques Dupuy, as librarians. His object was to produce a purely scientific and unbassed work, and for this reason he wrote it in Latin, giving it as title *Historia sui temporis* The first 18 books, embracing the period from 1545–1560, appeared in 1604 (1 vol folio), and the work was at once attacked by those whom the author himself calls *les envieux et les factieux* The second part, dealing with the first wars of religion (1560–1572), was put on the *Index librorum prohibitorum*.

The third part (up to 1574), and the fourth (up to 1584), which appeared in 1607 and 1608, caused a similar outcry, in spite of de Thou's efforts to remain impartial. In answer to his detractors, he wrote his *Mémoires*, which are a useful complement to the *History of his own Times*. After the death of Henry IV., the queen-regent refused him the position of first president of the parlement, appointing him instead as a member of the *Conseil des finances*. He continued to serve under Marie de Medicis, and took part in the negotiations of the treaties concluded at Ste Menehould (1614) and Loudun (1616). He died at Paris on May 7, 1617.

Three years after the death of de Thou, Pierre Dupuy and Nicolas Rigault brought out, with pt. v., the first complete edition of the *Historia sui temporis*, comprising 138 books; they appended to it the *Mémoires*, also given in Latin (1620) A hundred years later, an Englishman, Samuel Buckley, published a critical edition, the material for which had been collected in France itself by Thomas Carte (1733). De Thou's history is a model of exact research, drawn from the best sources, and presented in a style both elegant and animated The standard translation is *Histoire universelle*, by Le Beau, Le Mascrier, the Abbé Des Fontaines, 1734. The *Mémoires* had already been translated by Le Petit and Des Ifs (1711), in this form they have been reprinted in the collections of Petitot, Michaud and Buchon. To de Thou we also owe certain other works: a treatise *De re accipitraria* (1784), a *Life*, in Latin, of Papyre Masson, some *Poemata sacra*, etc.

For his life may be consulted the recollections of him collected by the brothers Dupuy (*Thuana, sive Excerpta J. A Thuani per fr. P. P.*, 1669; reprinted in the edition of 1733), and the biographies by J. M. Collinson (*The Life of Thuanus*, 1807), and Duntzer, (*De Thou's Leben*, 1837) Finally, *see* Henry Harrisse, *Le Président de Thou et ses descendants, leur célèbre bibliothèque* (1905).

THOUARS (tōō-ar), a town of W. France, in the department of Deux-Sèvres, on the right bank of the Thouet, 24 m S by W. of Saumur on the railway to Bordeaux. Pop (1936) 9,793 Thouars, which probably existed in the Gallo-Roman period, became in the 9th century the seat of powerful viscounts, who in later times supported the English. In 1372 the latter were expelled from the town by Bertrand du Guesclin. In 1563 Charles IX created Louis III., the head of the family of La Trémoille, duke of Thouars. In 1793 the Vendeans took the town by assault A massive stronghold built in the early 17th century by the La Trémoille family stands on a rocky hill overlooking the river. The adjoining 16th century Sainte-Chapelle is in the Gothic style with Renaissance details. The church of St Médard, rebuilt in the 15th century, has a Romanesque doorway. That of St. Laon (12th and 15th centuries) was formerly attached to an abbey, the buildings (17th century) of which serve as town-hall Remains of the 13th century ramparts of the town, flanked by huge towers, are still to be seen, and a bridge of the same period crosses the Thouet. The manufacture of shoes, and the preparation of veterinary medicine and lime, are carried on. Wine, live stock and agricultural produce are the chief articles of trade.

THOUGHT, LAWS OF. Logicians usually formulate certain ultimate principles or assumptions implied in all consistent thinking and reasoning. These principles are known as the "laws of thought" in the narrower and more usual sense of the expression, though in a wider sense the rules of the syllogism and of induction, etc., might be called laws of thought. Three or four such fundamental principles are usually formulated. Perhaps a fifth ought to be added. They are as follows. (1) *The Principle of Identity:* "A is A," or "a thing is what it is" or "everything has a certain character which it retains more or less" (*see* Identity, Principle of). (2) *The Principle of Contradiction:* "A is not non-A," or "A cannot both be B and not be B," or "A cannot be both B and non-B." "a thing cannot both have and not have a certain attribute," or "the same predicate cannot be both affirmed and denied of the same subject." (3) *The Principle of Excluded Middle:* "A either is or is not B," or "A is either B or non-B," or "a thing must either have or not have a certain character," or "of two contradictory predicates one can be asserted of every relevant subject" (4) *The Principle of Sufficient Reason:* "Nothing occurs for which one having sufficient knowledge might not be able to give a reason sufficient to determine why it is as it is and not otherwise" (Leibniz). (5) *The Principle of Uniformity of Reasons:* "Whatever is regarded as a sufficient reason in any one case must be regarded as a sufficient reason in all cases which are essentially of the same kind," or, expressed negatively, "nothing can be regarded as a sufficient reason in any one case unless it can also be regarded as a sufficient reason in all cases of that kind" (A. Wolf).

These principles are indemonstrable assumptions or postulates. If they cannot be proved, neither can they be disproved. Any one, who chooses to challenge, say, the principle of contradiction, would only put himself in an absurd position. For, by refusing to accept its validity, he admits the possibility that those who accept it and those who reject it may both be right. So he has nothing to object to. Again, in describing these principles as laws of *thought* it is not intended to contrast thought with things, and to suggest that they are mere peculiarities of human ways of thinking without foundation in objective fact—as Nietzsche and some pragmatists or sceptics would maintain Normally what we really think we believe to be true of the facts referred to. The laws of thought were originally assumed to hold good of things as well as of thought; and they are still so regarded by many thinkers. *See* Logic and the bibliography given there.

THOUGHT-READING, the perception of another person's thoughts in the absence, or apparent absence, of normal means of communication (*See* Psychical Research)

THOUGHT TRANSFERENCE: *see* Telepathy

THOUSAND AND ONE NIGHTS. In 1704 there appeared at Paris the first four volumes of a collection of Arabic stories called *Les Mille et Une Nuit*, translated by Antoine Galland (1646–1715; *q.v.*), an orientalist and archaeologist of high reputation in his day, but now remembered chiefly for this translation in which the *Nights* were first introduced to the Western world In 1705 volumes v. and vi. appeared; in 1706 volume vii.; in 1709 volume viii, only half of which was by Galland or from the *Nights;* in 1712 volumes ix. and x., wholly by Galland; in 1717, two years after Galland's death, volumes xi. and xii. from his papers The book had an enormous success; pirated editions at once appeared in Holland; there were many European versions made from it. At least as early as 1707, six of the volumes were rendered into English by an unknown translator, often called "the Grub Street translator," under a long descriptive title beginning with *Arabian Nights Entertainments.* It is safe to say that the *Arabian Nights* of the childhood of all of us was some form or other, complete or incomplete, of a version from Galland's French.

At two points the *Nights* were fortunate in their introduction to Europe First, Galland was a born story-teller and he was able to adapt these Oriental tales not only to the taste of the France of his time but to the universal story-reading public of all countries and times. Some of his versions have been rendered back even into Oriental languages and received with favour in the East. It cannot be claimed that he was a faithful translator—no one in his time was—and his recasting belongs more to French than to Arabic literature. But he produced a great French story-book and without his genius it is conceivable that the *Nights* would never have taken the place with us that they have done. And, second, fortune placed in his hands excellent materials. He had begun with a translation of Sinbad the Sailor; then he learned that this was only part of a larger collection and there were sent to him from Syria three volumes of a manuscript of the *Nights* which is still the oldest manuscript known and in many respects the best and the most authentic Later, when in his seventh volume he had exhausted the material in this manuscript, fortune again favoured him and introduced him to a Maronite

from Aleppo, named Hanna, brought to France by the traveller Paul Lucas Hanna related to him in Arabic some of the stories which fill his last four volumes and gave him copies of some of them in writing The Galland version is thus highly composite. Further details on it should be sought in H Zotenberg's *Histoire d' 'Alâ al-Din ou la Lampe Merveilleuse, Texte arabe publié avec une notice sur quelques manuscrits des Mille et une Nuits* (Paris, 1888). In this volume Zotenberg gave the Arabic text of "Aladdin," known until then only in Galland's translation; and in the *Journal of the Royal Asatic Society* (April 1910; Jan 1913) the present writer gave the only known Arabic text of "Ali Baba and the Forty Thieves," discovered by him in the Bodleian For the place which the Galland manuscript takes among the manuscripts of the *Nights*, reference may be made to an article by the present writer, "A Preliminary Classification of Some Manuscripts of the Arabian Nights" in the *Volume of Oriental Studies* presented to E. G. Browne in 1922

Early History.—But what do we know of the earlier history of this collection of tales? It is unfortunate that the Mohammedan world has never regarded it as belonging to polite literature; it fell rather into the class of recitations in the coffee-house and indicated an uncultivated, almost depraved taste in those who cared for it This has had two results. (1) We are thrown back for the history of the collection on stray allusions often difficult to interpret (2) The collection has never been stable but highly fluid, consisting at different times of different stories, it has been subject to the caprice of different redactors who drew upon the vast reservoir of popular tales to fill out the number of a thousand and one nights; and it may be said, in short, that the introductory framework story and the division in consequence into nights are about the only certain features in these different recensions. There is thus no such thing as a standard text of the *Nights* which has existed through its long history The text, which seems now to have attained to the dignity of a Vulgate and which is known to all through the translations of Lane, Torrens, Payne, Burton and Littmann, is quite modern It was compiled in Egypt by an unknown redactor toward the end of our 18th century, as Zotenberg has shown in his *Notice* cited above. There are numerous manuscripts of it in existence and all the printed texts are derived from it except two, the edition of the first 200 nights, known as Calcutta I., which is a remote descendant of the Galland manuscript (*see* "Classification" above, pp. 311 ff), and the Breslau edition (Breslau 1825–38) which is a compilation by the editor Habicht from a number of manuscripts including a large section from the Galland manuscript (*see* article in *Journal of Royal Asiatic Society*, July 1909, pp. 635 ff). Of this modern Egyptian Vulgate the first Bûlâq edition (A.H 1252:A.D. 1835) gives the most trustworthy text. The generally parallel second Calcutta edition (1839–42), also from an Egyptian manuscript, has been contaminated from Calcutta I. and Breslau.

The oldest testimony we have, apart from Indian folk-lore evidence, to the existence of a collection of stories held together by a framework story like that of our *Nights* is in the historical encyclopaedia of Mas'ûdî (d A.H. 345 = A.D. 956) commonly called "The Golden Meadows." In it (Paris ed. iv , pp. 89f), speaking of lying stories told by pseudo-traditionalists and by the popular purveyors of edifying legends, he says: "These are like the books transmitted to us and translated for us from the Persian, Indian and Greek, the origin of which was similar to these, such as 'The Book of *hasâr afsâna*,' or, translated from Persian to Arabic, 'of a thousand *khurâfas*,' for a *khurâfa* is called in Persian an *afsâna*. The people call this book 'A Thousand Nights and a Night.'" He, then, goes on to give an outline of the framework story which resembles that of our *Nights* but is not quite the same. *Khurâfa* is a rather disrespectful Arabic word for a pleasant and strange but incredible story The exact usage of it has varied at different times. As to the framework story in its different forms, Cosquin (*Revue Biblique*, January to April, 1909) has shown that a number of similar frames exist in Indian stories. It can be traced definitely back indeed to Indian folklore. Another form of the same passed into North Africa and is the framework story of a collection called *The Hundred and One Nights* (Gaudefroy-Demombynes *Les Cent et Une Nuits*, traduites de l'Arabe, Paris, no date) These folk-lore investigations show that any connections between this story and the Book of Esther and Persian national legends, according to De Goeje's hypothesis in earlier editions of this encyclopaedia, can only have been *en passant* when the story was on its way from the extreme east of Asia to the west of North Africa. Cosquin has removed the whole question from literary to folk-lore tradition Further, it is to be observed that there is no evidence that this *Thousand and One Nights* of Mas'ûdî contained any of the stories which are in our manuscripts of the *Nights*, except the framework story.

The next witness to a *Nights* is the *Fihrist*, a *catalogue raisonné* of Arabic literature, compiled between A H 377 and 400, or, perhaps, slightly later The author gives a wealth of information as to the origins and development of story-literature in Arabic He describes the Persian *Hasâr afsâna* with its origin; it contained 1,000 nights and less than 200 stories. It existed also in an Arabic translation, but he does not specifically call that "The Thousand and One Nights," as the earlier (Mas'ûdî) does He regarded it as a worthless and stupid book, although it is evident that he had not the learned Moslem prejudice against entertaining stories We may fairly deduce from the evidence that the first Arabic *Nights* was a straight translation of the Persian *Hasâr afsâna*; that it was a comparatively small book in which each story averaged about five nights, and that it was not of much value Again, there is no evidence as to what its stories were except that they must have been of Persian origin

The next scrap of evidence is derived from an al-Qurtî who wrote a history of Egypt under the last Fâtimid Caliph al-'Âdid (A.H. 555–567) In it he named specifically a book called *A Thousand and One Nights* and compared its stories to popular tales current in his time among the people We have not his history but we know this passage because it was quoted twice by al-Maqrîzî (d A H 845) in his *Khiṭaṭ*, i , p. 485; ii., p 181 and by al-Maqqarî (d A H 1041) in his *Nafh at-tîb*, *i* , p 653 This means that a *Nights*, of some form or other, was well known in Egypt in Fâtimid times

Next comes the manuscript which Galland used. It was sent to him from Syria after A.D. 1700, but had evidently been written in Egypt. From a note in it, it seems that it was at the Syrian Tripoli in A.H 943, A.D 1536–37, and it was at Aleppo in A H 1001, A.D. 1592–93. When the manuscript was written, before these dates, we do not know But we can give dates before which it could not have been written, from allusions in certain of the stories in it In the Cycle of the Porter of Baghdad, at the beginning of the story of the second calendar, that prince tells that part of his education was in the *Shâṭibîya*, the author of which died A H. 590, after al-Qurṭî's date. On the date of the story of the two Viziers, Nûr ad-Dîn 'Alî and Shams ad-Dîn Muhammad Prof. William Popper has recently gathered (*Journal of Royal Asiatic Society*, Jan 1926) a mass of valuable material He concludes that this story cannot be earlier than the reign of Baibars, A.H. 650–76 (A.D. 1260–77), and he is inclined to a date later than A H. 706 On historical references he would also date the Hunchback Cycle after A.H 819 Further, in that Cycle, when the Barber makes his apologia in reply to the story told by the young man it is plain that he is speaking after the capture of Baghdad by Hûlâgû in A H. 656 (A.D. 1258) But, further again, in the story told by the Christian broker, a Cairene Copt, about his dealings with the young man of Baghdad, the Khân of al-Jâwalî is mentioned. This Jâwalî died A.H. 745 (A.D. 1344–45), and the date of the story can hardly be pushed back before that date and may be considerably after that date. *See* details on all these points in the present writer's article "Earlier History of the Arabian Nights" in *Journal of the Royal Asiatic Society* pp. 353–97 (July 1924)

From the above it is plain that the *Nights* to which al-Qurṭî testifies as being current in Fâṭimid times cannot have been the *Nights* of the Galland manuscript. But the Egyptian recension which Zotenberg has shown was compiled in the later 18th century and which is the present Vulgate of the *Nights*, so far as editions and translations are concerned, was based demonstrably on a sister

manuscript to that of Galland but one more complete as to the number of *Nights;* the Galland manuscript reaches only *Night 281* On the other hand, this modern Egyptian recension has lost grievously in the course of transmission in freshness of vocabulary and wealth of details. We are left then with the apparent result that some time after A.D. 1400 an Egyptian lover of stories took the framework story of the *Nights* and built it up into a thousand and one nights, inserting the best stories current in his time that he could find An incomplete manuscript derived from his recension wandered up into Syria; others more complete remained in Egypt and formed the basis for the 18th century recension which Zotenberg identified. Still undefined is the relationship of these to certain old Syrian manuscripts preserved at Tubingen and Paris, and in the Rylands library at Manchester.

For the long and complicated bibliography of the *Nights* reference can be made to Victor Chauvin's *Bibliographie des Ouvrages Arabes*, pt. iv. to vii. (Liége, 1900–03). This is a thesaurus of the whole subject. Still worth reference is J. Østrup's *Studier over Tusind og en Nat* (Copenhagen, 1891). Of this there is an abbreviated French translation by E. Galtier in *Memoires de l'Institut Français du Caire*, vol xxvii, and a German translation by O Rescher (Stuttgart, 1925) with valuable additions bringing it to that date. English is fortunate in its direct translations from the Arabic, all, however, from the printed texts of the modern Egyptian Recension. In 1838, Henry Torrens published a very remarkable version (Calcutta and London) of the first 50 *Nights*, giving the feeling of the original in prose and verse better than almost any other. Lane's incomplete version (3 vol London, 1839–41) is from the Būlāq edition and shows his deep knowledge of Cairene Arabic; the commentary is very valuable. The version by John Payne (Villon Society, 9 vol. 1882–84) from the Calcutta edition is a faithful and complete rendering into rather sophisticated translator's English The prose part of Burton's version (*Benares*, 10 vol, 1885) is largely dependent upon Payne, but treated after Burton's fashion; the verse is his own An excellent and complete German translation by Enno Littmann of the University of Tübingen has appeared at Leipzig; it is from the Calcutta text with additions, and the sixth volume, published in 1928, contains a valuable study (pp 681–771) of the translating origin, contents and history of the *Nights*. The French version of J. C Mardrus (Paris, 1899 ff.), professedly from the Būlāq edition, is unfaithful to a large degree and represents no known Arabic text; the same holds of the various versions derived from it in English, Spanish and Polish. (D. B. M.)

THRACE, a name applied at various periods to areas of different extent Since 1923 Thrace has been divided between Greece (Western Thrace) and Turkey (Eastern Thrace) The boundaries of the Roman province of Thrace were—north, the Haemus; east, the Euxine sea; south, the Propontis, the Hellespont and the Aegean; and west, the Nestus. The distinguishing features of the country were the chain of Rhodope (Despotodagh) and the river Hebrus (Maritza). The former separates from the Haemus at right angles, and runs southward, parallel to the Nestus, until it approaches the sea, when it takes an easterly direction. Several of the summits of this chain are over 7,000ft in height. The Hebrus, with its tributaries, drains almost the whole of Thrace. It starts from near the point of junction of Haemus and Rhodope, and takes an easterly direction, but at Hadrianopolis it makes a sharp bend towards the south, and enters the sea nearly opposite the island of Samothrace The greater part of the country is hilly and irregular; besides Rhodope two other tolerably definite chains intersect it, one of which descends from Haemus to Adrianople, while the other follows the coast of the Euxine at no great distance inland. One district in the extreme north-west of Thrace lay beyond the watershed separating the streams that flow into the Aegean from those that reach the Danube: this was the territory of Sardica, the modern Sofia. In the later Roman period two main lines of road passed through the country. One of these skirted the southern coast, being a continuation of the Via Egnatia, from Dyrrhachium to Thessalonica, connecting the Adriatic and the Aegean; it became of the first importance after the foundation of Constantinople The other followed a north-westerly course through the interior, from Constantinople by Hadrianopolis and Philippopolis to the Haemus, and thence through Moesia in the direction of Pannonia, taking the route by which the railway now runs from Constantinople to Belgrade.

The climate of Thrace was regarded by the Greeks as severe, and that country was spoken of as the home of the north wind, Boreas. The coast of the Euxine was feared by sailors, as the harbours were few and the sea tempestuous; but on the southern shore we find the Greek colonies of Abdera and Mesambria on the Aegean, Perinthus on the Propontis, and the most famous of all, Byzantium (*q v.*). Colonies were also planted in the Thracian Chersonese, between the Hellespont and the Bay of Melas; among its cities were Sestos and Callipolis (Gallipoli). In order to prevent the incursions of the Thracians, a wall was built across its isthmus, which was less than 5m. in breadth.

History.—The most striking archaeological monuments of the prehistoric period are the sepulchral mounds, which are found especially in the neighbourhood of the ancient towns. Roman implements and ornaments have been found in some of them The country was overrun several times by Darius and his generals, and the Thracian Greeks contributed 120 ships to the armament of Xerxes (Herod. vii. 185) The most powerful Thracian tribe was the Odrysae, whose king, Teres, extended his dominion so as to include the greater part of Thrace During the Peloponnesian War his son Sitalces was an ally of the Athenians against the Macedonians. During the early period of the Roman empire the Thracian kings were allowed to maintain an independent sovereignty, while acknowledging the suzerainty of Rome, and it was not until the reign of Vespasian that the country was reduced to the form of a province. It was much exposed to the inroads of barbarian invaders, was overrun by the Goths on several occasions, and subsequently by the Huns; but its proximity to Constantinople caused its fortunes to be closely connected with the capital of the Eastern empire. In the middle ages the northern parts of Thrace were occupied by Bulgarians; in 1361 the Turks made themselves masters of Adrianople, which became the Turkish capital. When Constantinople fell in 1453, the whole country passed into the hands of the Turks, and in their possession it remained until 1878, when the northern portion of it was placed under a separate administration, with the title of Eastern Rumelia; this province has now become a part of Bulgaria.

Ancient Peoples.—The name "Thracians," from being used both ethnically and geographically, has led to confusion There were the indigenous Thracians, and also Celtic tribes, such as the Getae. These were the "red" Thracians of Greek writers, and they differed not merely in complexion, but also in their customs and religion, from the native Thracians (Herod., v. 14). The native Thracians were inferior in morals, allowing their girls complete licence until marriage. The chief native deities were Dionysus, Ares and Bendis (Artemis). The ancient Dionysiac rites, including a ritual play by "goat-men" carrying a wooden phallus, may still be seen at Bizye, the old residence of the Thracian kings (*see* R. M. Dawkins in *Hellenic Journal*, 1906, p. 191). The true Thracians were a dark-complexioned, long-skulled race, which had been in the Balkan peninsula from the stone age, closely akin to the Pelasgians (*q v.*), to the Ligurians, and to the Iberians In Homer, the term Thracian is applied to all the tribes dwelling from Pieria to the Euxine. There is no well-defined difference between aboriginal Thracians and Illyrians (*see* ILLYRIA). Thus there was an Illyrian tribe, Brygi; a Thracian tribe, Bryges, and, in Strabo's time, a tribe called Dardanii, then reckoned Illyrian, living next the Thracian Bessi (in whose land was the oldest oracle of Dionysus). were probably as much Thracian as Illyrian. All the Thracian and Illyrian tribes tattooed, thus being distinguished from the Celtic tribes. The Thracians differed only dialectically from the Illyrians, their tongue being closely allied to Greek. The Thracians of the region from Olympus to the Pangaean district, worked the gold and silver of that region, began to strike coins almost as early as the Greeks, and displayed on them much artistic skill. Alexander I. of Macedon, on his conquest of the Bisaltae, adopted the native coinage of their country placing on the coins his own name (*see* NUMISMATICS.)

(X)

THE 20th CENTURY

Thrace was one of the three theatres of the first Balkan war of 1912, when the Bulgarians entered it and defeated the Turks in the great battle of Lule Burgas, subsequently marching up to the ramparts of Chatalja, where the armistice with the Turks was signed With the assistance of Serbian troops the Bulgarians took Adrianople, and the Treaty of London of May 30, 1913 put back the frontier of European Turkey to a line drawn from Enos on the Aegean to Midia on the Black Sea Nearly all Thrace had thus fallen to the share of Bulgaria, but her quarrel with her allies over the spoils in Macedonia led to the second Balkan war of 1913, and the Turks took the opportunity to recapture Adrianople, to reoccupy Western Thrace and create the "independent government of Gumuljina," a mainly Moslem district.

The treaty of Constantinople of Sept. 29, 1913 set back the Turco-Bulgarian frontier in Thrace to the mouth of the river Rezvaya on the Black Sea, considerably to the north of Midia, and, while making the right branch of the Maritsa the frontier on the Aegean, so drew the line between those points as to include Kirk Kilisse and Adrianople within Turkish Thrace But Gumuljina was restored to Bulgaria, with the result that 14 Moslem deputies of Western Thrace held the balance of power in Bulgaria and, under the influence of their compatriot Talaat, helped to bring Bulgaria over to the Central Empires. Meanwhile the third Treaty of Bucharest fixed the Greco-Bulgarian frontier at the mouth of the Mesta, thus the Thracian coast from the Mesta to the Maritsa gave Bulgaria her coveted outlet on the Aegean. But the frontier cut the latter river and the Mustafa-Pasha (Svilen) Adrianople-Dedeagach railway so that Bulgarian trains had to traverse Turkish territory before reaching their Bulgarian port. The Maritsa was consequently declared free to the transit of both states till they had made fresh lines on their own territories. The cession of this awkward bend in the railway to Bulgaria in 1915 was a further inducement to enter the War on the Turkish side. Thrace was not long left in peace, for the operations at the Dardanelles brought her again within the war zone. The Treaty of Neuilly of 1919 again changed her boundaries Bulgaria was moved back from the Thracian sea coast in favour of Greece, which by Article 27 of the Treaty of Sèvres of 1920 obtained the lion's share of Thrace as far as "a point near the mouth of the Buyuk Dere" on the Black Sea, and "a point on the sea of Marmore about one kilometre southwest of Kalikratia"—in other words, up to the Chatalja lines.

But the Allies undertook to make the Maritsa an international river and "to ensure the economic outlet of Bulgaria to the Aegean" by Article 48 of the Treaty of Neuilly. This they effected —in theory—by "the Thracian Treaty," signed on the same day as that of Sèvres, which decreed, as a condition of the recognition of Greek sovereignty over the former Bulgarian territories in Thrace, that Bulgaria should have "freedom of transit over the territories and in the ports assigned to Greece in the present Treaty," that "in the port of Dedeagach Bulgaria will be accorded a lease in perpetuity, subject to determination by the League of Nations, of a zone," and that Dedeagach be "declared a port of international concern," free to all members of the League. In practice, Bulgaria did not avail herself of this provision, rejecting Venizelos' offer in 1922 of a lease of the port and preferring a corridor and actual possession. The Greek tenure of Eastern Thrace was brief. After the disaster in Asia Minor, Article 2 of the second Treaty of Lausanne of July 24, 1923 restored Eastern Thrace up to the Maritsa to Turkey, leaving Western Thrace, *minus* the enclave of Karagach, to Greece. By conventions 3 and 6, on either side of these Greco-Turkish and Bulgaro-Turkish frontiers in Thrace demilitarized zones of about 30 km. were established and existing fortifications ordered to be dismantled, and the Moslem inhabitants of Western Thrace were exempted from the obligatory exchange of populations. Thus Thrace became divided between Turkey, Greece and Bulgaria

Economic Conditions.—Heavy damage was inflicted on south-western Thrace, the most fertile portion of the country, during the Balkan wars of 1912–13 Railway communications are complicated by the unscientific frontier near Adrianople, whereby the line from Western Europe to Constantinople traverses a tiny strip of Turkish territory, re-enters Greece and then recrosses into Turkey The Turks have in hand (1928) a scheme to build a line farther to the north, which will obviate the necessity of passing through Greek territory Thrace is in a primitive condition, but amongst the steps taken by the Turkish Government to improve the position is the establishment of a modern sugar factory and the encouragement of modern methods in the cheese manufacture of the Adrianople area. Turkish Thrace is now ethnologically overwhelmingly Turkish, while the Greeks find the remaining Muslims of the western half useful for the tobacco culture The demilitarization of the Gallipoli peninsula by the Lausanne Treaty should spare Thrace the spectacle of hostile armies But the situation created by the treaties following the World War must be regarded as provisional and artificial

(W M)

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THRASEA PAETUS, PUBLIUS CLODIUS, Roman senator and Stoic philosopher, lived during the reign of Nero. He was the husband of Arria the daughter of Arria (*q.v.*), father-in-law of Helvidius Priscus, and a friend and kinsman of the poet Persius At first he was treated with great consideration by Nero, probably owing to the influence of Seneca, and became consul in A.D. 56 and one of the keepers of the Sibylline books. In 59 Thrasea retired from the senate without voting after the emperor's letter justifying the murder of Agrippina had been read In 62 he prevented the execution of the praetor Antistius, who had written a libel upon the emperor, and persuaded the senate to pass a milder sentence From this time (63) till his death in 66 Thrasea retired into private life and did not enter the senate-house again Various charges were brought against him, and the senate, awed by the presence of large bodies of troops, condemned him to death. When the news was brought to Thrasea at his house, where he was entertaining a number of friends, he retired to his room and had the veins of his arms opened. He wrote a panegyric on Cato of Utica, largely used by Plutarch.

See Tacitus, *Annals* (ed Furneaux), XIII 49, XIV. 12, 48, XV. 20–22, XVI. 21–35, containing a full account of his trial and condemnation.

THRASHER, a group of birds belonging to the same American family *Mimidae* as the mocking bird (*q.v.*). Perhaps the best of these accomplished songsters is Sennett's thrasher (*Toxostoma longirostre*) of southeast Texas and northeast Mexico, but the brown thrasher (*T. rufum*) of eastern North America also has a fine song. A third species is the sage thrasher (*Oroscoptes montanus*) of the Southwestern States of the United States.

THRASHING or THRESHING is the separation of grain or other plant seeds from their husks or pods. Until the middle of 19th century the chief methods were flailing by hand or treading by animals on a threshing floor.

The flail as developed consists of two pieces of wood, the handstaff or helve and the beater, held together at one end by a thong. The first is a light rod about 5 ft. long, and the latter is a cylinder about 30 in. long and 1¼ in. in diameter. With this implement, one man could thresh 7 bu. of wheat, 18 of oats, 15 of barley, 8 of rye or 20 of buckwheat in a day. Although the flail is of immense but unknown antiquity, variants are still used in less developed countries, and on vegetable and flower seeds and special crops if the quantity does not justify a special threshing machine. The grain might also be separated from the straw by driving oxen, horses or other animals over the sheaves, or by dragging a weighted plank with teeth or a crude roller over them until the grain was shelled.

The straw was then carefully raked away and the grain separated from the chaff by winnowing. This process consisted in tossing the mixture into the air so that the wind carried away

the chaff. The heaviest kernels fell near the operator while the lighter fell farther away. If there was no wind a fan was used on the mixture as it was poured from a vessel

The first step in the mechanization of threshing came in the 17th century when fanning mills were developed for winnowing. Probably the earliest threshing machine was the contrivance operated by water power which Michael Menzies, a Scotchman, built in 1732. It remained, however, for another Scot, Andrew Meikle, to build a machine in 1786 which was the prototype of present-day threshers. It combined the blow of the flail with the rubbing action of the threshing floor. The first was given by beaters fastened to a revolving drum, while the second was obtained by allowing the beaters to force the grain against the ribs of a sparred concave placed below the drum and held in place by weighted levers. Meikle later added mechanisms for removing the straw and cleaning the grain. A few of Meikle's machines were taken to the United States before the end of the 18th century, and both English and Scotch designs were being used in the wheat regions by the early 1820s. Relatively simple and inexpensive small hand-power and horse-power machines of local design and construction were also available Probably the best known and most successful of the early American machines was the invention of Jacob Pope of Boston, later of Hallowell, Me. It utilized an endless belt to carry the grain under a revolving beater whose blows dislodged the grain from the straw.

In the 1830s the needs of the grain-growing regions prompted a tremendous interest in the invention, construction and marketing of threshers. One farm editor asserted that there were 700 different machines available in 1833. Most of these were notoriously faulty, both in design and construction, and it remained for Hiram A. and John A. Pitts of Winthrop, Me., to combine the threshing, separating and winnowing processes in a portable machine which became the model for later American development. Hiram Pitts ultimately settled in Chicago and his brother John in Buffalo, N.Y.; it was in these cities that the so-called Chicago-Pitts and Buffalo-Pitts threshers were manufactured for many years.

The type of power applied to the machines underwent considerable change. The early stationary machines were usually operated by hand. Two means of applying horse power, namely by treading an endless belt and by the revolving of a sweep, were gradually improved and applied to portable machines The use of the steam engine as the source of power was introduced before 1860 and was general by 1880 After 1900 the internal combustion engine as developed for tractors gradually superseded steam power

The combined harvester-thresher (*see* REAPING) is the most important development in the 20th century Less than 5% of the wheat crop of the United States was harvested with combines in 1920, but approximately 50% was combined in 1938 The early combines were large machines and called for a large investment However, the savings in hired labor and threshing costs and the increased flexibility of operations justified the expenditure in the great plains region. Introduced in 1935, the "baby combine," equipped with pneumatic tires and driven by a power take-off from a tractor, cuts and threshes a swath 5 or 6 ft. wide and can be operated by one man. Its utility on moderate-sized farms and its adaptability to many crops insured its rapid acceptance. In 1939 the "midget combine" cutting a 40 in. swath was introduced.

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THRASYBULUS, an Athenian general, whose public career began in 411 B.C, when he frustrated the oligarchic rising in Samos (*see* PELOPONNESIAN WAR). Elected general by the troops, he effected the recall of Alcibiades and assisted him in the ensuing naval campaigns, contributing to the victories of Cynossema (411) and Cyzicus (410). He commanded a ship at Arginusae and after the engagement was commissioned with Theramenes (*q.v.*) to rescue the men on the wrecks.

In 404, when exiled by the Thirty Tyrants he retired to Thebes. Late that year, with seventy men, he seized Phyle, a hill fort on Mt. Parnes. A force sent by the Thirty was routed by a surprise attack. Thrasybulus then gained the Peiraeus, 1,000 strong, and held Munychia against the oligarchs Eventually a Spartan expedition under king Pausanias arrived and effected a settlement by which the democracy was restored. Thrasybulus was now the hero of the people, but a decree by which he secured the franchise for all his followers, including many slaves, was rescinded as illegal.

In 395 Thrasybulus induced Athens to join the Theban league against Sparta, and in 389 he led a new fleet of 40 ships against the Spartans at Rhodes. Sailing first to the Bosporus he effected a democratic revolution at Byzantium and renewed the corn-toll. After a successful descent on Lesbos and the renewal of the 5% import tax at Thasos and Clazomenae he sailed south in quest of further contributions, and was killed in a skirmish at Aspendus

See Thucydides, viii. 75–105, Xenophon, *Hellenica*, Lysias, *c. Eratosth.* 55–61 and *c. Ergocl.* 5, 8; and *Const. ath.* xl. Diodorus xiii., xiv., Justin v. 9, 10, and Nepos depend almost wholly on Xenophon.

THREAT, a statement made for the purpose of overcoming the will of the person to whom it is addressed. The employment of threats or other forms of intimidation to induce a person to enter into a contract will give the right to sue for its rescission or avoidance, or to sue for damages occasioned by entering into the contract. (*See* COERCION; CONTRACT.)

In criminal law the sending of threatening letters (or causing them to be received), demanding with menaces and without reasonable cause money or other valuable thing, is a felony. It is also a felony to threaten to accuse a person of a crime for the purpose of extorting money, or merely to demand money or other property, without having any claim to it, by means of a threat (*See* BLACKMAIL, LARCENY.) In the United States, threat very largely is covered by statutes in the several States, with variations, but following in the main the English law

THREE BODIES, PROBLEM OF, the problem of determining the motion of three bodies moving under no influence but that of their mutual gravitation No general solution of this problem is possible. As practically attacked it consists in the problem of determining the perturbations or disturbances in the motion of one of the bodies around the principal or central body, produced by the attraction of the third Examples are the motion of the moon around the earth as disturbed by the action of the sun, and of one planet around the sun as disturbed by the action of another planet.

THREE-COLOUR PROCESS: *see* COLOUR PRINTING.

THREE RIVERS or TROIS-RIVIÈRES, a city and port of entry of Quebec, Canada, and capital of St Maurice county, at the confluence of the rivers St Maurice and St Lawrence. The St Maurice flows in from the north, and, being divided at its mouth by two islands, the channels give the town its name It is on the line of the Canadian Pacific and Canadian National railways, 78 mi. S.W. of Quebec and 92 mi. N.E. of Montreal, and has a municipal airport and a steam ferry to the south shore Founded in 1634 by Champlain, Three Rivers is one of the oldest towns in Quebec It is the centre of a large lumber trade which is carried on along the St Maurice and its tributaries Some miles from the city are the St Maurice forges, where iron wares were manufactured as early as the 17th century. The city is the seat of a Roman Catholic bishopric Trade is carried on in lumber, grain, cattle, etc., which are shipped to South America, the West Indies, Great Britain and the United States, and great industrial development followed utilization of the water power of the St Maurice at Shawinigan, Grande Mère and other falls. Besides the manufacture of wood pulp, there are cotton mills, white wear and clothing factories and various other establishments. Pop. (1951) 46,074 (C. CV.)

THRING, EDWARD (1821–1887), English schoolmaster, was born at Alford, Somerset, on Nov. 19, 1821. He was educated at Eton and at King's college, Cambridge On leaving the university in 1846 he was ordained, and served for a short time in two curacies. In 1853 he became headmaster of Uppingham school, a post which he retained until his death in 1887. Thring found only 25 boys in the school, but he raised it, both in numbers and repute, to the rank of the best English public schools.

Among the distinctive features of his plans and achievements were (1) his strong sense of the need for a closer study of the characteristics of individual boys than is generally found possible in large public schools, (2) his resolute adherence to the discipline of the ancient languages, in connection with English, as the staple of a liberal education; (3) his provision of additional employments and interests, in studies and in games, to suit the aptitudes of different pupils, (4) the value he attached to the aesthetic side of school training, to music and to drawing and to the artistic decoration of the schoolrooms, and above all (5) his rebellion against mere routine and his constant insistence on the moral purpose of a school as a training ground for character

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THROAT, the term applied to the front external part of the neck from below the chin to the collarbone in human and animal anatomy, and to the internal parts, which include the gullet, viz., the fauces, pharynx and oesophagus and the windpipe, viz., the larynx and trachea (*see* ALIMENTARY CANAL; PHARYNX; RESPIRATORY SYSTEM, ANATOMY OF) (F. L. A.)

THROAT, DISEASES OF: *see* EAR, NOSE AND THROAT, DISEASES OF

THROCKMORTON (or THROGMORTON), **FRANCIS** (1554–1584), English conspirator, was the son of Sir John Throckmorton of Feckenham in Worcestershire, and his wife Margery Puttenham. Sir John had been concerned in Wyat's rebellion against Queen Mary Tudor, but was afterward known as a sympathizer with the Roman Catholic party in the reign of Queen Elizabeth, and in 1580 was removed from his office of chief justice of Chester for irregularities in his office, but probably because he was suspected of disloyalty by the government. Francis entered Hart hall, Oxford in 1572, and in 1576 he was enrolled in the Inner Temple.

At Oxford Throckmorton came under the influence of the Roman Catholics, and when Edmund Campion and Robert Parsons (*qq.v.*), the first of the Jesuit missionaries, came to England in 1580 Francis Throckmorton was one of a society of members of the Inner Temple who united to hide and help them. In that year he went abroad, where he consorted with exiled papists, and engaged in treasonable intrigues. In 1583 he returned to act as the confidential agent of a conspiracy which had for its object the invasion of England by a French force for the purpose of releasing Mary Queen of Scots and restoring the papal authority.

Throckmorton occupied a house on Paul's wharf, London, which served as a meeting place for the conspirators. The suspicions of the government being aroused, Throckmorton was arrested in Nov. 1583. He was ciphering a letter to Queen Mary when the constables came upon him, but he found time to send a casket of compromising papers to Mendoza, and a card in cipher in which he promised to reveal nothing. On being threatened with a second application of the torture, however, his strength and courage failed and he made a full confession. His trial took place on May 21, 1584, and he was executed at Tyburn on the 10th of July. The arrest and confession of Throckmorton eventually led to the expulsion of the Spanish ambassador and so to war with Spain.

THROCKMORTON (or THROGMORTON), **SIR NICHOLAS** (1515–1571), English diplomat and politician, was the son of Sir George Throckmorton of Coughton in Warwickshire, and uncle of Francis Throckmorton (*q.v.*). A member of the household of Catherine Parr, the last wife of Henry VIII, he was favourable to the reformers in religion. He sat in parliament from 1545 to 1567. During the reign of Edward VI he was in high favour. When on the death of Edward VI an attempt was made to place Lady Jane Grey on the throne, he contrived to appear the friend of both parties, and secured the favour of Mary Tudor. He was, however, suspected of complicity in Wyat's rebellion in 1554, was brought to trial but was acquitted, though he was detained in the Tower till the following year. But he made his peace with Queen Mary. After the accession of Elizabeth he rose rapidly into favour. He became chamberlain of the exchequer, and from May 1559 to April 1564 he was ambassador in France. During this embassy, in which he was from Sept. 1562 associated with Sir Thomas Smith, Throckmorton was a strong supporter of the Huguenots and was taken prisoner at the battle of Dreux. He also conducted the negotiations which accompanied Mary Queen of Scots's return to Scotland, and though he supported the reformers on political grounds, he became her personal friend.

On returning to England Throckmorton was sent as ambassador to Scotland in May 1565, to prevent Queen Mary's marriage with Darnley, which however he was unable to do. After the murder of Darnley he was again sent to Scotland in June 1567 with the still more hopeless task of persuading the Scottish barons who had just imprisoned the queen to restore her to her authority.

Throckmorton's known friendship for Queen Mary, and his constant support of her claim to be recognized as Elizabeth's successor, made him an unwelcome representative of England in that crisis. In Edinburgh Throckmorton could effect little, but he exerted himself to secure the personal safety of the queen. He offended his mistress by showing his instructions to the Scottish barons, and was recalled in August.

In 1569 Throckmorton fell under suspicion during the duke of Norfolk's conspiracy in favour of Mary, and was imprisoned for a time at Windsor, but was not further proceeded against. He died on Feb. 12, 1571.

Sir Nicholas married Anne Carew, and his daughter Elizabeth became the wife of Sir Walter Raleigh.

THROMBOSIS AND EMBOLISM. In health the blood remains fluid in the circulatory system, but under certain conditions a thrombus, or clot within a blood vessel, may form and obstruct the passage of blood. Should part of the clot detach and become free to travel in the circulatory system as an embolus, it will lodge in another part of the vascular system, also interfering with blood flow. The symptoms of thrombosis or embolism, as the processes are called, are determined by the site of the obstruction and may be similar.

Thrombosis tends to occur in an artery, vein, or chamber of the heart (*see* VASCULAR SYSTEM) when the velocity of blood flow is reduced, the lining of the vascular system is roughened, or the clotting tendency of blood is enhanced. Injury, surgery, general or local infection, arterial disease, heart failure, pregnancy and certain disorders of the blood all predispose to thrombus formation.

The incidence of thrombosis increases with age. It occurs most often in the large veins of the pelvis and legs, the small arteries of the heart and the brain, and in the chambers of the left heart, but, under appropriate circumstances, may occur anywhere in the circulatory system.

If the intravascular clotting occurs in a vein, the process is called phlebothrombosis and may produce no symptoms unless productive of embolism. Usually there is also an element of inflammation present which may cause local pain and swelling of the region drained by the affected vein, and then it is designated thrombophlebitis.

While venous thrombosis may sometimes lead to embolism, it is not the threat to life that is met with in arterial thrombosis. The coronary and cerebral arteries to the heart and brain (see VASCULAR SYSTEM) are often the site of arteriosclerosis, thickening and irregularity of the vessel lining, which may predispose to clot formation. Should this occur, the mass of heart muscle or brain ordinarily supplied by the thrombosed vessel dies, and, if the victim survives the initial insult, healing follows with scar formation. A favourable course in such an instance will depend upon the extent of involvement and the absence of complicating thromboses, either attached to the lining of the injured heart wall or arising in the veins of the leg, which may give rise to fatal emboli.

Thrombosis depends upon the coagulability of the blood. The blood clot begins as a few blood platelets which adhere to some irregular or injured area of vessel wall and form microscopic ridges at right angles to the blood flow. Then, rapidly joined by white blood cells, they imitate precipitation of multitudinous strands of

fibrin in which become enmeshed all the formed elements of the blood The thrombus may then propagate itself, filling the involved vessel and extending back to its origin. The "tail" of the thrombus thus formed may lie free in a parent vessel and, should it break free, an embolus is born After its development, the thrombus begins a gradual process of contraction, disintegration and reabsorption, which ultimately may permit some return of blood flow through the clogged vessel

Emboli are usually composed of coagulated blood but may rarely consist of tumour cells, air, fat particles or bacterial clumps (septic emboli) They are a common cause of sudden death but are by no means always fatal The embolus arising anywhere in the venous system or in the right side of the heart will lodge in the ramifications of the pulmonary artery If the embolus is large enough, one of the main pulmonary arteries is obstructed and death occurs Should it be smaller, the segment of lung dependent upon the obstructed artery dies. In certain types of heart disease an embolus may originate from one of the chambers of the left side of the heart, or from the mitral or aortic valves therein, in which case the blood stream will carry it to one of the branches of the peripheral arterial tree Should such an embolus lodge in certain internal organs, pain might be the only consequence, but occlusion of even a small artery to the heart, the eye, the brain, the intestine or one of the extremities will lead also to the death of enough tissue to cause severe disruption, if not cessation, of function of the part. However, tissue death does not occur in all arterial obstructions, for in many locations there are neighbouring collateral arteries which can carry enough blood into the affected area to allow adequate circulation

In the years after 1940 there were rapid advances in the treatment and prevention of thrombosis and embolism by the use of anticoagulants. Heparin, dicoumarol and related chemicals were shown to greatly reduce the frequency of thrombosis and complicating embolism when administered to postoperative and cardiac patients.

Surgical ligation of the vein proximal to a thrombosis in order to prevent subsequent embolism has been attempted. After embolism has occurred, surgical removal of the offending clot may frequently save a limb if it can be achieved within six to eight hours after onset

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THRONE. The throne is the ancestor of all chairs, which were originally symbols of authority and rule. In early days and in Oriental countries thrones were of barbaric magnificence. Solomon's was of ivory "overlaid with the best gold." There were two figures of lions at the sides, with two other lions on each of the six steps The remains of a throne in rock-crystal were found in the ruins of Sennacherib's palace. The Persian throne made for Abbas the Great was of white marble. This monarch in 1605 presented a throne to the Russian Tsar Boris, covered with sheets of gold and decorated with precious stones and pearls Michael Feodorovitch, grandfather of Peter the Great, had a "golden throne" set with 8,000 turquoises, 1,500 rubies, 4 great amethysts and 2 large topazes

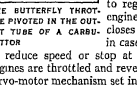
One of the glories of Delhi, until it was sacked by Nadir Shah, was the "peacock throne," which was ascended by silver steps and stood on golden feet set with jewels. It was adorned with two open peacocks' tails composed of magnificent diamonds, rubies and other stones.

The mediaeval emperors of Byzantium had a throne, which is supposed to have been imitated from, as well as named after, that of Solomon, was guarded by golden lions, which rose to their feet and roared when some artful mechanism was set in motion. An exceedingly ancient chair of State is the so-called throne of Dagobert. The most recent writers on this remarkable relic suggest that it is a bronze copy of Dagobert's golden throne. However that may be, there can be no doubt that it possesses at least one illustrious modern association, for Napoleon sat in it when he distributed the first decoration of the Legion of Honour in his camp at Boulogne in 1804. The throne which Napoleon had made for himself was a heavy gilded chair with an abundance of Egyptian ornament, lions' heads and imperial eagles. One of the many curiosities of a conclave for the electing of a pope is that every cardinal present occupies a throne, since, during the vacancy of the Holy See, each member of the Sacred college is a potential sovereign When the election has taken place the canopy of every throne is lowered, with the exception of that occupied by the new pontiff. The palaces of the great Roman nobles contained—and still in some cases contain—a throne for use in the event of a visit from the pope. The papal throne itself is an antique bronze chair which stands in St Peter's.

The British coronation chair is not, properly speaking, a throne, since it is used only during a portion of the coronation ceremonies. The actual throne of Great Britain is the oaken Gothic chair in the House of Lords occupied by the sovereign at the opening and prorogation of parliament.

THROOP, an anthracite-mining borough of Lackawanna county, Pennsylvania, U.S., on the Lackawanna river, 3 mi. N.E. of Scranton; served by the New York, Ontario and Western railway. The population was 5,861 in 1950 and was 7,382 in 1940 by the federal census The borough was incorporated in 1894.

THROTTLE is a valve which controls admission of steam to an engine or turbine or of an explosive mixture to an internal-combustion engine or of draught to a boiler furnace The amount of opening can be variously regulated by hand, by foot or by a governor in different cases The butterfly throttle is an established type for large valves, and is a favoured type in the small passages which lead from carburettors in automobile and aero-engines (*see* fig.) The turning of the spindle causes the valve gradually to close the passage. An altitude cock is employed in conjunction with the throttle for aero-engines to provide compensation for the different conditions at various heights Large throttle-valves for steam engines have a piston-valve construction with packing rings, and the action is such that opening and closing can be performed with great ease Governor control acts on a throttle to regulate the engine speed, in winding engines the safety overwinding apparatus closes the throttle and applies the brakes in case of neglect on the part of the driver to reduce speed or stop at the correct times. Big rolling-mill engines are throttled and reversed with great precision by a steam servo-motor mechanism set in motion by the driver's control lever.



THE BUTTERFLY THROTTLE PIVOTED IN THE OUTLET TUBE OF A CARBURETTOR

THROWING THE DISCUS: *see* DISCUS THROWING

THRUSH, the name of two English species of the genus *Turdus,* the type of the family *Turdidae;* and of six American species of the family. The first of these is the song thrush or mavis (*T. ericetorum*), one of the finest songsters in Europe. Common throughout Europe, this bird has a brown back and a speckled breast in both sexes

It feeds very largely on worms and snails, which latter it "shells" by beating on a stone and then rubbing off the fragments of the mollusc's "house." It is an early breeder, rearing two broods a year; the nest, a deep cup, is lined with mud, cow-dung and rotten wood, formed into a smooth layer by the pressure of the bird's breast. The eggs, four or five in number, are a bluish green, spotted with black

The second species is the missel thrush (*T. viscivorus*) also called mistletoe thrush, from its fondness for the berries of that plant, and storm-cock, from its habit of singing in squally weather. It is larger than the last species, reaching a length of 11 in. Otherwise it resembles its relative in appearance, but is greyer and has a white edge to the tail Its song is loud and wild, but less sweet than that of the mavis. The bird boldly attacks marauding crows, jays and even cats, driving them away from its nest. The hermit thrush (*Hylocichla guttata*) of North America is the finest songster of the continent. The rufous tail and whitish eye ring are distinctive features. The wood-thrush (*H. mustelina*), is little inferior to the last as a singer and has spotted sides as well as breast. The olive-backed thrush (*H. ustu-*

laia) has a similar lovely song

The genus *Turdus* includes also the blackbird (*q.v.*), ring-ousel (*see* OUSEL), fieldfare (*q.v.*), redwing (*q.v.*), and others Included in the *Turdidae* are the wheatears, stonechats and whinchats (*see* WHEATEAR), redstarts (*q.v.*), robins (*see* REDBREAST), and hedge sparrows (*see* SPARROW). The "ant-thrushes" belong to a different family (*see* PITTA).

THRUSH (Aphthous Stomatitis), a contagious disease of nursing infants, known also as sprue or infantile sore mouth It is caused by a fungus (*Oidium albicans* or *Saccharomyces albicans*) which produces small, round, white patches on the lining membrane of mouth and throat and on the tongue surface These patches, called *aphthae*, consist of slight elevations of the outer (epithelial) layer of the mucous membrane, covering a small quantity of watery (serous) fluid When this outer layer, which contains the fungoid growth, peels off, a raw surface is exposed. During an attack, which is of about 10 days' duration, crops of *aphthae* usually succeed each other at brief intervals, rendering the mouth very sore, so that sucking becomes extremely painful The onset of the disease is accompanied by fever, colic and diarrhoea. Thrush rarely occurs in infants of normal health, and is dangerous only when the *aphthae* develop a gangrenous condition However, nursing infants whose normal vigor has been depressed by eruptive diseases, pneumonia or intestinal disorders, are liable to attack Effective preventive measures require not only absolute cleanliness of nipples and nursing bottles but also sterilization of milk and other food. When the characteristic *aphthae* have appeared a thorough but gently managed washing of the mouth with a solution of boracic acid, potassium permanganate or other mild antiseptic is recommended.

THRUST BLOCK: *see* BEARINGS.

THUBURBO MAIUS (mod. HENCHIR-KASBAT), an ancient city of Roman North Africa, in the province of Africa proper; 2 m. N. of the station of Pont-du-Fahs on the railway from Tunis to Kef. Octavian founded it near a native town, which was fused with it under Commodus The forum and its surroundings have been completely excavated The Capitolium is well preserved.

See A Merlin, *Le Forum de Thuburbo Maius* (1922).

THUBURSICU NUMIDORUM (mod KHAMISSA), some 20 m by road S.W of Souk Ahras, the junction of the railway to Tebessa from the main line from Algiers to Tunis It was originally a native town, and became a Roman municipality under Trajan. There are extensive Roman remains, including two temples, a large civil basilica, and a well preserved theatre

THUCYDIDES (Θουκυδίδης), Athenian historian. Materials for his biography are scanty, and the facts are of interest chiefly as aids to the appreciation of his life's labour, the *History of the Peloponnesian War*. He was anciently believed to have been born in or about 471 B.C., but modern criticism inclines to a later date, about 460 (*see* Busolt, *Gr. Gesch* iii., pt. 2, p. 621) Thucydides' father Olorus, a citizen of Athens, belonged to a family which derived wealth from the possession of gold-mines at Scaptē Hylē, on the Thracian coast opposite Thasos His supposed connection with Miltiades's family was presumed from a similarity of names (Olorus was the name of Miltiades's father-in-law), and rests on no surer evidence It is plain, too, that the statement that his tomb was at Athens, a statement containing one manifestly anachronistic detail, is not to be trusted. No one knew where or how he died. Even in antiquity there were three or four legends on the question, all of them obvious guesses As to the date of his death, it cannot have been very long after his return to Athens either at, or shortly after the time of the Tyranny of the 30.

The development of Athens during the middle of the 5th century was, in itself, the best education which such a mind as that of Thucydides could have received. The expansion and consolidation of Athenian power was completed, and the inner resources of the city were being applied to the embellishment and ennoblement of Athenian life (*see* CIMON; PERICLES). Yet the *History* tells us nothing of the literature, the art or the social life under whose influences its author had grown up. The "Funeral Oration" contains, indeed, his general testimony to the value and the charm of those influences. But he leaves us to supply all examples and details for ourselves Beyond a passing reference to public "festivals," and to "beautiful surroundings in private life," he makes no attempt to define those "recreations for the spirit" which the Athenian genius had provided in such abundance He alludes to the newly-built Parthenon only as containing the treasury; to the statue of Athena Parthenos which it enshrined, only on account of the gold which, at extreme need, could be detached from the image, to the Propylaea and other buildings with which Athens had been adorned under Pericles, only as works which had reduced the surplus of funds available for the war He makes no reference to Aeschylus, Sophocles, Euripides, Aristophanes; the architect Ictinus; the sculptor Pheidias, the physician Hippocrates; the philosophers Anaxagoras and Socrates. Herodotus, if he had dealt with this period, would have found countless occasions for invaluable digressions on men and manners, on letters and art The difference between the methods of the two historians arises from the fact that Thucydides was writing of events which were contemporary with the audience for which he wrote, whereas Herodotus dealt with the story of a war which had taken place 30 years before the time of his writing, and of preliminaries of that war which extended into an unstoried past.

The biography which bears the name of Marcellinus states that Thucydides was the disciple of Anaxagoras in philosophy and of Antiphon in rhetoric There is no evidence to confirm this tradition But Thucydides and Antiphon at least belong to the same rhetorical school and represent the same early stage of Attic prose. It is probable that both of them were fired with enthusiasm for that Sicilian Greek rhetoric with which Gorgias amazed the Athens of 427. Both writers used words of an antique or decidedly poetical cast, both point verbal contrasts by insisting on the precise difference between terms of similar import; and both use metaphors somewhat bolder than were congenial to Greek prose in its riper age The differences, on the other hand, between the style of Thucydides and that of Antiphon arise chiefly from two general causes. First, Antiphon wrote for hearers, Thucydides for readers, the latter, consequently, can use a degree of condensation and a freedom in the arrangement of words which would have been hardly possible for the former. Again, the thought of Thucydides is often more complex than any which Antiphon undertook to interpret; and the greater intricacy of the historian's style exhibits the endeavor to express each thought[1]. Few things in the history of literary prose are more interesting than to watch that vigorous mind in its struggle to mould a language of magnificent but immature capabilities. The obscurity with which Thucydides has sometimes been reproached often arises from the very clearness with which a complex idea is present to his mind, and his strenuous effort to present it in its entirety. He never sacrifices thought to language, but he will sometimes sacrifice language to thought A student may always be consoled by the reflection that he is not engaged in unravelling a mere rhetorical tangle Every light on the sense will be a light on the words; and when, as is not seldom the case, Thucydides comes victoriously out of this struggle of thought and language, having achieved perfect expression of his meaning in a sufficiently lucid form, then his style rises into an intellectual brilliancy (thoroughly manly, and also penetrated with intense feeling) which nothing in Greek prose literature surpasses In one sense, a moral sense, Thucydides is unique among Greek authors To him the "good" is not a term with the peculiar Greek connotation of it, but one which he uses with the same meaning which it possesses to-day.

The uncertainty as to the date of Thucydides' birth renders futile any discussion of the fact that before 431 he took no prominent part in Athenian politics. If he was born in 455, the fact needs no explanation, if in 471, it is possible that his opportunities were modified by the necessity of frequent visits to Thrace, where the management of such an important property as the gold-mines must have claimed his presence. The manner in which he refers to his personal influence in that region is such as to suggest that he had sometimes resided there (iv. 105, 1). He was at Athens in the spring of 430, when the plague broke out. If his account of the symptoms has not enabled physicians to

[1] See Jebb's *Attic Orators*, i 35

agree on a diagnosis of the malady, it is at least singularly full and vivid He had himself been attacked by the plague, and, as he briefly adds, "he had seen others suffer"

The turning point in the life of Thucydides came in the winter of 424 He was then 47 (or, according to Busolt, about 36), and for the first time he is found holding an official position He was one of two generals entrusted with the command of the regions towards Thrace (*τὰ ἐπὶ Θράκης*), a phrase which denotes the whole Thracian seaboard from Macedonia eastward to the vicinity of the Thracian Chersonese, though often used with more special reference to the Chalcidic peninsula His colleague in the command was Eucles About the end of Nov 424 Eucles was in Amphipolis, the stronghold of Athenian power in the north-west To guard it with all possible vigilance was a matter of peculiar urgency at that moment The ablest of Spartan leaders, Brasidas (*q v*), was in the Chalcidic peninsula, where he had already gained rapid success, and part of the population between that peninsula and Amphipolis was known to be disaffected to Athens Under such circumstances we might have expected that Thucydides who had seven ships of war with him, would have been ready to cooperate with Eucles It appears, however, that, with his ships, he was at the island of Thasos when Brasidas suddenly appeared before Amphipolis Eucles sent in all haste for Thucydides, who arrived with his ships from Thasos just in time to beat off the enemy from Eion at the mouth of the Strymon, but not in time to save Amphipolis. The profound vexation and dismay felt at Athens found expression in the punishment of Thucydides, who was exiled

From 423 to 404 Thucydides lived on his property in Thrace, but much of his time appears to have been spent in travel. He visited the countries of the Peloponnesian allies (*cf* his account of the battle of Mantinea in 418, the Spartan version of the story), recommended to them by his quality as an exile from Athens; and he thus enjoyed the rare advantage of contemplating the war from various points of view He speaks of the increased leisure which his banishment secured to his study of events He refers partly, doubtless, to detachment from Athenian politics, partly also, we may suppose, to the opportunity of visiting places signalized by recent events and of examining their topography The local knowledge which is often apparent in his Sicilian books was acquired at this period He visited Syracuse after the siege was over This is shown by the accuracy of his topography, and by the fact that his knowledge of affairs at Athens contemporary with the siege came to an end at the time of the departure from Athens of the last reinforcements sent to Syracuse, showing that he drew information from the Athenian prisoners The mind of Thucydides was naturally judicial, and his impartiality (which seems almost superhuman by contrast with Xenophon's *Hellenica*) was in some degree a result of temperament But it cannot be doubted that the evenness with which he holds the scales was greatly assisted by his experience during these years of exile.

His own words make it clear that he returned to Athens, at least for a time, in 404, though the precise date is uncertain The older view was that he returned some six months after Athens surrendered to Lysander More probably he was recalled by the special resolution carried by Demobius prior to the acceptance of Lysander's terms (Busolt, *ubi*, p 628) The preponderance of testimony certainly goes to show that he died in Thrace, and by violence It would seem that, when he wrote chapter 116 of his third book, he was ignorant of an eruption of Etna which took place in 396. There is indeed, strong reason for thinking that he did not live later than 399. The abruptness with which the *History* breaks off agrees with the story of a sudden death The historian's daughter is said to have saved the unfinished work and to have placed it in the hands of an editor This editor, according to one account, was Xenophon, to whom Diogenes Laertius (ii 6, 13) assigns the credit of having "brought the work into reputation, when he might have suppressed it" The tradition is, however, very doubtful; it may have been suggested by a feeling that no one then living could more appropriately have discharged the office of literary executor than the writer who, in his *Hellenica*, continued the narrative

The History.—At the outset of the *History* Thucydides indicates his general conception of his work, and states the principles which governed its composition. His purpose had been formed at the very beginning of the war, in the conviction that it would prove more important than any event of which Greeks had record The leading belligerents, Athens and Sparta, were both in the highest condition of effective equipment The whole Hellenic world (including Greek settlements outside of Greece proper) was divided into two parties, either actively helping one of the two combatants or meditating such action Nor was the movement confined within even the widest limits of Hellas; the "barbarian" world also was affected by it—the non-Hellenic populations of Thrace, Macedonia, Epirus, Sicily and, finally, the Persian kingdom itself The aim of Thucydides was to preserve an accurate record of this war, not only in view of the intrinsic interest and importance of the facts, but also in order that these facts might be permanent sources of political teaching to posterity His hope was, as he says, that his *History* would be found profitable by "those who desire an exact knowledge of the past as a key to the future, which in all probability will repeat or resemble the past The work is meant to be a possession for ever, not the rhetorical triumph of an hour." As this context shows, the oft-quoted phrase, "a possession for ever," had, in its author's meaning, a more definite import than any mere anticipation of abiding fame for his *History*. It referred to the permanent value of the lessons which his *History* contained

Such being the spirit in which he approached his task, it is interesting to enquire what were the points which he himself considered to be distinctive in his method of executing it His Greek predecessors in the recording of events had been, he conceived, of two classes First, there were the epic poets, with Homer at their head, whose characteristic tendency, in the eyes of Thucydides, is to exaggerate the greatness or splendour of things past Secondly, there were the Ionian prose writers whom he calls "chroniclers" (*see* LOGOGRAPHI), whose general object was to diffuse a knowledge of legends, preserved by oral tradition, and of written documents (usually lists of officials or genealogies) preserved in public archives; and they published their materials as they found them, without criticism. Thucydides describes their work by the word *ξυντίθεναι* but his own by *ξυγγράφειν*—the difference between the terms answering to that between compilation of a somewhat mechanical kind and historical composition, in a higher sense The vice of the "chroniclers," in his view, is that they cared only for popularity, and took no pains to make their narratives trustworthy Herodotus was presumably regarded by him as in the same general category.

In contrast with these predecessors Thucydides has subjected his materials to the most searching scrutiny The ruling principle of his work has been strict adherence to carefully verified facts. "As to the deeds done in the war, I have not thought myself at liberty to record them on hearsay from the first informant or on arbitrary conjecture My account rests either on personal knowledge or on the closest possible scrutiny of each statement made by others. The process of research was laborious, because conflicting accounts were given by those who had witnessed the several events, as partiality swayed or memory served them"

The Speeches.—It might be supposed that the speeches which Thucydides has introduced into his *History* conflict with this standard of scientific accuracy, it is, therefore, well to consider their nature and purpose rather closely. The speeches constitute between a fourth and a fifth part of the *History*. If they were eliminated, an admirable narrative would indeed remain, with a few comments, usually brief, on the more striking characters and events But we should lose all the most vivid light on the inner workings of the Greek political mind, on the motives of the actors and the arguments which they used—in a word, on the whole play of contemporary feeling and opinion. To the speeches is due in no small measure the imperishable intellectual interest of the *History*, since it is chiefly by the speeches that the facts of the Peloponnesian War are so lit up with keen thought as to become illustrations of general laws, and to acquire a permanent suggestiveness for the student of politics When Herodotus made his persons hold conversations or deliver speeches, he was following the precedent of epic poetry; his tone is usually colloquial rather

than rhetorical; he is merely making thought and motive vivid in the way natural to a simple age. Thucydides is the real founder of the tradition by which historians were so long held to be warranted in introducing set speeches of their own composition. His own account of his practice is given in the following words "As to the speeches made on the eve of the war, or in its course, I have found it difficult to retain a memory of the precise words which I had heard spoken, and so it was with those who brought me reports But I have made the persons say what it seemed to me most opportune for them to say in view of each situation, at the same time I have adhered as closely as possible to the general sense of what was actually said." So far as the language of the speeches is concerned, then, Thucydides plainly avows that it is mainly or wholly his own As a general rule, there is little attempt to mark different styles. The case of Pericles, whom Thucydides must have repeatedly heard, is probably an exception the Thucydidean speeches of Pericles offer several examples of that bold imagery which Aristotle and Plutarch agree in ascribing to him, while the "Funeral Oration," especially, has a certain majesty of rhythm, a certain union of impetuous movement with lofty grandeur, which the historian has given to no other speaker. Such strongly marked characteristics as the curt bluntness of the Spartan ephor Sthenelaidas, or the insolent vehemence of Alcibiades, are also indicated But the dramatic truth of the speeches generally resides in the matter, not in the form In regard to those speeches which were delivered at Athens before his banishment in 424 (and seven such speeches are contained in the *History*) Thucydides could rely either on his own recollection or on the sources accessible to a resident citizen In these cases there is good reason to believe that he has reproduced the substance of what was actually said. In other cases he had to trust to more or less imperfect reports of the "general sense"; and in some instances, no doubt, the speech represents simply his own conception of what it would have been "most opportune" to say. The most evident of such instances occur in the addresses of leaders to their troops The historian's aim in these military harangues (which are usually short) is to bring out the points of a strategical situation; a modern writer would have attained the object by comments prefixed or subjoined to his account of the battle The comparative indifference of Thucydides to dramatic verisimilitude in these military orations is curiously shown by the fact that the speech of the general on the one side is sometimes as distinctly a reply to the speech of the general on the other as if they had been delivered in debate. We may be sure, however, that, wherever Thucydides had any authentic clue to the actual tenor of a speech, he preferred to follow that clue rather than to draw on his own invention Why, however, did he not content himself with simply stating in his own person, the arguments and opinions which he conceived to have been prevalent? The question must be viewed from the standpoint of a Greek in the 5th century B C. Epic poetry had then for many generations exercised a powerful influence over the Greek mind Homer had accustomed Greeks to look for two elements in any complete expression of human energy—first, an account of a man's deeds, then an image of his mind in the report of his words The Homeric heroes are exhibited both in action and in speech Further, the contemporary readers of Thucydides were men habituated to a civic life in which public speech played an all-important part Every adult citizen of a Greek democracy was a member of the assembly which debated and decided great issues. The law courts, the festivals, the drama, the market-place itself, ministered to the Greek love of animated description. To a Greek of that age a written history of political events would have seemed strangely insipid if speech "in the first person," had been absent from it, especially if it did not offer some mirror of those debates which were inseparably associated with the central interests and the decisive moments of political life. In making historical persons say what they might have said, Thucydides confined that oratorical licence to the purpose which is its best justification; with him it is strictly dramatic, an aid to the complete presentment of action, by the vivid expression of ideas and arguments which were really current at the time Among later historians who continued the practice, Polybius, Sallust and Tacitus most resemble Thucydides in this particular

Divisions of the Book.—The present division of the *History* into eight books is one which might well have proceeded from the author himself, as being a natural and convenient disposition of the contents The first book, after a general introduction, sets forth the causes of the Peloponnesian War. The first nine years of the war are contained in the second, third and fourth books —three years in each The fifth book contains the tenth year, followed by the interval of the "insecure peace" The Sicilian expedition fills the sixth and seventh books The eighth book opens that last chapter of the struggle which is known as the "Decelean" or "Ionian" War, and breaks off abruptly in the year 411.

The principal reason against believing that the division into eight books was made by Thucydides himself is the fact that a different division, into 13 books, was also current in antiquity, as appears from Marcellinus (§ 58) It is very improbable (indeed hardly conceivable) that this should have been the case if the eight-book division had come down from the hand of the author. We may infer, then, that the division of the work into eight books was introduced at Alexandria—perhaps in the 3rd or 2nd century B C That division was already familiar to the grammarians of the Augustan age Dionysius of Halicarnassus, who recognizes it, has also another mode of indicating portions of the work, viz., by *stichometria*, or the number of lines which they contained Thus, in the MS which he used, the first 87 chapters of book 1 contained about 2,000 lines (equivalent to about 1,700 lines in Bekker's stereotyped 8vo. text) (On the order of composition, *see* Peloponnesian War, *ad init*, and Greece *History; Ancient to 146* B C *General Ancient Authorities*)

The division of the war by summer and winter (κατὰ θέρος καὶ χειμῶνα)—the end of the winter being considered as the end of the year—is perhaps the only one which Thucydides himself used, for there is no indication that he made any division of the *History* into books His "summer" includes spring and autumn and extends, generally speaking, from March or the beginning of April to the end of October His "winter" (November to February inclusive) means practically the period during which military operations, by land and sea, are wholly or partly suspended When he speaks of "summer" and "winter" as answering respectively to "half" the year (v 20, 3), the phrase is not to be pressed; it means merely that he divides his year into these two parts. The mode of reckoning is essentially a rough one, and is not to be viewed as if the commencement of summer or of winter could be precisely fixed to constant dates. For chronology, besides the festivals, he uses the Athenian list of archons, the Spartan list of ephors and the Argive list of priestesses of Hera

There is no reference to the *History* of Thucydides in the extant Greek writers of the 4th century B C , but Lucian has preserved a tradition of the enthusiasm with which it was studied by Demosthenes. The great orator is said to have copied it out eight times, or even to have learnt it by heart. The Alexandrian critics acknowledged Thucydides as a great master of Attic. Sallust, Cornelius Nepos, Cicero and Quintilian are among the Roman writers whose admiration for him can be traced in their work, or has been expressly recorded The most elaborate ancient criticism on the diction and composition of Thucydides is contained in three essays by Dionysius of Halicarnassus.

Bibliography.—Among the best mss. of Thucydides, the Codex Vaticanus 126 (11th century) represents a recension made in the Alexandrian or Roman age In the first six books the number of passages in which the Vaticanus alone has preserved a true reading is comparatively small; in book vii it is somewhat larger; in book viii. it is so large that here the Vaticanus, as compared with the other mss., acquires the character of a revised text. Other important mss. are the Palatinus 252 (11th century); the Casselanus (A.D 1252); The Augustanus Monacensis 430 (A.D. 1301). A collation, in books I, ii., of two Cambridge mss. of the 15th century (Nn. 3, 18; Kk. 5, 19) has been published by Shilleto. Several Parisian mss (H. C. A. F.) and a Venetian mss. (V.) collated by Arnold, also deserve mention. The Aldine ed. was pub in 1502. It was formerly supposed that there had been two Juntine eds. Shilleto, in the "Notice" prefixed to bk. I., first pointed out that the only Juntine ed. was that of 1526, and that the belief in an earlier Juntine of 1506, arose merely from the accidental omission of the word *vicesimo* in the Latin

version of the imprint Some papyrus fragments were published in Grenfell and Hunt's *Oxyrhynchus papyri*, vi (1908), which also contains an anonymous commentary (pub 1st century) on Thuc ii. A useful ed is Classen's, in the Weidmann series (1862–78, new ed by Steup, 1882–92); each book can be obtained separately Arnold's ed (1838–52) contains much that is still valuable. For bks 1 and ii Shilleto's ed (1872–96) furnishes a commentary which, though not full, deals admirably with many difficult points Among other important complete eds, it is enough to name those of Duker, Bekker, Goeller, Poppo and Krüger For eds. of separate books and selections (up to 1895) see J B Mayor's *Guide to the Choice of Classical Books* Special mention may be made of those by E C Marchant Later eds. of the text are by H Stuart Jones (1900–01), in the Oxford *Scriptorum classicorum bibliotheca*, and C Hude (Teubner Series, 1901; ed. minor, 1901) Bétant's lexicon to Thucydides (1843) is well executed. Jowett's trans (1883) is supplemented by a volume of notes Dale's version (Bohn) also deserves mention for its fidelity, as Crawley's (1876) for its vigour *Thucydides and the History of His Age* by G B Grundy discusses various general questions connected with the history of the time, and has a long summary of the controversy on the mode and times in which the historian composed his work *Hellenica* (1880) contains an essay on "The Speeches of Thucydides," which has been trans into German (see Eduard Meyer, *Forschungen zur alten Geschichte*, vol ii, pp. 269–436) The best clue to Thucydidean bibl is in Engelmann's *Scriptores graeci* (1880), supp by the arts. by G Meyer in Bursian's *Jahresberichi*, lxxx (1894), lxxviii (1897). Busolt, *Griechische Geschichte*, iii, 616–693, is invaluable For the life of Thucydides, U. von Wilamowitz-Moellendorff, "Die Thukydides-Legende," *Hermes*, xii (1878), is all important All works on ancient Greek history contain discussions of Thucydides, and see J B Bury, *Ancient Greek Historians* (1909) and *Cambridge Anc History*, vol iv and v (1926–27) (R C J , X)

THUGGA (mod. Dougga), an ancient city of North Africa, lying on a commanding site about 1 mi. W. of the military road from Carthage to Tebessa (68 mi by road S.W of Tunis) Its importance dates from Punic times, and it appears to have been taken from Carthage by the Numidian king Masinissa in the 2nd century B.C Its most important buildings date from c. A.D. 150–250 and it became a municipality only under Septimius Severus, and a colony even later. The well-preserved Capitolium, or temple of Jupiter, Juno and Minerva, built by Marcus Aurelius, occupies the finest position in the city; to the west of it lies the forum, and to the east the temple of Mercury West of the forum, which is surrounded by fortifications of the Byzantine period, lies the beautiful crescent-shaped temple of Caelestis, the Phoenician Tanit, built in the time of Alexander Severus

To the northeast of the forum is a well-preserved theatre (A.D. 166–169), with a view over the surrounding country To the north is a temple of Saturn (A.D 195), the Romanized form of Baal-Hammon, with six large columns, close to it is a small Christian church, while to the west lie the remains of what may have been the pre-Roman acropolis, with dolmenic native tombs beyond it, further on are the remains of a circus To the southeast, built against the hillside, is a group of private houses decorated with mosaics and fountains.

THUGS, or Thags, a well-organized confederacy of professional assassins, who travelled in gangs through India, wormed themselves into the confidence of wayfarers and, when a favourable opportunity occurred, strangled them by throwing a handkerchief or noose round their necks and then plundered and buried them (Sanskrit *sthag*, "to conceal," hence *sthaga*, "a cheat," in modern vernaculars *thag*) All this was done according to certain ancient and rigidly prescribed forms and after the performance of special religious rites, in which the consecration of the pickaxe and the sacrifice of sugar formed a prominent part. From their using the noose they were also frequently called *phansigars*, or "noose operators" Though they themselves traced their origin to seven Mohammedan tribes, Hindus appear to have been associated with them at an early period; at any rate, their religious creed and practices as staunch worshippers of Kali (Devi, Durga), the Hindu goddess of destruction, had certainly no flavour of Islam. The fraternity possessed a jargon of their own (*Ramasi*), and signs by which its members recognized each other.

Though sporadic efforts were made toward the extinction of the gangs, it was not till Lord William Bentinck took vigorous steps (1828–35) that the system was seriously attacked. His chief agent, Captain (afterward Sir William) Sleeman, with the cooperation of a number of native states, succeeded so well in grappling with the evil that between 1831 and 1837 no fewer than 3,266 thugs had been committed, of whom 412 were hanged, 483 admitted as approvers and the remainder transported or imprisoned for life According to the *Thuggee and Dacoity Report* for 1879, registered Punjabi and Hindustani thugs then still numbered 344; but all of these had already been registered as such before 1852, and the whole fraternity thereafter became extinct.

Bibliography.—Sherwood, "On the Murderers Called Phansigars," and J Shakespear, "Observations Regarding Bradheks and Thugs," in *Asiatic Researches*, vol xiii (Calcutta, 1820); W N Sleeman, *Ramaseeana, or a Vocabulary of the Language used by the Thugs, with an Introduction and Appendix* (Calcutta, 1836) and *Rambles and Recollections of an Indian Official* (London, 1844), 3rd ed. (1915); Meadows Taylor, *Confessions of a Thug* (London, 1839), new ed (1916), R V Russell and Hira Lal, *The Tribes and Castes of the Central Provinces of India*, vol. iv (London, 1916)

THUGUT, JOHANN AMADEUS FRANCIS DE PAULA, Baron (1736–1818), Austrian diplomatist, was born at Linz on May 24, 1736 In 1769 he was appointed chargé d'affaires at Constantinople, and in that capacity secured a grant of money and a promise of the territory of Little Wallachia from the Turks during the negotiations connected with the first partition of Poland (See Poland: *History*.) In 1771 he was ennobled and appointed internuncio at Constantinople and was actively engaged, under the direction of Prince Kaunitz, in all the diplomacy of Austria in Turkey and Poland until he secured the cession of the Bukovina on May 7, 1775.

After 1775 Thugut travelled in France and Italy, partly on diplomatic service. In 1778 he acted as intermediary in Maria Theresa's negotiations with Frederick the Great In 1780 he was Austrian envoy in Warsaw, but in 1783 applied for leave and spent four years in Paris, where he invested his savings and became acquainted with many of the leaders in the Revolution From 1787 to 1789 he was minister at Naples In 1790 he was sent by the emperor Joseph II to Bucharest, nominally as commissioner with the hospodar of Wallachia, but in reality in order that he might open negotiations for peace with the Turks In 1792 he was associate diplomatic agent at the headquarters of the allied army which invaded France, and was then appointed director of the foreign affairs of Austria (March 25, 1793), becoming chancellor in 1794 on the death of Kaunitz

The selfish policy which Thugut followed (1793–1800) in Austria was bitterly resented by Austria's allies, and although Thugut probably thought that he was only doing his duty, he committed many acts which were more than dubious. After the defeats of Austria in Italy in 1796–97 and the peace of Campo Formio, it became a fixed object with the French, and with a growing party in Austria who held him responsible for the disasters of the war, to secure Thugut's removal.

The battle of Hohenlinden (Dec 3, 1800) made his position untenable. He retired from public life, and left Vienna for Pressburg. He afterward returned to Vienna and lived quietly on a pension of 7,000 florins till his death on May 28, 1818

THUILLE, LUDWIG (1861–1907), German composer, was born at Bozen (Bolzano) on Nov 30, 1861. After being taught by his father, an amateur, and by J. Pembaur at Innsbruck, he went to Munich in 1879 to finish his studies under Barmen and J. G. von Rheinberger. In 1883 he was appointed professor at the Munich school of music, and while there became a close friend of Alexander Ritter and Richard Strauss. His first opera, *Theuerdank*, was produced in Munich in 1897; a second, *Lobetanz*, at Mannheim in 1898; and a third, *Gugeline*, at Bremen in 1901 Two interesting choral works are *Traumsommernacht*, for female voices, and *Weihnacht im Walde*, for men's chorus (op. 14). His chamber music includes a sextet, op 6, for piano and wind instruments (1887) and a violoncello sonata

See Friedrich Munter, *Ludwig Thuille* (Munich, 1923).

THULE (thōō'lē), Greek and Roman name for the most northerly land in the world Pytheas (*c.* 300 B.C.), according to Polybius' account of his voyage, reached it after six days' sail from Britain; it was inhabited, but corn grew there sparingly and ripened ill; in summer the nights were long and bright. The few surviving fragments of his works do not determine where his Thule was Scholars at various times have believed it to

be the Shetlands, Iceland, or some section of the Norwegian coastline Agricola's fleet in AD 84 sailing up the east coast of Scotland is said to have espied but not to have reached Thule (*dispecta est Thule*) but the phrase is merely literary The actual point meant may be the Orkneys or the Shetlands, or even some fragment of Scotland seen across the water. In some later writers (Procopius, etc) Thule seems sometimes used to denote Scandinavia The phrase "ultima Thule" is commonly used to describe the farthest limit possible.

THULIUM, a very rare metallic element (symbol Tm, atomic number 69, atomic weight 169.4) of the rare-earth group, was discovered by Cleve in 1879 while examining crude erbium oxide It was first obtained in the form of a pure compound by C. James in 1911 by the fractional crystallization of its bromate. Thulium occurs to a very slight extent along with its commoner associates in the minerals gadolinite, euxenite, xenotime, etc. Very large quantities of the minerals must be employed to obtain a little pure salt. The oxide, of a greenish-white colour, gives a beautiful carmine glow when gently heated in the Bunsen burner. Salts of thulium possess a pale green colour and solutions show a very characteristic absorption spectrum. (*See* RARE EARTHS.) (C J)

THUN, a picturesque town in the Swiss canton of Berne, built on the banks of the Aar, just as it issues from the Lake of Thun, and by rail 19 mi. S.E of Berne. Its population in 1941 was 20,193, mostly German-speaking and Protestants; in 1930 it was 16,524 From 1798 to 1802 Thun was the capital of the canton Oberland of the Helvetic Republic. It is now the capital of the Bernese Oberland.

THUN, LAKE OF, in the Swiss canton of Berne, the second lake (the first being that of Brienz) into which the river Aar (*q v.*) expands. These two lakes occupy an ancient terminal basin of a glacier and are separated by a lacustrine delta on which Interlaken stands. Lake Thun (with the town of Thun at its north-western end) is 12½ mi long, 2 mi. wide, its maximum depth is 712 ft, while its area is 18½ sq mi., and its altitude 1,837 ft.

THUNDER, the noise which accompanies or follows a flash of lightning (*q v*), on account of the air disturbance caused by the sudden heating and expansion of air during the electrical discharge (*See* ELECTRICITY, ATMOSPHERIC and METEOROLOGY)

THUNDERSTORMS, The sound of thunder originates in a compression wave formed along the highly heated path of the lightning stroke Each portion of the path of a lightning stroke sends out intense sound waves which travel different paths to the observer Smce sound travels at the rate of approximately 330 metres per sec and since the stroke may be several kilometres in length, the thunder is usually heard as a drawn out rumbling, having character and time duration depending upon the length and shape of the stroke and upon its distance from the observer. Under ordinary atmospheric conditions thunder cannot be heard at distances greater than 15 to 20 km., although under some conditions of temperature inversion (temperatures greater at higher altitudes than near the ground) it may be heard at a distance of 40 km.

In general, thunderstorms occur where there is a deep layer of moist air having a vertical temperature distribution which favours local vertical circulation. In this process of convection the onset of condensation must take place at a temperature above, or at least not much below, 0°C Although the storm as a whole may move rapidly, it is essential that the rising column remain nearly vertical Forecasters frequently overlook this requirement and forecast thunderstorms on the basis of a vertical distribution of temperature and moisture when the storms do not develop because of a lateral shearing effect due to yawing winds aloft. Thunderstorms may occur as isolated clouds, or many may be within sight at one time, but in most cases the immediate locale of the storm is characterized by a clear sky.

Usually, an official record of a thunderstorm is made when thunder is heard at a weather observing station Since many storms may occur unheard between stations, it is difficult to estimate the total number of such storms annually expected within a particular area. C. E P. Brooks, however, made a study of thunderstorm distribution over the northern hemisphere which indicates that an average of approximately 50,000 storms occur on the earth each day On the assumption that a storm can be heard at a distance of 16 km., this means that on the average, an earth dweller would hear about 25 storms each year. Conditions affecting the occurrence of thunderstorms over the surface of the earth are so varied that the actual local frequency may be once in a lifetime in many localities and one every other day in many areas (the tropics)

It is perhaps desirable to understand the physical requirements for thunderstorm formation and to be able to make inferences relative to frequency of occurrence in terms of local conditions, rather than to recite details concerning frequency distribution

It is useful to consider the properties which a large deep air mass would acquire if it remained over a warm surface sufficiently long for steady conditions to be realized Consider the air in question to be dry The air in the lower layers will expand by warming and become less dense, and vertical mixing will occur As this process continues (without appreciable loss or gain of heat through the lateral boundaries or by radiation), the vertical column will approach a condition of neutral equilibrium, which is characterized by a decrease of temperature with height of approximately 1°C. per 100 metres The pressure at any point would decrease with increase in altitude in a manner consistent with this temperature distribution and with the decrease in weight of air above the point in question The rate of decrease of temperature with increase in elevation is referred to as a *lapse rate*, and under these conditions the lapse rate is said to be equal to the *dry adiabatic lapse rate* Any portion of this atmosphere could, neglecting friction, be moved up or down without the gain or loss of total energy. It, however, any thermally isolated portion of such atmosphere is heated above the temperature of adjacent layers of air, it will rise to the top Even though the heated portion of air is cooled through expansion as it rises, it will remain at all times warmer than its surroundings. Conversely, any similar portion which might be cooled will sink to the bottom of such an atmosphere

When water vapour is present in appreciable amounts, the situation described is significantly changed The ratio of the partial pressure of water vapour at saturation to the partial pressure of dry air decreases with decrease in temperature A warmed portion of air containing water vapour will rise and be cooled in the process When saturation is reached and condensation sets in, the latent heat of condensation will be added to the parcel of air. As a result of this addition of heat as the air rises, the rate of decrease of temperature with altitude will be less than it would be if the sample of air were dry. Moreover, this lapse rate would not be uniform with height because the latent heats added would be different at different levels, since the amount of heat added per unit change of altitude is less at the higher elevations. Also, when saturation at the freezing level exists, an increased amount of heat will be added due to latent heat of sublimation or of fusion, as the case may be

If the parcel of air under discussion were to move upward without the transfer of heat across its boundary, the rate of decrease of temperature with height is said to be equal to the *saturation adiabatic lapse rate*. It is observed that the average lapse rate over the surface of the earth approximates the saturation of adiabatic lapse rate, which is about 0.6°C per 100 metres in the lower layers This is in a large measure conditioned by the vertical transport of moist air in the atmosphere.

Although this average lapse rate represents a limiting condition of stability, local conditions may produce much higher lapse rates leading to instability or conditional instability as the case may be—conditional instability being defined as "that which exists when the lapse rate has a value between that of the wet and the dry adiabatic lapse rate." (E. J. WN)

Types of Thunderstorms.—Thunderstorms can be classified according to factors that contribute to the development of steep lapse rates with resultant convection. Five important classes are given:

(1) *Heating of air by contact with warm surfaces* (a) When the surface of the ground is warmed by radiation from the sun, water vapour may be carried up by convection currents to a level at which condensation occurs With the lapse rate of tem-

perature in the air above this level being greater than in the cumulus clouds, thunderstorms may develop A special case of this class is the heating of mountain slopes at high levels, which frequently contributes to the development of thunderstorms near the summits (b) When air flows over warmer ground or warmer water, the air may become warmed sufficiently from below for convection and possibly thunderstorms to occur

(2) *Lifting of warm air over cold currents.* If a current of cold air meets a current of warm air, the warmer air, being lighter, is forced upwards either by cold air underrunning warm air or by warm air overrunning cold air. Clouds form in the rising warm air, and if conditions are favourable, tower upward to form thunderstorms

(3) *Converging air-flow within warm currents.* A converging flow may force warm air up to its condensation level releasing convection

(4) *Interaction of cold and warm air currents at different levels* The underrunning of cool air by warm air may initiate convection Similarly, overrunning of warm air by colder air as well as combinations of these factors may be effective in releasing convective overturning and thunderstorms.

(5) *Lifting of air by movement upslope from lower to higher ground* Movement of air against a mountain range or other upslope surface may lift air to its condensation level and initiate convection.

The Distribution of Thunderstorms.—The storms of class (1a) are most frequent in certain portions of the tropics; they occur in summer in the temperate zone especially in mountain regions These storms show a well-marked diurnal variation; they develop generally during the afternoon Storms of class (1b) are characteristic of the rear of barometric depressions occurring over the sea in winter especially just off the east coasts of the large continents where cold air may pass over comparatively warm water.

The "frontal" storms of class (2) are found in the temperate zone. They are associated with line-squalls and "warm front" precipitation in extra-tropical cyclones.

Storms of classes (3) and (4) frequently occur in advance of "cold fronts" or troughs of low pressure in the temperate zone and tend to occur more frequently at night than during the day.

Storms of class (5) occur especially on windward mountain slopes in middle latitudes (L. L. Ms)

Thunderstorm Mechanism.—When moist air becomes unstable without much horizontal mixing, convection may take place on a large cellular scale As the air is lifted it cools, and condensation takes place With the onset of condensation, heat is added to the air, and if the stability of the adjacent air is critical (near the adiabatic lapse rate), a violent chimney-like updraft will develop If the vertical extent of the cloud thus formed is such that its base extends below or at least near the zero isotherm and the top to temperatures of lower than approximately −20°C , a thunderstorm is almost certain to result At about the time that the cloud reaches the large bulging cumulus stage giving the appearance of ice crystals on the top surface, electrical charge separation takes place within the cloud, and, shortly thereafter, precipitation appears near the bottom of the clouds. The region of charge separation appears to be located in the region of updraft. There is evidence that the point of emergence of precipitation is at the side of this updraft. In the simple types of thunderstorms these electrical charge centres will develop in magnitude and intensity with a negative charge centre below and a positive charge centre above. The first electrical discharges usually take place entirely within the cloud between these two charge centres These discharges will be rather small at first and will increase in magnitude, and thunder may be heard from this region Precipitation from the base of the cloud is usually well developed following this stage, and lightning strokes are likely to emerge from the base of the cloud and make contact with the ground. Evidence indicates that the great majority and possibly all of these lightning strokes transport negative electricity from cloud to ground. The charge quantities are from 5 to 200 coulombs (averaging about 25) They generally may be associated in rapid sequence, with time separations of a few hundredths of a second, with other discharges which travel between the two charge centres within the cloud. As the storm advances, the positive charge centre within the cloud is likely to become more diffuse and to give rise, as the storm ages, to a greater multiplicity of stroke sequences within the cloud This general charge distribution in the cloud has been verified by many observers including E. J Workman, R E Holzer, Sir George Simpson, F J Scrase and Ross Gunn. Simpson and his colleagues observed a positive charge centre near the lower boundary of the cloud in the vicinity of the rain sheet, but it is believed that this charge centre is of secondary origin and not related to the primary process of electrical charge development in the thunderstorm. It probably arises from the breaking of falling water drops, acting according to the well-known breaking-drop phenomenon. This condition is supported by the observation that as precipitation continues from the base of the cloud, these positive charge centres do develop and act as terminal points for negative transfer of electricity from the cloud This is evidenced by the downward branching of air discharges as the thunderstorm approaches maturity or old age following heavy precipitation The entire di-pole arrangement may be inclined considerably from the vertical, positive charge centres being transported to positions nearer the base of the cloud. In this stage there appears a preponderance of lightning discharges which seem to transfer electricity from the region of the rain sheet to other portions near the base of the cloud Many of these discharges actually travel great distances in a nearly horizontal direction below the cloud base and terminate at each end within the cloud.

No laboratory experiments had been reported by 1946 which demonstrated a mechanism of charge formation and charge separation in thunderstorms which is consistent with the observed structure of thunderstorms. Indeed, these processes were not understood in 1946 This is not surprising because it was not until the years 1930–40 that there was general agreement among investigators as to the fundamentals of charge distribution within a cloud Also, it is very difficult to reproduce in the laboratory the physical conditions which obtain within the cloud This is especially true with respect to the control of purity of the substances involved and *the conditions relating to supercooling.* The charge-generating process may well be the result of more than one primary physical process. The active region of the thunderstorm appears to have a charge-generating process in the region of the updraft which is associated with condensation forms of more than one phase (both ice and water) The negative portion of the cloud is usually at a higher elevation than the zero isotherm, in the region of 0°C. to −5°C , whereas in a well developed storm the positive charges may exist in several regions within the cloud This distribution gives some support to the contention of some investigators that the positive charges move upward through the updraft and descend along the precipitation forms in channels adjacent to this region Although interpretation of the observations may be invalidated by the breaking-drop phenomenon, a process considered unlikely to be the primary charge-generating mechanism, it is certainly true that positive charges are carried well downward into the rain sheet below the cloud. This is especially noticeable in storms where the cloud base is several kilometres above the ground and where its temperature is in the neighbourhood of 0°C. In storms occurring where the air is warmer and moister than in the case just described, there is evidence to support the existence of a small positive charge centre within the cloud, but near the base.

Many storms of intermediate intensity appear to have a pulsating action of quite indefinite period but of the order of 30 minutes As studied from the outside, the cloud appears to grow in height in a series of these pulses, and lightning actually follows in a similar periodicity In fact, the top of the cloud during intermediate stages of its development may even appear to subside during these intervals

It is of interest in this connection that a particular updraft chimney which causes a large amount of precipitation is self-regulating in a sense because the downward flow of cold precipitation forms, cold water drops and ice, tend to cool the bottom of

the cloud and the air below it. This action doubtless has a bearing on the fact that a large thundercloud—that is, one having a large cloud base—will usually develop a number of vertical updraft channels, two or more of which may be active at the same time These are evidenced by bulbous extensions on the upper sides of the cloud and by relatively concentrated regions of lightning activity from the bottom of the cloud This action, as might be expected, is more noticeable in large, nearly stationary storms.

Most investigators consider the ice phase to be essential in intense thunderstorm action It is to be pointed out, however, that this view is somewhat controversial because some storms have been reported in tropical regions under conditions in which it is difficult to conceive of ice being present. One might guess that some process of electrical charge separation which might play a secondary role in any thunderstorm could produce effects sufficiently large to produce lightning strokes in these apparently unusual cases.

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THUN-HOHENSTEIN. The family of Thun-Hohenstein, one of the wealthiest of the Austrian nobility, which for more than 200 years had settled at Tetschen, in Bohemia, gave several distinguished members to the Austrian public service. Of the three sons of Count Franz, the eldest, FRIEDRICH (1810–81), entered the diplomatic service; after holding other posts he was in 1850 appointed president of the restored German diet at Frankfort, where he represented the anti-Prussian policy of Schwarzenberg, and often came into conflict with Bismarck, who was Prussian envoy. He was afterwards ambassador at Berlin and St. Petersburg. After his retirement from the public service in 1863 he supported in the Bohemian *Landtag* and the Austrian *Reichsrat* the federal policy of his brother Leo. In 1879 he was made hereditary member of the upper house. He died on Sept. 24, 1881

The third son of Count Franz, LEOPOLD or LEO (1811–88), was one of the leading Austrian statesmen. After studying at the University of Prague he travelled through Europe and, upon his return home, interested himself in the revival of Czech language and literature and the growth of Bohemian national feeling After serving under Stadion in Galicia, he was in 1848, after the outbreak of the revolution, appointed president of the administration and acting Stadthalter in Bohemia. In 1849 he became minister of religion and education and devoted himself to the task of building up an adequate system of schools. He summoned experienced teachers from Germany, established middle and higher schools in all parts of the empire, superseded the antiquated textbooks and methods of instruction and encouraged the growth of learned societies The crisis of 1860, by which the office he held was abolished, was the end of his official career; for the rest of his life he was very prominent as the leader of the Federalist party in Bohemia He helped draft the declaration of 1868 and the fundamental articles of 1871, and established the *Vaterland*, organ of the Clerical and Federalist party. He died in Vienna on Dec. 17, 1888.

THURET, GUSTAVE ADOLPHE (1817–1875), French botanist, was born in Paris on May 23, 1817. He was encouraged to undertake his algological studies by Joseph Decaisne, whose pupil he became; and after travelling in Syria and Egypt in 1841 he returned to France and thenceforth devoted himself to scientific research. He had already, in 1840, published his first scientific paper, "Notes sur l'anthère de *Chara* et les animalcules qu'elle renferme," and he continued his studies of the zoospores and male cells of algae and other cryptogams. He spent a great part of his time, up to 1857, on the Atlantic coast of France, assiduously observing the marine algae in their natural habitat and at all seasons. He and his friend Édouard Bornet, became the recognized authorities on this group of plants Their work, while remarkable for taxonomic accuracy, was more especially concentrated on the natural history, development and modes of reproduction of the plants investigated The discovery of sexual reproduction in seaweeds is almost wholly the work of these two men The researches on the fecundation of the Fucaceae were published by Thuret in 1853 and 1855; the complicated and difficult question of the sexual reproduction in Florideae was solved by the joint work of Thuret and Bornet (1867). These great discoveries—of far-reaching biological significance—stand out as the chief, but every group of marine algae was elucidated by the researches of Thuret and his colleague The *Notes algologiques* (1876–80), and the *Études phycologiques* (1878) were posthumously published. In 1857 Thuret moved to Antibes, where he established a botanic garden which became famous He died at Nice, on May 10, 1875

See notices by Bornet in *Ann des Sci. Nat.* Sei., VI, vol. ii (1875) and Farlow in *Journ of Bot.* (1876)

THURGAU, a canton of northeast Switzerland, bordered by the Lake of Constance and, for a short distance, by the Rhine below the lake. It is in contact with Schaffhausen and Zurich to the west and St. Gall to the south. Thurgau is divided into three well-wooded hill masses running northwest to southeast by the middle course of the river Thur (rising in the Toggenburg, *q.v.*) and by its affluent, the Murg.

The canton is traversed by the main railway line from Winterthur to Romanshorn (with branches to Constance, to the Toggenburg and to St. Gall), another important line extends from Rorschach along the lake shore via Constance, thence to Schaffhausen The canton is a highly prosperous agricultural area, and though termed the "garden and granary of Helvetia" it also possesses an important cotton-spinning, dyeing and printing industry. The population in 1941 was 138,076; in 1930 it was 136,063, of whom 132,448 were German-speaking, 2,687 were Italian-speaking and 578 were French-speaking, while there were 90,634 Protestants, 44,584 Catholics and 142 Jews. Its capital is Frauenfeld on the Murg, pop. 9,209. Other towns are Arbon (8,570), Kreuzlingen (3,615) and Romanshorn (6,095).

History.—The Thurgau originally took in all the country, roughly speaking, between the Reuss, the Lake of Lucerne, the Rhine and the Lake of Constance, but many smaller districts (Zürichgau, Toggenburg, Appenzell, St. Gall) were gradually carved out of it, and the county was reduced to about the size of the present canton when in 1264 it passed by the gift of the last count of Kyburg to his nephew Rudolph of Habsburg, chosen emperor in 1273. In 1460–61 it was seized by the Confederates and henceforth it was ruled as a "subject district" by seven members of the League—Bern occupied in the west, not being admitted to a share in the government till 1712, after one of the wars of religion. In 1499 the confederation obtained from the emperor the supreme jurisdiction.

In 1798 it became free, and was one of the 19 cantons of the Helvetic republic, being formally received (like the other "subject lands") as a full member of the Swiss confederation in 1803 by the Act of Mediation. The very advanced Cantonal constitution dates to 1869. (*See* SWITZERLAND. *Government.*)

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THURIBLE, the ecclesiastical term for a censer, a portable vessel in which burning incense (*q.v.*) can be carried. The censer, to use the more general term, is a vessel which contains burning charcoal on which the aromatic substances to be burned are sprinkled The early Jewish portable censer would seem to have been a bowl with a handle, resembling a ladle. A similar form was used by the ancient Egyptians long prior to the Jewish use. The Greek and Roman censers (*θυμιατήριον* and *turibulum* or *thuribulum*) are of quite different shape. They are small portable braziers (*foculi*) of bronze or sometimes of silver and of highly ornate design.

The censers or thuribles in Christian usage have been specially adapted to be swung, though many early specimens of heavy weight were obviously not meant to be used in this way.

THURII or THURIUM, Italy, a city of Magna Graecia on the Gulf of Tarentum, near the site of the older Sybaris (*q.v.*). It owed its origin to an attempt made in 452 B.C. by Sybarite exiles and their descendants to repeople their old home. The new settlement was crushed by Crotona, but the Athenians lent aid to the fugitives, and in 443 Pericles sent out to Thurii a mixed body of colonists from various parts of Greece, among whom were Herodotus and the orator Lysias. In 390 it was severely defeated by the Lucanians, and at length called in the help of the Romans against the Lucanians, and then in 282 against Tarentum. Thenceforward it was dependent, and in the Second Punic War it was depopulated and plundered by Hannibal (204). In 194 a Roman colony was founded, known for a time as Copiae, but afterwards as Thurii.

THURINGIA (*Land Thuringen*), former German Free state, after 1933 a *Land* of the German reich; it consists of the former Thuringian states of Saxe-Weimar-Eisenach, Saxe-Meiningen, Reuss, Saxe-Altenburg, Saxe-Gotha (Coburg having been merged with Bavaria), Schwarzburg-Rudolstadt, and Schwarzburg-Sondershausen, which decided in 1919 to combine into one state. They maintained their identity as administrative districts until April 1, 1923, but were then completely merged into Thuringia. The country falls into two main divisions: the southern division is bounded on the north and west by Prussia, on the east by Saxony and on the south by Bavaria, while the smaller northern division is surrounded by Prussia. Its total area is 4,540 5 sq mi

A considerable part of the country is occupied by the picturesque, rounded hills of the Thuringian forest. Among the chief elevations are the Beerberg (3,225 ft.), the Schneekopf (3,179 ft.) and the Inselberg (2,957 ft.), on the northern slopes of the Thuringian forest. The Altenburg district in East Thuringia is traversed by the westerly offshoots of the Erzgebirge, while the Rhön mountains extend into West Thuringia. The southeastern portion of Thuringia belongs to the bleak, mountainous region of the Frankenwald and the Vogtland. The principal river is the Saale, which runs in a northwesterly direction as far as Saalfeld, and then flows northeast by Rudolstadt and Jena. Among the other rivers are the Werra, Ilm, Gera, Unstrut, Elster, Weisse, Wipper, Helbe and Pleisse. The district watered by the Pleisse contains some of the richest agricultural soil in Germany

Of the total area of Thuringia, about 44% is occupied by arable land, 33% by forest and 10% by pasture land. The chief mineral resources of Thuringia are lignite (found mainly in the Altenburg district), and potash in the valley of the Werra and in the Sondershausen district. Iron ore, marble, cobalt, copper, slates, chalk and basalt are also found; and there are salt works at Salzungen and Neusalza, and brine springs at Heinrichshall and elsewhere. Among the principal industrial products of Thuringia are textiles, glass and porcelain, iron goods and machinery, paper and leather goods, musical instruments, beer, chemicals, wooden toys, etc. The manufacture of toys and textile goods is largely carried on under the domestic system. The optical instruments of Jena and the scientific instruments of Ilmenau are well known.

In 1939 Thuringia had 1,760,170 inhabitants, or 387 to the sq mi. The population is mainly Teutonic, but there is a Wendish or Slavonic element. The population is 90% Protestant. The University of Jena is the chief centre for higher education.

The constitution dated March 11, 1921, provided for a Landtag consisting of 72 members After 1933 this constitution was superseded by the administration of Fritz Sauckel, the national socialist district leader (*gauleiter*) and governor (Reichsstatthalter). The capital is Weimar, but Gera and Jena are larger towns and Gotha, Eisenach, Altenburg and Greiz are also noteworthy.

History.—In the 5th century the Thuringians lived between the Harz mountains and the Thuringian forest. They were tributary to Attila the Hun, under whom they served at the battle of Châlons in 451. In the 6th century they were conquered by the Franks and remained under the direct rule of the Frankish kings until 634, when King Dagobert I appointed Radulf duke of the Thuringians, under whom they became virtually independent. They were again brought under Frankish rule by Charles Martel, who abolished the office of duke and divided the country among Frankish counts About 804 Charlemagne, in order to defend the line of the Saale against the Slavs, founded the Thuringian mark. In 849 King Louis the German recognized Tlakulf as duke and some of his successors bore the title of margrave until the death of Burkhard in 908, when the country was seized by Otto the Illustrious, duke of Saxony. Thuringia was retained by Otto's son and successor, Henry I the Fowler.

In the 11th century a new dominion was founded by Louis the Bearded, who by purchase, gift or marriage obtained several counties in Thuringia. These passed on his death in 1056 to his son Louis the Springer (d. 1123), who took part in the Saxon risings against the emperors Henry IV and Henry V His son Louis was appointed landgrave of Thuringia in 1130 by the emperor Lothair II, by his marriage with Hedwig of Gudensberg in 1137 he obtained a large part of Hesse Louis was succeeded in 1140 by his son Louis II the Hard, who married Judith, a sister of the emperor Frederick I, and on his behalf took a leading part in the opposition to his powerful neighbour Henry the Lion, duke of Saxony. In 1172 he was succeeded by his son Louis III the Pious. He acquired the Saxon palatinate in 1179, on the death of Adalbert, count of Sommerschenburg, went to Italy to assist Frederick I in 1157, joined in the war against Henry the Lion in 1180, and distinguished himself at the siege of Acre in the Third Crusade, on the return from which he died at Cyprus in 1190 He was succeeded by his brother Hermann I, during whose reign Thuringia suffered greatly from the war between Philip duke of Swabia and Otto of Brunswick. The next landgrave (1217–27) was his son Louis IV, a celebrated figure in mediaeval German literature, who married St. Elizabeth, daughter of Andrew II, king of Hungary, and died at Otranto while accompanying the emperor Frederick II on crusade. The next ruler was Henry Raspe, who made himself regent on behalf of his nephew Hermann II from 1227 to 1238 and in 1241 succeeded his former ward as landgrave

After a disputed succession to the landgraviate it fell in 1263, together with the Saxon palatinate, to Henry III margrave of Meissen Two years later Henry apportioned Thuringia to his son Albert the Degenerate, who sold it in 1293 to the German king Adolph of Nassau for 12,000 marks of silver. Albert's sons Frederick the Undaunted and Dietrich contested this transaction, and the attempts of Adolph and his successor Albert I to enforce it led to the infliction of great hardships upon the Thuringians. Frederick defeated Albert decisively and in 1314 was formally invested with Thuringia by the emperor Henry VII. His son Frederick II the Grave (1323–49) consolidated the power of his dynasty against rebellious vassals and the neighbouring counts of Weimar and Schwarzburg. His son Frederick III the Strong (1349–81) and his grandson Balthasar (1381–1406) further extended their dominon by marriage and conquest, and the latter of these founded the university at Erfurt (1392) Balthasar's son, Frederick the Peaceful, became landgrave in 1406 but left the government largely to his father-in-law Günther, count of Schwarzburg. He died childless in 1440, and Thuringia then passed to the electoral dynasty of Saxony. After a joint rule by Frederick II and his brother William, the latter in 1445 became sole landgrave as William III and died without sons in 1482. In 1485 his nephews and heirs Albert and Ernest made a division of their lands, and Thuringia was given to the Ernestine branch of the family of Wettin, with which its history down to 1918 is identified (*see* SAXONY).

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THURLES, a town of Co. Tipperary, Eire, on the Suir and on the main line of the Great Southern and Western railway, 87

mi. S W. of Dublin Pop. (1936) 5,648. Originally the town was called Durlas O'Fogarty. In the 10th century it was the scene of a defeat of the Irish by the Danes A preceptory was founded here by the Knights Templars, who held a 13th century castle, of which there are remains. A castle was subsequently erected by James Butler, first lord palatine of Tipperary, of which the keep collapsed in 1868 The Cistercian abbey of Holy Cross stands 3½ mi S W. of the town. It was founded by Donnell O'Brien (1168–94). Thurles is the seat of the Roman Catholic archdiocese of Cashel

THURLOE, JOHN (1616–1668), English politician, son of Thomas Thurloe, rector of Abbot's Roding in Essex, was baptized on June 12, 1616. He studied law, entered the service of Oliver St. John, through whose interest he was appointed a secretary to the parliamentary commissioners at Uxbridge in 1645, other employments followed On March 29, 1652, he was appointed secretary to the council of state. His duties included the control of the intelligence department and of the posts, and his perfect system of collecting information and success in discovering the plans of the enemies of the administration astonished his contemporaries. In the parliaments of 1654 and 1656 he represented Ely, he was appointed a member of Cromwell's second council in 1657.

After Oliver's death Thurloe supported Richard Cromwell's succession, and took part in the administration, sitting in the parliament of Jan. 1659 as member for Cambridge university. Appointed secretary of state on Feb. 27, 1660, he appears to have steadily resisted the Restoration, and his promises of support to Hyde in April inspired little confidence. On May 15, 1660, he was arrested on the charge of high treason, but was freed on June 29, subject to the obligation of attending the secretaries of state "for the service of the state whenever they should require" He subsequently wrote several papers on the subject of foreign affairs for Clarendon's information He died on Feb. 21, 1668.

His extensive correspondence, the originals of which are in the Bodleian Library at Oxford and the British Museum (*Add. MSS* 4156, 4157, 4158), is one of the chief sources of information for the period A portion was published with a memoir by T. Birch in 1742, and other correspondence is printed in R. Vaughan's *Protectorate of Oliver Cromwell* (1836)

THURLOW, EDWARD THURLOW, 1ST BARON (1731–1806), English lord chancellor, was born at Bracon Ash, in the county of Norfolk, on Dec 9, 1731, the eldest son of the Rev. Thomas Thurlow. He was educated at Canterbury Grammar school and Caius college, Cambridge, but went down without a degree In 1754 he went on the western circuit and after a successful brush with Fletcher Norton his reputation rose. He took silk in 1761, and in 1768 became M P. for Tavistock in the Tory interest. The next year he led for the plaintiff in the Douglas peerage case. In 1770 he was made solicitor-general, and supported the Government views against the rights of juries in libel cases (*R.* v. *Miller*, 20 *St Tr.* 870) and the liberty of the press (16 *Parl Hist.* 1144). In 1771 he became attorney-general. Politically he was factious and violent; he was a venomous opponent of the American colonies, he made a savage speech in aggravation of punishment in the Horne Tooke case (20 St. Tr. 777), and was opposed to all interference with the slave trade. In 1778 he became lord chancellor with a peerage. His position in the Lords was almost autocratic, and he continued to oppose the reforming schemes of Burke. Under Rockingham and Shelburne he remained chancellor; under the coalition he worked in opposition for the king; got the India bill rejected; and returned to the woolsack under Pitt (1783). Finally he came out openly in opposition to the National Debt Redemption scheme. Pitt then insisted on his dismissal (1792), and he retired with the title of Baron Thurlow of Thurlow. He continued to speak in the Lords till 1802 and died at Brighton on Sept. 12, 1806

Thurlow was a master of caustic wit, habitually displayed in profanity. His judicial and his ecclesiastical patronage were wisely exercised; he was the patron of Dr. Johnson and of Crabbe; and was the first to detect the great legal merits of Eldon Thurlow's personal appearance was striking. His dark complexion, harsh but regular features, severe and dignified demeanour, piercing black eyes, and bushy eyebrows, doubtless contributed to his political eminence, and provoked the sarcasm of Fox that he *looked* wiser than any man ever *was*.

See Lord Campbell's *Lives of the Chancellors*, vii 153–333, Foss's *Judges of England*, viii. 374–385, *Public Characters* (1798); *Notes and Queries*, 2nd series, vol iii p 283; 3rd series, vol iii. p 122; *Reports* of his decisions by Brown, Dickens and Vesey (Jun), Brougham's *Statesmen of the Time of George III.*

THURMAN, ALLEN GRANBERY (1813–1895), U S jurist and statesman, was born at Lynchburg (Va.), on Nov 13, 1813. In 1819 he removed with his parents to Chillicothe (O), where he attended the local academy for two years, studied law in the office of his uncle, William Allen, and in 1835 was admitted to the bar, becoming his uncle's law partner. He began to take an active part in politics in 1844, and in 1845–47 was a Democratic representative in congress, where he advocated the Wilmot Proviso.

He was Democratic candidate for governor of Ohio in 1867, and was defeated by Rutherford B. Hayes by a majority of less than 3,000 votes, but the Democrats gained a majority in both branches of the state legislature, and Thurman was elected to the United States senate, where he served from 1869 until 1881—during the 46th Congress (1879–81) as president *pro tempore* Here he became the recognized Democratic leader and in 1879–81 was chairman of the judiciary committee He introduced the Thurman bill, for which he was chiefly responsible, which became law in May, 1878, and readjusted the Government's relations with the bond-aided Pacific railways.

Thurman was a member of the electoral commission of 1877 and was one of the American delegates to the international monetary conference at Paris in 1881. In 1876, 1880 and 1884 he was a candidate for the presidential nomination, and in 1888 was nominated for vice-president on the ticket with Grover Cleveland, but was defeated in the election. He died at Columbus (O.) on Dec. 12, 1895.

THURSDAY ISLAND, a small island belonging to Queensland, Australia, situated 30 mi. to the northwest of Cape York in Torres Straits It has an excellent harbour (Port Kennedy) which is the centre for the pearl, etc., fleets of the northeast. (*See* AUSTRALIA: *Fisheries*) Pop. (1935) 1,200.

THURSO, a small burgh and seaport of Caithness, Scotland Pop (est. 1938) 3,152. It is situated at the mouth of the Thurso, on Thurso bay, 21 mi. N W. of Wick, and 319 mi N. of Edinburgh, by the L M.S.R., the most northerly town on the mainland of Scotland A town planning scheme is in operation.

In Macdonald square there is a statue of Sir John Sinclair, first baronet, who did much for the improvement of northern Scottish agriculture. The town hall contains a public library and museum, which possesses the geological and botanical specimens of Robert Dick (1811–1866), the "Thurso baker," and a collection of northern birds. To the east is Thurso castle, home of the Ulbster branch of the Sinclairs, and near it is Harold's tower, built over the grave of Earl Harold, once owner of half of Caithness, and half of the Orkneys and Shetlands, who fell in battle with Earl Harold the Wicked in 1190. About ¾ mi. W. stand the ruins of the bishop's palace, destroyed by fire in 1222. Thurso was the centre of the Norse power on the mainland when at its height under Thorfinn (1014), and afterwards till the battle of Largs (1263). Count Modach, nephew of King Duncan, quartered his army for a time at Thurso and despoiled it until surprised and slain by Thorfinn in 1040.

THURSTAN or TURSTIN (d. 1140), archbishop of York, was the son of a certain Anger, or Auger, prebendary of St. Paul's, London, and a brother of Audoen (d. 1139), bishop of Evreux. He himself was a prebendary of St. Paul's, and was also a clerk in the service of William II and then of Henry I, who secured his election as archbishop of York in Aug 1114. He now entered upon the great controversy which occupied him during a large part of his subsequent life and made him for several years an exile from England. Archbishop Ralph of Canterbury refused to consecrate him unless he made a profession of obedience to the southern see; this Thurstan refused and asked the king for permission to go to Rome to consult Pope Paschal II. Henry I

declined to allow him to make the journey, while Paschal declared against Archbishop Ralph. At the Council of Salisbury in 1116 the English king ordered Thurstan to submit, but instead he resigned his archbishopric, although this did not take effect. The new pope, Gelasius II, and also his successor, Calixtus II, espoused the cause of the stubborn archbishop, and in Oct. 1119, he was consecrated by Calixtus at Reims.

Enraged at this the king refused to allow Thurstan to enter England, and he remained for some time in the company of the pope At length, however, his friends succeeded in reconciling him with Henry, and, after serving the king in Normandy, he was recalled to England In 1138 he made a truce at Roxburgh between England and Scotland, and took active part in gathering together the army which defeated the Scots at the Battle of the Standard in Aug 1138 Early in 1140 he entered the order of the Cluniacs at Pontefract and here he died on Feb 6, 1140. Thurstan displayed marked generosity toward the churches of his diocese during his bishopric and was also the founder of a number of religious houses

See his life in the *Fasti eboracenses*, ed J Raine (1863).

THYLACINE or MARSUPIAL WOLF (*Thylacinus cynocephalus*), a large carnivorous marsupial, superficially resembling a dog or wolf. Now confined to Tasmania and almost extinct there, it was found on the Australian mainland in the Pleistocene The face is sharp and fox-like, while the base of the tail is thick. The thylacine is grayish brown, the back marked with transverse, blackish-brown bars from behind the shoulders to the base of the tail. The pouch opens backwards, two to four young are born and carried in this for about three months In size the marsupial wolf is smaller than true wolves, but it is the largest carnivorous marsupial It feeds on wallabies, small mammals and birds; when sheep were introduced it became a serious predator on the flocks, which led to its being persecuted by the settlers. (J E. HT.)

THYMBRA, BATTLE OF. This battle of 546 B.C. was the decisive act in Cyrus the Great's overthrow of Croesus, king of Lydia, which in turn led to his subjugation of Asia Minor, and thus brought the Persians in contact with the Greeks—with momentous consequences to both. (*See* GRAECO-PERSIAN WARS.) As described in Xenophon's *Cyropaedia* the battle is rather instructional than historical, yet even so of far-reaching historical importance. For this projection on to an historical screen of Xenophon's conception of the "model" commander and the "model" battle, affected the course of many wars yet undreamt of. It served as the foundation of the study and reflection of the great captains of antiquity—Scipio, for example, is said to have carried the *Cyropaedia* with him throughout his campaigns And with the Renaissance, and the revival of Greek studies, it lightened afresh the path of the great captains of the 16th, 17th and 18th centuries As pictured by Xenophon, Croesus draws up his army in the customary single line many ranks deep, while Cyrus forms his in a deep series of lines, each only a few deep, capable of mutual support and manoeuvre. When Croesus uses his superiority of numbers to wheel inwards his far-stretching wings in order to crush Cyrus's wedge-like formation between them, Cyrus fends them off by lines of scythed chariots charging outwards, while his cavalry and camelry reserve attacks the flanks of the inwheeling Lydian wings Then under cover of a frontal chariot attack on Croesus's centre, a small picked reserve of horse and foot is hurled at the point where one of the enemy wings joins on to the centre. This pierced, the cut off centre is "played on" by arrows and javelins until it surrenders. There is an extraordinary parallel between this sequence of action—distention of the enemy's line, dislocation of a joint, followed by a disruption which decides the issue—and the fundamentals of Napoleon's tactic more than 2,000 years later *See* Herodotus, i, 79–80, Xenophon, *Cyropaedia*

THYME. The genus *Thymus* (family Labiatae) comprises a number of fragrant aromatic undershrubs, with very small leaves and whorls of small, purple, honey-bearing flowers in the axils of the leaves or at the ends of the branches. The common garden thyme, a native of the Mediterranean region, is *T. vulgaris;* the wild thyme of English banks is *T. serpyllum*, now naturalized in eastern North America from Nova Scotia to Pennsylvania. Pot marjoram (*Origanum*) and sweet marjoram (*Majorana*) are also closely allied. All these plants are remarkable for their essential oil, from which thymol is produced.

THYMELAEACEAE, a family of dicotyledonous plants, with about 43 genera and in excess of 700 species recognized They are mostly shrubs or trees, rarely herbaceous, and representatives occur in most parts of the world, even in Arctic regions. Large genera are *Gnidia*, with about 175 species, chiefly African, *Wikstroemia*, with 120 species, chiefly Indo-Malaysian, and *Pimelea*, chiefly Australian, with 100 species. The bast fibres of many species are very strong, and are extensively utilized in various parts of the world, and especially in Japan, for manufacturing thin tough writing paper Some species of *Daphne* (*q v*.) are cultivated for ornamental purposes. Eaglewood or agalloch, prized because of its pleasant odour, is the product of representatives of the genus *Aquilaria*. (E. D. ML.)

THYMOL: *see* CAMPHORS.

THYMUS: *see* DUCTLESS GLANDS; LYMPHATIC SYSTEM, DISEASES OF.

THYROID, an anatomical term applied to (1) the largest of the laryngeal cartilages (*see* RESPIRATORY SYSTEM, ANATOMY OF), (2) a vascular ductless gland which rests on the larynx and upper part of the trachea and (3) each of the four arteries which supply the thyroid gland (*see* ARTERIES) The thyroid gland plays a most important role in the human economy, particularly as a regulator of the body metabolism In human beings two abnormal states may result from a lack of thyroid secretion, depending on whether the onset is congenital or has started during early life; *i.e.*, cretinism (*q v*.), or that which occurs later in life, *i.e.*, myxoedema (*q v*.). (*See* DUCTLESS GLANDS.)

The thyroid gland is used in medicine in two forms *Thyroideum siccum* is a light, dull brown powder, usually available in tablet form, and prepared by drying the thyroid glands of sheep or cattle Its chief constituent is a protein known as thyreoglobulin, the active principle of which contains 9 3% iodine and 0.5% phosphorus, and is known as iodothyrin or thyroiodin. The dried gland easily becomes damp and deteriorates. *Liquor thyroidei* is a pink turbid liquid made by macerating the fresh gland of a sheep with glycerin and phenol. The active principle in pure form—thyroxin—was isolated in 1914 by E C. Kendall at the Mayo clinic, Rochester, Minn It contains 65% iodine.

Thyroid gland administered to man increases the pulse rate, causes an increased force of the cardiac beat and leads to increased metabolism, consequently an excess of urea, uric acid, iodine, calcium and phosphates are excreted in the urine; it therefore reduces the body weight Glycosuria may develop from the consequent inability of the body to metabolize glucose properly. Overdoses of thyroid cause rapid pulse, headaches and vomiting, together with diarrhoea and pruritis, emaciation and muscular weakness These symptoms are those of hyperthyroidism

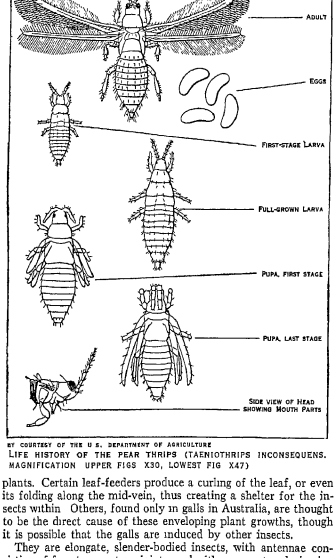
Thyroid gland was originally introduced for the treatment of goitre, myxoedema and cretinism. It has also been used in dwarfism, excessive obesity, psoriasis and scleroderma. (G M Cs.)

THYRSUS, a kind of staff carried by Dionysus (*q v*.) and his votaries (Gr. *θύρσος*). It was a reed, sometimes having a spear point at one end, topped with a pine cone Another form terminated in a bunch of grapes and vine leaves, or ivy berries and leaves. The pine cone or bunch of leaves was sometimes supposed to cover the head of a spear, and the thyrsus was termed *θυρσόλογχος*.

See F. J M. de Waele, *The Magic Staff or Rod* (1927).

THYSANOPTERA, the name of a small order of insects commonly known as *thrips*. Most of the species are not far from $\frac{1}{25}$ in in length, though some of the tropical and Australian giants of the order measure about $\frac{1}{2}$ inch. To the group belong such destructive species as the greenhouse thrips, pear thrips, orange thrips and onion thrips, as well as some which carry virus diseases of tomato, pineapple, bean, sugar cane, etc Though extremely abundant as individuals, possibly outnumbering beetles or flies or ants, they are commonly overlooked, even by entomologists, because of their small size; and not more than 3,000 species have been described Their distribution is world-wide and includes all areas that are sufficiently warm for the development of a summer vegetation. They feed upon the sap of nearly all kinds of seed plants (and also a few ferns), extracting it from

the buds, flowers, leaves or stems by means of their sucking mouth-parts Others take juices from decaying plant remains, fungi, small insects and mites One has been reported to ingest human blood occasionally, and one large group of species takes in the minute spores of various fungi, instead of juices. Some are restricted closely to a single kind of plant, while others occur in approximately equal abundance upon many kinds of unrelated



BY COURTESY OF THE U S. DEPARTMENT OF AGRICULTURE

LIFE HISTORY OF THE PEAR THRIPS (TAENIOTHRIPS INCONSEQUENS. MAGNIFICATION UPPER FIGS X30, LOWEST FIG X47)

plants. Certain leaf-feeders produce a curling of the leaf, or even its folding along the mid-vein, thus creating a shelter for the insects within Others, found only in galls in Australia, are thought to be the direct cause of these enveloping plant growths, though it is possible that the galls are induced by other insects.

They are elongate, slender-bodied insects, with antennae consisting of four to nine true joints, and with asymmetrical piercing mouth-parts. The wings are almost invariably long and strap-like, with greatly reduced venation and long fringes of marginal hairs. The tarsi are two-segmented; the apex of each tarsus contains a minute protrusible bladder which enables them to climb even the smoothest surface The young closely resemble the adults in general form, though generally paler and more brilliantly coloured. Before becoming adult, they pass through a prepupal stage and one or two pupal stages. Wings, commonly present in the adults of both sexes, are invariably lacking in the males of certain species and frequently reduced in both females and males, especially under optimum environmental conditions. Parthenogenesis is frequent in the order, and males are either unknown or very rare in several species. In other species parthenogenesis occurs, although males are common. In a few highly specialized species embryonic development is largely, or even fully, completed within the body of the mother, the young being born alive in the latter event.

The Thysanoptera are divided into two suborders: (1) Terebrantia, in which the female has a saw-like ovipositor and usually a conically-pointed abdomen, the male having the abdomen bluntly rounded, and (2) Tubulifera, in which the female is without an ovipositor, both sexes having the last segment of the abdomen (except in a very few instances) tubular in form. The Terebrantia are the more primitive group, with more veins in the wings and often with the wings relatively broad Most of the species of this group feed upon living plants The female usually inserts the eggs under the epidermis of the plant by means of her ovipositor A number of fossil species are known, particularly from Baltic amber. The Tubulifera, on the other hand, are more specialized the ovipositor has been lost, the antennae have usually fewer segments, the wings are narrow and the veins have been reduced to a single median vestige. Most of the species of this group are found under and on the bark of living or dead trees, on fungi, in turf and under leaves, although a few live on foliage or in flowers, or are predacious. Lacking an ovipositor, those species which lay eggs usually hide them in protected places. This group is almost unknown as fossils.

BIBLIOGRAPHY.—H Priesner, *Die Thysanopteren Europas* (1926–28) is the most useful and most important work, and contains a very complete bibliography. Earlier works of importance include H Uzel's *Monographie der Ordnung Thysanoptera* (1895), and W E Hinds, "Contribution to a Monograph of the Insects of the Order Thysanoptera Inhabiting North America," *Proc., U.S Nat. Museum*, vol xxvi (1902). No recent comprehensive works have appeared, and the extensive literature must be searched for in numerous scientific periodicals. The principal authors are Priesner, H. Karny, R. S. Bagnall and J. D. Hood. (J D Hn)

THYSANURA, the name of an order of primitive wingless insects many of which are known as bristletails They are recognizable by their elongate feelers and tail-processes (*cerci*). *Campodea* (*q.v.*) *Machilis* and *Lepisma*—to which belongs the "silverfish" (*q.v.*)—are the best known genera. (*See* also APTERYGOTA.)

THYSDRUS, an ancient city of North Africa (the site is occupied by the modern village of El Djem, 43 mi. S. of Sousse by rail). It acquired importance owing to the fertility of its environs, and also as the meeting place of six ancient roads. The amphitheatre, 163 by 133 yd., is the finest Roman monument in North Africa, and is second in size only to the Flavian amphitheatre (the Colosseum) in Rome.

THYSSAGETAE, an ancient tribe described by Herodotus (iv, 22, 123) as occupying a district to the northeast of Scythia separated from the Budini by a desert seven days' journey broad.

THYSSEN, AUGUST (1842–1926), German industrialist, was born at Eschweiler on May 17, 1842, and, with his brother Josef, founded a firm in Duisburg for the manufacture of hoop iron, which became exceedingly prosperous during the Franco-Prussian war After the war Thyssen established a factory at Müllheim, and then began the policy of grouping interdependent industries. In 1903 he began the formation of a metal "vertical" trust, which had interests in the iron-fields of Lorraine, in other raw materials of heavy industry, in shipping and in electrical power The power of the group was consolidated in World War I. August Thyssen himself conducted the business personally until 1922. He died on April 15, 1926.

TIARA, the papal crown, a bee-hive shaped, somewhat bulging head-covering, ornamented with three crowns (whence *triregnum* or "triple crown"). It has no sacral character, being solely the ensign of sovereign power (*cf.* Innocent III Serm. vii *in S. Silvest*), and is therefore never worn at liturgical functions, when the pope always wears the mitre. The tiara is first mentioned, under the name of *camelaucum*, in the *Vita* of Pope Constantine (d. 715), and next under the name of *pileus phrygius* or *phrygium*, or the *Constitutum Constantini*, the so-called "Donation of Constantine." In the 9th century it appears in the 9th *Ordo* of Mabillon in connection with the description of the consecration of the pope. On papal coins it first appears on those of Sergius III (d 911) and then on those of Benedict VII (d. 983). At this period it was, according to the *Ordo* above mentioned, a sort of cap of white stuff, and helmet-shaped. Before the 9th century the tiara was certainly without any crown; any such ornament would not have been in keeping with the circumstances of the time and seems also to be excluded by the terms of the *Constitutum Constantini.*

At the beginning of the 13th century, however, the papal tiara was already decorated with a circlet as the 12th *Ordo* and statements made by Bruno of Segni (d. 1123) and Suger, abbot of St. Denys (1122–51), prove; but it is only in representations of the tiara dating from the late 13th century that the circlet appears as a regular spiked crown. The two pendants at the back of the tiara (*caudae, infulae*) are likewise traceable only to this period. The second circlet was added by Boniface VIII, as is proved by three statues executed during his lifetime (one in the Lateran church and two in the crypt of St. Peter's).

The earliest effigy of a pope with a triple-crowned tiara is, therefore, that of Benedict XII (d. 1342), of which the head is preserved in the museum at Avignon, while an effigy of the same pope in the crypt of St. Peter's at Rome has a tiara with only two crowns.

TIARET (*Tahert*), a town of Algeria, in the Tell Atlas, department of Oran, 122 m. S.E. of Mostaganem by rail. Pop. (1948) 22,794. It occupies an important strategic position on a mountain pass at an elevation of 3,552 ft. The Wadi Tiaret flows through the town in a series of cascades. The upper town, the residential quarter, is on the right bank of this stream. The citadel occupies a separate hill on the other side of the wadi. The chief business centre is the lower town, where are also the principal public buildings. On another hill opposite the citadel is the native town. The railway, which extends to Burdeen, forms the outlet of the fertile Sersou plateau, the 1,000,000 ac. of which have been under colonization since 1900.

The citadel occupies the site of a Roman station. Tiaret (Berber for "station") was a town of note at the time of the Arab invasion of North Africa in the 7th century. In 761 it was taken by Abdurrahman ibn Rostem, the founder of the dynasty of the Beni Rustām (Rostem). Their empire, which during the reign of Abdurrahman (761–784) and his son Abdul Wahab (784–823) extended over the greater part of the modern Algeria, was known as the Ibadite empire from Abdallah ibn Ibad, the founder of the heretical sect to which Abdurrahman belonged. The Ibadites represented the moderate section of the Kharijites (*See* ISLAM.) Seven princes of the Rustamite house succeeded Abdul Wahab at Tiaret, but in 909 the dynasty was overthrown by the Fatimites. The Ibadites, after being expelled from the Tell, took refuge in Warqla. They were driven thence in the 11th century and migrated to Mzab, where their descendants still profess the Ibadite doctrines and traditions. After its second capture by the Fatimites, Tiaret ceased to be the capital of a separate state. For a long period it was included in the sultanate of Tlemçen, and in the 16th century fell to the Turks. It was one of the chief towns of Abd el Kader but was occupied by the French in 1843. (*See* ALGERIA.)

TIBER, a river of central Italy (anc. *Tiberis;* Ital. *Tevere*). It traverses the Tuscan Apennines—in which it rises at a point about 12 mi. N. of Pieve San Stefano, 4,160 ft. above sea level, nearly 20 mi. E. from the headwaters of the Arno—in a series of picturesque ravines, flows nearly south by Borgo S. Sepolcro and Città di Castello, then runs between Perugia and Todi to Orte, where it receives the Nera (which brings with it the waters of the Velino; *see* TERNI), skirts the west foot of the Sabine mountains in a broad shallow valley, then crosses the Roman Campagna, cutting its way through Rome, and finally enters the Tyrrhenian (Mediterranean) sea by two arms at Ostia and Fiumicino, the latter artificial. Its principal tributaries are the Paglia, the Nera and the Anio or Teverone, and it is generally navigable by boats up to the confluence of the Nera, a distance of 104 mi.; though, because of the rapidity of the current, there is very little navigation above Rome. The total length of the river is 245 mi., of which 21 mi. lie between Rome and the sea. This latter portion of the river's course is tortuous, but in spite of this, and although the depth varies from only 7 to 20 ft., and in places at low water does not exceed 4 ft., it is nevertheless navigated by vessels up to 180 tons burden. The area of the Tiber basin is 6,719 sq. mi., and it is the largest in Italy except the Po. The stream is heavily charged with sediment, and from that circumstance got its ancient epithet of *flavus* (tawny). The discharge at the mouth is 250 cu.m. per second, but it can fall as low as 90, and in floods rises to 3,400. It has advanced at each mouth about 2 mi. since Roman times, while the effect of the sediment it brings down is seen on the northwest almost as far as Palo (anc. *Alsium*), and on the southeast beyond Torre Paterno (*see* LAVINIUM) in the gradual advance of the coast. The rate of advance at Fiumicino is estimated at 13 ft. per annum. From Rome to the sea the fall is only 6 per 1,000. The arm which reaches the sea at Fiumicino is a canal, dug by Claudius and improved by Trajan (*see* PORTUS).

In the prehistoric period the mouth of the Tiber must have been situated at the point where the hills which follow it on each side cease, about 12 mi. below Rome. On the right bank they are of Pliocene gravel, on the left of tufa; and on the latter, on a cliff above the river (the ancient *Pulta sexa*) stood Ficana (marked by the farmhouse of Dragoncello), which is said to have owed its origin to Ancus Martius. Beyond these hills the low coast belt formed by the solid matter brought down by the river begins; and on each side of the mouth in the flat ground were salt marshes. (*See* OSTIA, PORTUS.)

TIBERIAS, a town of Palestine, on the western shore of the Sea of Galilee, attractively situated on a narrow strip of land between the high ground and the water, 680 ft. below sea level (mod. *Tabariyeh*); pop. (1931) 8,601. The old city lay to the south of the modern. Not much of archaeological interest remains visible, but excavations on the site of the old town are being conducted by the Jewish Exploration fund.

History.—Tiberias was built about A.D. 22 by Herod Antipas, and was so called after the emperor Tiberius. Herod made it his capital and developed its life on Greek lines. The town was built on an ancient site, probably Rakkath (Josh. xix, 35), and in the course of construction a graveyard was disturbed. In consequence the Jews, fearful of uncleanness, refused to live there, and Herod had to resort to compulsion to people his town (Joseph, *Antiq.*, xviii, 2, 3). No mention is made of Tiberias in the gospels, except the casual reference in John vi, 23. The city was of too recent date and too Hellenistic in outlook to invite attention; and it is unlikely that Christ ever visited it. It flung open its gates to Vespasian and his legions to earn consideration and favour. Hadrian sought to implant paganism by erecting a temple, but with no marked success. Toward the close of the 2nd century, the Sanhedrin transferred itself thither from its first Galilean home at Sepphoris. From the rabbinic school at Tiberias came Judah hak-Kādhōsh, the collector and editor of the *Mishnah* (*c.* 220). The Talmud was there edited 200 years later. The Jewish philosopher Maimonides and Rabbi 'Akiba are buried there.

Christianity found in Tiberias no congenial soil, and not until the 4th century could it make headway. In the 5th century there was a bishop of Tiberias, who subscribed to the acts of the Council of Chalcedon. In 637 came the Arabs. When the crusaders established their kingdom of Jerusalem, Tancred was appointed ruler in Galilee; Tiberias became his capital and was in part rebuilt on a new site farther north. In 1187, before the battle of Hattin, it fell into the hands of Saladin. In the 18th century Dhāhir el-Amīr fortified the town; and in their advance on Damascus, British troops seized it in Oct. 1918. (E. Ro.)

TIBERIUS [TIBERIUS CLAUDIUS NERO] (42 B.C.–A.D. 37), Roman emperor, was born on Nov. 16, 42 B.C. His father, who bore the same name, was an officer of Julius Caesar's, who, after a stormy career, returned to Rome when the general amnesty was proclaimed in 39 B.C. Livia, the mother of Tiberius, was also of the Claudian family; her husband ceded her to Octavian in 38 shortly before Drusus, Tiberius' brother, was born. Livia had no children by Augustus, and therefore devoted all her remarkable gifts to the advancement of her sons. Tiberius passed through the list of state offices in the usual princely fashion, beginning with the quaestorship at the age of 18, and attaining the consulate for the first time at 29.

But from 22 to 6 B.C. and again from A.D. 4 to 10 by far the greater part of Tiberius' time was spent in the camp. His first service was as legionary tribune in one of the desperate wars in the Spanish peninsula. In 20 B.C. Augustus sent Tiberius with

an army to seat Tigranes of Armenia on the throne as a Roman vassal This he did without opposition He spent the following year as governor of Transalpine Gaul. In the next year (15) he was despatched to aid his brother Drusus in subjugating the Raeti and Vindelici in the mountains at the source of the Rhine and Danube. Drusus attacked from the eastern side, while Tiberius operated from the upper waters of the Rhine, and the mountaineers were subdued, which ensured the safety of communications between northern Italy and Gaul In 12 B.C. Agrippa, the great general of the emperor Augustus, died at the age of fifty-one, leaving Julia, the emperor's only child, a widow Vipsania, who was the daughter of Agrippa by an earlier marriage, was wife of Tiberius, and had borne him a son Drusus Livia, with great difficulty, prevailed upon Augustus to replace Agrippa by Tiberius, who was compelled to exchange Vipsania for Julia, with bitter grief on his part. During the year of mourning for Agrippa, which delayed his new marriage, Tiberius was occupied with a victorious campaign against the Pannonians, followed by successful expeditions in the three succeeding summers For this he received the triumphal insignia, now first separated from the triumph itself Drusus died in 9 B.C., and Tiberius became the first soldier of the empire.

In the campaign of the year after Drusus's death Tiberius traversed all Germany between the Rhine and the Elbe, and met with slight opposition He was rewarded with the full triumph, the military title of "imperator," and his second consulship In 7 B.C. there was another but insignificant campaign in Germany. Next year Augustus bestowed on his stepson the tribunician authority for five years

Tiberius at this time suddenly begged permission to retire to Rhodes and devote himself to study He seems to have declined absolutely at the time to state his reasons for this course, but he obstinately adhered to it. The departure from Italy was as secret as it could be made. Years afterwards, when Tiberius broke silence about his motives, he declared that he had retired in order to allow the young princes, Gaius and Lucius, sons of Agrippa and Julia, a free course.

At Rhodes Tiberius lived simply, passing his time mainly in the company of Greek professors, with whom he associated on pretty equal terms After five years' absence from Rome, he begged for leave to return; but the boon was angrily refused, and Livia with difficulty got her son made nominally a legate of Augustus, so as in some degree to veil his disgrace. The next two years were spent in solitude and gloom. Then, on the intercession of Gaius, Augustus allowed Tiberius to come back to Rome, but on the express understanding that he was to hold aloof from public functions He had scarcely returned before death removed (A.D. 2) Lucius, the younger of the two princes, and a year and a half later Gaius also died The emperor was thus left with only one male descendant, Agrippa Postumus, youngest son of Julia, and still a boy. Four months after Gaius's death Augustus adopted Agrippa and at the same time Tiberius. The emperor now indicated clearly his expectation that Tiberius would be his principal successor.

In A.D. 5 it became necessary to attack the formidable confederacy built up by Marobodius, with its centre in Bohemia. At the most critical moment, when Pannonia and Dalmatia broke out into insurrection, Marobodius accepted an honourable peace. The four serious campaigns which the war cost displayed Tiberius at his best as a general. When he was about to celebrate his well-won triumphs, the terrible catastrophe to Varus and his legions (A.D 9) produced a profound change in the Roman policy towards Germany. Although Tiberius with his nephew and adopted son Germanicus made in A.D. 9 and 10 two more marches into the interior of Germany, the Rhine was permanently accepted as the frontier. Tiberius was thus robbed in great part of the fruit of his campaigns; but nothing can deprive him of the credit of being a chief founder of the imperial system in the lands of Europe From the beginning of 11, when he celebrated a magnificent triumph, to the time of the emperor's death in 14 Tiberius remained almost entirely in Italy, and held rather the position of joint emperor than that of expectant heir.

Tiberius ascended the throne at the age of fifty-six. What struck every one of his contemporaries most was his absolute impenetrability. Tiberius proved himself capable in every department of the state more by virtue of industry and application than by genius His mind moved so slowly and he was accustomed to deliberate so long that men sometimes made the mistake of deeming him a waverer.

The change of masters had been anticipated by the Roman world with apprehension, but it was smoothly accomplished Livia expected to share the imperial authority with her son At first Tiberius allowed some recognition to the claim; but he soon shook himself free, and later became estranged from his mother and held no communication with her for years before her death. The history of Tiberius's relations with other members of his family is hardly less miserable. Perhaps with any other commander than Germanicus the dangerous mutiny of the troops on the Rhine which broke out soon after Tiberius's accession would have ended in a march of the discontented legions upon the capital The perilous episode of Arminius caused the recall of Germanicus and his despatch to the East on an honourable but comparatively inactive mission. Tiberius seems to have set Piso to watch and thwart him, but there is no authority for the suspicion that he had him poisoned The death of Germanicus was followed four years later by that of the emperor's son Drusus When Drusus died, Tiberius nominated two of the sons of Agrippina, Germanicus' widow, as his heirs. But Seianus, Tiberius's minister, had grown strong by nursing the emperor's suspicions and dislike for the household of Germanicus and the mother and the princes were imprisoned on a charge of crime In his memoirs of his own life Tiberius declared that he killed Seianus because he had discovered that he entertained a mad rage against the sons of Germanicus But the destruction of Seianus did not save Agrippina and her two children. The third son, Gaius Caesar (Caligula), lived to become emperor when Tiberius died in 37.

The care expended by Tiberius on the provinces was unremitting Soldiers, governors and officials of all kinds were kept in wholesome dread of vengeance if they oppressed their inferiors or encouraged irregularity of any kind Strict economy permitted light taxation and enabled the emperor to show generosity in periods of exceptional distress. Public security both in Italy and abroad was maintained by a strong hand, and commerce was stimulated by the improvement of communications Jurisdiction both within and without the capital was on the whole exercised with steadiness and equity, and the laws of the empire were at many points improved

Our ancient authorities are Tacitus, to some extent biased by senatorial traditions; Suetonius, a rather scandalous biographer; and Velleius Paterculus, the nearest in point of time, an officer who had served under him. Dio is probably dependent on Tacitus The chief account of Tiberius in English is that contained in Dean Merivale's *History of the Romans under the Empire* Professor E. S Beesly has written an interesting defence of him in his *Catiline, Clodius and Tiberius* (1878). The best recent history of this period is Hermann Schuller's *Geschichte der römischen Kaiserzeit* (Gotha, 1883) Much historical information is given in the editions of the *Annals* of Tacitus, of which the best in English is that of Furneaux (Oxford, 1884); Freytag, *Tiberius and Tacitus* (Berlin, 1870) (following Stahr, *Tiberius*, Berlin, 1863), exposes the inconsistencies of Tacitus' account. *See* also Hinz, *Zur Ehrenrettung des Kaisers Tiberius* (Strassburg, 1892); Gentile, *L'Imperatore Tiberio secondo la moderna critica storica* (1887); J. C Tarver, *Tiberius the Tyrant* (1902); E. S. Beesly, *Cataline, Clodius and Tiberius* (1907), A. Lang, *Kaiser Tiberius* (Jena, 1911); O Kunte, *Tiberius Caesar and the Roman Constitution* (Seattle, 1924). For the imperial administration of the provinces by Tiberius *see* Mommsen, *History of Rome*, vol. v.

TIBESTI, a mountainous region of the central Sahara, inhabited by the Tibbu people. Tibesti includes the highest summit of the Sahara, the volcanic massif of Kussi, which reaches 3,400 metres. The eruptive rocks have forced their way through a substratum of crystalline rocks covered by enormous thicknesses of horizontal Silurian grits, the scarp of which is quite brusque above the surrounding plains, which are some hundreds of metres above sea-level. Great dry water-courses, deeply cut in all the faces of the massif, indicate a climate formerly more humid. The daily variations of temperature reach 30° at times. The inhab-

itants, at most 10,000, are chiefly nomads, although there are some sedentary elements. Tibesti had been partly explored by Nachtigall in 1870, after when no European went there till 1915, when Col. Tilho wrote a very complete description of it and mapped it. The frontier was fixed by the Franco-English convention of Sept 8, 1919.

See S. Tilho, *Exploration en Afrique centrale* (*La Géographie*, xxi., 1916–17), id. *Carte de Tibesti* (*La Géographie*, xxxvi., 1921), C. Lofler, *La pacification du Tibesti* (*L'Afrique française*, 1916), D. A. Rothea, *Etude sur le Tibesti* (*Bulletin du Comité d'Etudes historiques et scientifiques de l'Afrique occidentale française*, 1922).

TIBET or **THIBET,** a country of Central Asia. It is the highest country in the world, comprising table-lands, averaging about 16,000 ft. above the sea, the valleys being at 12,000 to 17,400 ft., the peaks at 20,000 to 24,600 ft., and the passes at 16,000 to 19,000 feet. It is bounded on the north by Sinkiang, on the northeast by the Chinese province of Chinghai, on the east by the Chinese province of Sikang, on the west by Kashmir and Ladakh, and on the south by India, Nepal and Bhutan. The still indefinite border with Chinghai and Sikang, and the doubtful limits between Tibet and Sinkiang prevent any calculation of the area of Tibet. The population is probably less than 3,000,000.

Origin of Name.—The Tibetans call their country Bod, which word in colloquial pronunciation is aspirated into *Bhod* or *Bhot*, and in the modern Lhasa dialect is curtailed into *Bho*. Hence the country is known to Indians as *Bhōt*, and the inhabitants as *Bhōt-ias*. This territory came to be known to Europeans as "Tibet," evidently because the great plateau, with its uplands bordering the frontiers of China, Mongolia and Kashmir, through which travellers communicated with this country, is called by the natives *To-bhōt* (written *stod-bod*) or "High *Bod*" or "Tibet."

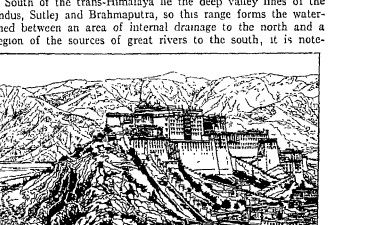
Physical Geography.—Almost all the country from the south of the Takla-makan desert to the Himalaya was formerly included under the name of Tibet in general usage. The Kuenlun mts were, under this scheme, the northern mountains of Tibet; they are in any case the oldest of the great mountain-systems of the Tibetan highland. Their rocks are mostly Lower Palaeozoic and highly metamorphosed, while Mesozoic deposits occur only as land sediments in the valleys of the chain; this part and the region to the north and north-east have thus apparently been land since Triassic times. To the south of the Kuenlun, Mesozoic deposits become more important, and suggest that the broad zone between that chain and the Deccan (part of the ancient Gondwanaland) was then largely under water at times, though during the Upper Jurassic phase land conditions prevailed over wide areas. In the Cretaceous epoch began the great upfolding of the Himalayan region, which probably reached its maximum activity in the Eocene age. Parts of this folding seem to have been directed southward, as is indicated in the Garwhal thrust-plane, but the story is highly complex and there is much penetration of young volcanic rocks, while geysers and hot springs tell the same tale. In the uprise of the younger mountains not only did great fault-lines appear in the south and east of the Tibetan highland, but also the Kuenlun was much broken, and the old Tarim block to the north of it sank. In several parts of its area the Kuenlun attains a height of 7,000 metres, while, in the west, the peak Mustagh (Muztagh or K5) attains 7,282 metres (23,890 ft.), and is, perhaps, the highest point in the chain, though it has been claimed that there are within it heights of nearly 8,000 metres.

Between the western Kuenlun and the Himalaya is the great dissected highland of the Karakorum. The heights attained in the Karakorum are very great, several summits attaining about 8,000 metres, while K2 is 8,610 metres or 28,250 ft. high.

On the general Tibetan highland the oldest formation exposed is the Upper Jurassic, betraying land conditions followed in the next phase by submersion. The highland seems to pass into the mountain-systems of its periphery and to have a general height of 15,000–16,000ft; the highest point known in this region is about 23,600 feet. There are many fault-lines, thrust lines and hot springs. This plateau of inland drainage, characterized by lakes, mostly salt, and hot springs, is called Chang-t'ang.

The southern rim of the general highland just described is the trans-Himalaya or Hedin range of mountains, the average height of which may exceed that of the Himalaya, though the highest peaks (nearly 24,000ft.) are not so great as those of either the Himalaya or the Karakorum. This great series of mountains was very little known until Sven Hedin explored there.

South of the trans-Himalaya lie the deep valley lines of the Indus, Sutlej and Brahmaputra, so this range forms the watershed between an area of internal drainage to the north and a region of the sources of great rivers to the south, it is noteworthy that the three great rivers mentioned make their way through the Himalaya to the south, and many feeders of the Brahmaputra, Ganges and Indus have also penetrated into the Himalaya. Between Bunji, in Gilgit, and the Darel district the bed of the Indus is about 915 metres above sea-level, while the crests on either side of the gorge rise to 6,000 metres, or 20,000 feet. The Brahmaputra way through is as striking, for the river reaches down to the 10,000ft contour only as it begins to work around the base of Nameha Batwa, 25,445ft high.



LHASA, SHOWING THE POTALA, THE EARLY 17TH CENTURY FORTRESS PALACE OF THE DALAI LAMA, AND THE CITY BELOW

The long line of the Upper Indus and Upper Brahmaputra is the most marked feature of southern Tibet, and the Upper Sutlej follows a closely related line between them. Some tributaries of the Brahmaputra join the main river in such a way as to suggest that it once flowed westwards, and that its present course is a result of capture. Near the source of the Sutlej are the two sacred lakes, Manasarowar and Rakas-tal, which communicate by a channel of water after heavy rain.

The snow line is usually, but not quite always, higher on the north than in the south, because of the much heavier precipitation on the south; on this latter side it is said to run near the 5,000 metre (16,400ft.) contour. Near Leh it is at 5,300–5,800 metres, and in the Karakorum at 5,600–5,900 metres. The glaciers formerly reached down to 3,300–3,600 metres in the Spiti region, and to 2,100 metres in the Upper Indus region. It is thus highly probable that during the maximal ice phases the whole of the great highland was glaciated, with no doubt some lines of crest projecting above the ice-sheets. The Pleistocene deposits are enormously thick in many places, an estimate of 3,000ft having been made for this in the upper Sutlej valley.

A remarkable economic feature is the almost universal distribution of gold through Tibet. The gold-digging is referred to in somewhat mythical terms by Herodotus. Every river which rises in Tibet washes down sands impregnated with gold, and it has been proved that this gold is not the product of intervening strata, but must have existed primarily in crystalline rocks of the main axes of upheaval. In western Tibet the gold mines of Jalung have been worked since 1875.

Iron is found in eastern Tibet in the form of pyrites, and is rudely smelted locally. Salt, soda, potash and borax exist in abundance in the western lake regions (Chang-t'ang).

Climate.—Tibet lies so high that its climatic relations are very peculiar. The Himalaya captures most of the rainfall of the summer monsoon, but a little gets through the passes and is captured by the trans-Himalaya, beyond which the climate is

extremely dry and we are in the region of internal drainage.

In July the Tarim basin has average temperatures varying from 68° to as high as 90° F. in different places On the Tibetan highland figures are lower and are correlated with elevation, thus, at an elevation of 3,000 metres the temperature in July in north Tibet is known for one or two stations and is about 59°, for a station at 4,000 metres it is less than 50°, and for the general area of Chang-t'ang, with a height of 5,000 metres, it is probably about 40°, or even less. But the daily variations are extreme

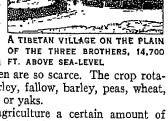
There is more snow in the winter, towards the west, and more rain, in the summer, towards the south-east The total fall of rain and snow over most of Tibet, except the south-east and patches of the trans-Himalaya, is about 8in. per annum.

Vegetation.—The severe conditions of Chang-t'ang limit its plants to some high-steppe grasses in the valleys, with a few bushes here and there up to the 15,000ft. contour. Towards the western Kuenlun, on the one hand, and towards the Chinese border on the other, there is more woodland Prjevalsky, the pioneer collector, and Thsileton-Dyer class the flora as Arctic-Alpine and ancient, with many endemic species. It is chiefly composed of immigrants from the Himalaya and Mongolia The river valleys between the Himalaya and trans-Himalaya, are warmer, and peaches, apricots, apples, plums, grapes, water-melons, and even pomegranates are raised, while trees include plane, poplar, maple, walnut, oak, cypress and a variety of conifers Barley and buckwheat are the chief cereals

Animals.—Herds of yak, wild ass (kiang) musk deer, Tibetan antelope (*Pantholops*), wild sheep (*bharal* of the Himalayas) and wild goats roam the high wastes, while bears, leopards, wolves, foxes, marmots, squirrels, monkeys, cats and dogs also occur. The sloth-bear (*Aeluropus*) and the so-called unicorn-antelope (*Budorcas*) are Indo-Malayan forms that reach up into Tibet. Several water-fowl breed in Tibet, notably the bar-headed goose (*Anser indicus*) and towards the eastern borders there occur several rare and handsome varieties of pheasant.

Population and Economic Life.—The people of Tibet, like its plants, must be considered as post-glacial immigrants, Tibet having apparently been an ice desert during the phases of great extension of the ice-sheets Indeed, it is doubtful whether mankind could spread up into these wastes until long after the last ice-maximum had passed away. This helps to interpret the further fact that the majority of the inhabitants is related in physical type to the peoples of the steppes and deserts farther to the north The Tibetans have high power of resistance to cold and hunger if they can obtain buttered tea, which they drink at frequent intervals. The country can support only a small population, and estimates are mostly below 3,000,000, a large number of these being celibates in monasteries. (*See* LAMAISM.) Polyandry is practised to a certain extent, the brothers in a family, in such a case, having a wife in common.

The herdsmen, tent-dwellers, among them are usually called Drok-pa, and their tents are of yak's hair, with a low wall of dung or stones around the tent-base The tents are moved at intervals, and once a year the herdsmen make their way down-hill to market, mostly at Lhasa. Their food is mainly composed of products of yak's milk. The peasant-cultivator inhabits chiefly the valleys of the south and south-east, and is mostly tied to the soil, partly, no doubt, because men are so scarce. The crop rotation may give the sequence. barley, fallow, barley, peas, wheat, and the plough is drawn by oxen or yaks.



A TIBETAN VILLAGE ON THE PLAIN OF THE THREE BROTHERS, 14,700 FT. ABOVE SEA-LEVEL

In addition to herding and agriculture a certain amount of wool-spinning, weaving and knitting is fairly widely-distributed in Tibet, but the immense importance of religious matters in this country makes the production of images and cult-objects a more important matter.

Tibet is so difficult a country that the steppe-conquerors of various periods have usually avoided it completely, and it has practical autonomy, in spite of varying relations, chiefly diplomatic, with China, and to some extent with Britain, through India, and even at times with Russia Its central position and the longitudinal valleys of the Brahmaputra (Sanpo), the Sutlej and the Indus—the passes from the last across into the Tarim basin—and the communications via the valleys of the two last and other Himalayan streams with Kashmir and India, have made Tibet of importance in the caravan trade across Asia.

Batang (Pa-an) and Changtu (Chamdo) in Sikang province are among the stations on the ways up from China, the former connecting more especially with Szechuan and Yunnan, the latter with Szechuan, Kansu and Mongolia. To the west, in Tibet proper, the valley between the Himalaya and the trans-Himalaya provides the main line of communication, and portions of the Brahmaputra are navigable. Lhasa is the chief station From Lhasa it is possible to go south, via Gyantse, to the passes between high peaks that lead to Sikkim and India Ya-tung in the Chumbi valley, was created a mart for Indo-Tibetan trade by the regulations appended (1893) to the Sikkim-Tibet convention of 1890, but it was not successful, and in 1904 an additional mart was fixed at Gyantse Westward from Lhasa the trade route goes to Shigatse and on past the sacred lakes, Manasarowar and Rakas-tal, reaching the Indus system near Gartok, another mart for Indo-Tibetan trade fixed by the 1904 convention Gartok has ways leading through the Himalaya south to Almora, and a less important one west to Simla; it stands more than 14,000ft. above sea-level. From Gartok the trade route goes on down the Indus to the mart at Leh, the capital of Ladakh, whence there are routes to Kashmir and to the Tarim basin The main route through Tibet here described is known as the Janglam. The high wilderness of the Chang-t'ang is of less importance for transit purposes, but a route from Lhasa goes north via Nag-chu-ka, farther east, to Urga, in Mongolia Camels are left at Nag-chu-ka on the way to Lhasa, and the caravans assemble twice a year at Kuku-nor (lake), reaching Lhasa in August and in January. Mules are much used, as also are yaks. Musk, wool and woollen materials, furs, rhubarb, yak's tails, cult-objects, medicinal herbs, etc., are carried especially to China, and tea, rice, porcelain, horses, cereals, silks are imported thence The trade with India is mainly an exchange of Tibetan wool for manufactured goods. Postal transport may, with good fortune, cover as much as 75m a day, and there is a telegraph line from Lhasa to Gyantse.

Government.—The ruler is the Dalai Lama, who lives in a palace near Lhasa and is nominally supreme both in civil and in religious affairs. He is supposed to be chosen by the heads of the three chief Buddhist monasteries of Lhasa (Ganden, Sera and Drepung) with the help of the State oracle at Lhasa and the oracle at Sam-ye. The second lama of the Tibetan Church is the head of the monastery of Tashi-Lhunpo, near Shigatse, and this Tashi Lama is held by some Tibetans to have a spiritual authority higher than that of the Dalai Lama The renown of Tashi-lhunpo is chiefly a matter of the last three centuries, and at various times it has sought to undermine the power of the Dalai Lama, who keeps agents to watch matters at Shigatse. Until 1912, the amban, or representative of China, had a share in government

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autonomy in outlying areas of a region with such difficulties of communication, but the personal authority and prestige of the Dalai Lama have often been very marked. It arises partly from the fact that the occupiers of this great position have on several occasions proved themselves to be strong-minded men, and partly from the fact that the supreme head is held to be one who has won the right to Nirvana but has consented to rebirth for the sake of his fellow men. As such he is venerated, not only in

Tibet, but, in varying degrees wherever, in Asia, Buddhist ideas have penetrated and maintained themselves

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(H. J. F.)

ETHNOLOGY

1. GENERAL

The Mongolian plateau is the origin of a considerable part of the population, in which other elements have been discovered, including a type with fairly long heads, wavy, even curly hair, as well as lighter skin.

The people may be roughly divided into four main classes, namely, the nobility, the traders, the peasants, and the herdsmen. Many of the nobility reside in Lhasa. They have also their country residences scattered over the country Next in the social scale come the traders. These are usually laymen, though many also among the monks trade on behalf of their monasteries. The traders move about into all parts of the country, spending perhaps a portion of the year in the north to obtain salt from the lakes, in the east, trading in tea with China, and in the south selling wool, yak-tails, hides, etc, in India, and bringing thence cotton goods and the varied utilities of western civilization

There is no strong middle-class in Tibet. The peasant farms generally on a small scale He works in the fields of the local nobleman, monastery or other landlord, as well as tending his own small plot of land The herdsmen seek pastures for their flocks mainly in the uplands, at altitudes of over 14,000ft, and frequently move their camps to new ground Among other members of the social organization are the beggars and the brigands.



BY COURTESY OF THE UNITED CHRISTIAN MISSIONARY SOCIETY

A TIBETAN NOMAD CHIEF CARRYING A CHARM BOX UNDER HIS LEFT ARM

Bodily Traits.—The males are short, often not more than 5ft. 5in. in height, except in eastern Tibet, where 5ft 9in is a general height; the females are appreciably shorter. The head is mesaticephalic, verging on brachycephalic in the case of many of the hereditary herdsmen; the hair is black and somewhat wavy; the eyes are usually of a clear brown, in some cases even hazel; the cheek-bones are high, the nose is thick, sometimes depressed at the root, in other cases prominent, even aquiline, though the nostrils are broad. The teeth are strong but irregular, the ears, with tolerably large lobes, stand out from the head. The mouth is broad, the lips not full, and, among the people of the lower altitudes, decidedly thin The beard is sparse, and is often plucked out with tweezers Moustaches are worn occasionally.

The shoulders are broad, the arms round. The legs are moderately developed in the people of the central and more settled parts of the country But the eastern Tibetans and the Bhutanese branch of the Tibetan race, being all hardy denizens of steep and lofty mountains, have not only well-developed legs but are in general physical build fine specimens of the human race. The foot is somewhat small but broad, the hand coarse The waist is much less pronounced than among many nations, as is quickly recognized by Europeans and Americans who don Tibetan attire The colour of the skin is a light brown, sometimes so light as to show ruddy cheeks in children, though where exposed to the weather it becomes dark brown.

Dwellings.—The landed proprietors live in houses, solidly built around a rectangular courtyard. On three sides of this courtyard are stables and storehouses; on the fourth, opposite the gate, is the mansion itself, one or two storeys higher than the other three sides, and sometimes as much as five storeys in height. The walls are constructed of flat stones bound together with mud In the smaller buildings, and especially in the upper layers, the stones are replaced by sun-dried bricks. The roof is flat, and is formed like the earth floor, but is not polished Windows are plentiful, but glass is rare Its place is taken by waxcloth or other similar material, strong wooden shutters protecting this from rough usage The houses of the peasants are, as a rule, solid and substantial. Here, too, the walls are of stone or sun-dried bricks, though occasionally of clods of earth. Flat roofs of beaten earth are the rule throughout the interior of the country, but in the Chumbi valley and other rainy districts they are laid on a gentle slope Where pine trees grow, the roofs are constructed of pine shingles, kept in position by heavy stones The shepherds and herdsmen dwell in tents of yak-hair These tents are rectangular in shape, often some 12ft. in length, but sometimes up to 50 feet. An aperture, about two feet in width along the middle of the roof, lets out the smoke

Food and Drink.—The staple diet of the ordinary Tibetan is yak's meat, mutton, barley flour, cheese and tea. The rich, and those who dwell in the lower altitudes, also eat fruit and vegetables in small quantities. The climate is so cold that Tibetans are compelled to eat meat, although as Buddhists they should abstain from doing so, and the production of grain, vegetables or fruit at great altitudes is very difficult Rice cannot be grown in the cold uplands, and is thus a luxury for the wealthy only. The chief Tibetan grain food is barley.

The main beverage is tea Brick tea from China is used, and is boiled up in water flavoured with soda. When thoroughly boiled, the mixture is taken out with a ladle and poured through a strainer into a churn. Butter and salt are added and the whole churned until it is well mixed. It looks then like *café au lait* The consumption of this beverage among Tibetans is enormous, for they drink on an average from 30 to 50 cups of tea a day. They eschew tea as known in Europe and America, finding it indigestible and lacking in nutriment The other chief beverage is beer It is brewed from barley, and being but mildly intoxicating, a good deal can be drunk with impunity.

Religion.—Religion occupies a predominant position in the life of the Tibetan people. Their religion is the form of Buddhism (*see* MAHAYANA and LAMAISM), which was introduced into Tibet in the 7th century A.D. under King Song-tsen Gam-po It includes a widespread belief in reincarnation. An incarnation may be born into any family, however humble; for example, the Dalai Lama, the religious and secular ruler of the whole country, has often reincarnated in the family of a peasant. Hermits are found here and there throughout the land in houses or caves in [illegible] which they devote to religion, the Tibetans are one of the most —if not the most—religious people in the world. A huge number, estimated by some at a seventh, by others as high as a

fourth, of the entire male population, enters the priesthood Great monasteries, often housing more than a thousand monks, are scattered over the countryside, as well as hermitages and smaller collections of priests.

The priesthood is divided into two main divisions There is the original establishment known as *Nying-ma*, dating from the 7th century of the Christian era, when Buddhism first made real headway in Tibet And there is the reformed sect, known as *Ge-luk*, which dates from the 14th century of the same era The *Nying-ma* is divided into a number of sects, among whom the *Ka-gyu* have numerous adherents, especially in Bhutan The different sects abstain from open dispute with each other, so that the religion is not torn by sectarian disputes, but presents a united front to the outside world



A TIBETAN WOMAN WEARING NATIVE HEAD-DRESS AND CHARM BOX ON THE THROAT

National Characteristics.—The Tibetans are a cheerful, pleasure-loving people. Their chief forms of recreation include gambling, horse-racing, picnics (held especially in the parks which surround such few large towns as there are) and theatrical entertainments They are particularly fond of the last, which often form part of their religious festivals Another very marked characteristic is their insistence on ceremonial and etiquette The form of address used towards a social superior, equal or inferior, the presentation of ceremonial scarves, and many other details of daily intercourse rest on rules which are observed by high and low.

II. DETAILS OF SOCIAL ORGANIZATION

The Nobles.—The nobility are a class apart The Tibetan nobleman traces his descent to one of three sources. It may be that an ancestor was ennobled for good work done for the country. The founder of the Pa-lha family, for example, was a Bhutanese ex-priest of the 17th century, whose work in the service of the Lhasa Government was rewarded by a place on the supreme council and the gift of an estate near Gyantse containing 130 farms Secondly, the family in which a Dalai Lama or a Tashi Lama takes re-birth, however lowly it may be, is *ipso facto* ennobled and receives large estates from the Government Some of the leading Lhasa nobles are descended from the brothers of previous Dalai Lamas. The third section of the aristocracy is the oldest and smallest of all They trace their ancestry right back to the early monarchs who ruled Tibet before the 10th century of the Christian era The houses of Lha-gyal-ri and Ra-ka-shar both claim unbroken descent from these early rulers, who are known as the "Religious Kings." Thus the heads of these two families are even now greeted by their tenants with the forms of obeisance that are accorded only to Lamas.

The nobility of Tibet are wealthy by comparison with their fellow-subjects For instance, on the Pa-lha estates there are at least 1,400 farms, as well as 13 grazing grounds, each of the latter supporting 15 to 20 families of graziers The tenantry pay rent in service, grain and cash. Out of this the nobleman pays a considerable proportion to the Government, both in cash and in grain He also passes on to the Government some of the service of his peasants, to provide transport animals, etc., for travellers armed with a governmental authorization for the same. In addition to taxes, the nobleman's family is bound to supply one or two members to work as Government officials at nominal salaries.

The laws of inheritance vary in different parts of the country. In central Tibet, when the father dies the sons usually remain in joint possession When there are sons, daughters receive no portion of the land, but are given a small share when they marry. If, however, a nobleman dies leaving a daughter but no son, this daughter inherits the property When she marries she adopts her husband into her family. She does not take his name; he takes hers. She is entitled to the deciding voice in the management of the property. There have been innumerable instances of such adoption among the high families of Lhasa. As a general rule the daughter succeeds in preference to a nephew Throughout the greater part of Tibet there are families of noble stock In the Tsang provinces are eight or nine who stand above the others Eastern Tibet has its chiefs, styled *Gyal-po*, *De-ba*, etc Ladakh has a remnant of the royal line, and Sikkim, till recently part of Tibet, has its ruler descended from an eastern Tibetan chief

The names of the leading Lhasa families are as follows — *Chang-lo-chen*, *Do-rung*, *Hor-kang*, *Lha-ding*, *Lha-lu*, *Nam-se-ling*, *Pa-lha*, *Pin-kang*, *Ra-ka-shar*, *Ram-pa*, *Sam-trup Po-trang*, *Se-chung*, *Sha-tra*, *Sur-kang*, *Tom-pa*, *Trum-pa*, *Yap-shi Sar-pa*, (*i e*, "The New Patrimony"), the name by which the family of an existing Dalai Lama is known. When the latter dies, his family take another name. The family of *Lha-gyal-ri* does not belong to Lhasa

The Traders.—Tibetan society falls almost entirely into two classes, the landed gentry on the one side, and the peasantry and shepherds on the other Such middle-class as there is, however, is provided by the traders The chief articles of export are wool, yak-tails, hides, the soft underwool of the shawl-wool goat, borax, salt, musk and medicinal herbs The chief imports are tea and cotton goods, and, in a smaller degree, woollen goods, hardware, corals, precious stones, tobacco, dried fruits, sugar, molasses and matches. needles, soap, etc (*See* above *Population and Economic Life*) The trading instinct is deeply embedded in the Tibetan character Nobles and monks alike engage in trade, as well as the ordinary class of professional traders The large monasteries trade widely, and are able to do so because each has its administrative department Even the robber tribes issue from their haunts and go to other districts to trade

Women often manage the shops and the general retail trade Especially is this the case in Lhasa; men take charge of the commercial dealings which necessitate long journeys, and in any case in which the issue is a large one the decision as a rule rests with them. The wealthiest traders may be seen together with the poorest, exposing their goods for sale in the market-places

The Peasants.—On plains and in valleys that lie below an elevation of 14,000ft above sea-level there is much land that is fit for the plough But, owing to the steadily decreasing population, largely a result of the overwhelming proportion of celibate monks, the problem of obtaining sufficient man-power to carry on the every-day duties of life is a very real one; and in no department is it more acute than in that of the cultivation of the soil Tibet does not lack land for cultivation, but she lacks the men to till it. This is emphasized by the fact that a peasant is not allowed to quit his home without first obtaining the landlord's permission. If he wishes to go away, he must ask for leave, or, as the Tibetan phrase runs, "petition for man-separation" He must also pay a large sum if the request is allowed, but such permission is usually refused.



A TIBETAN NOBLEMAN
Showing characteristic costume and official ear-ring

There is a great gulf fixed between the peasant and his landlord. The former must use a different vocabulary when addressing the latter and bow low before him. But there is mutual fellowship between the two, and the tenantry usually take a pride in the standing and traditions of the master, whom they surround and serve The larger landed proprietors have, after feudal fashion, large staffs of servants, of whom many are employed during the winter, when the land is icebound, in spinning wool and weaving it into cloth This is utilized in part for the servants' clothes; the balance is sold to traders or to neighbours

Slavery is not common in Tibet, and where it occurs the slaves are often treated better than the paid servants or tenants. They are allowed to move about freely, and, when not at work, they



PHOTOGRAPHS, (1, 3, 6) PIX FROM PUBLIX, (2) COWLING FROM EWING GALLOWAY (4) REV F D LEARNER AND DR GEORGE A FITCH, (5) EWING GALLOWAY

TIBETAN VIEWS

1. Complicated headdress of a Tibetan woman A piece of heavy cloth, studded with gold nuggets, silver, coral, amber and turquoise, is attached to the end of the braids and extends down to the heels
2. Pack caravan resting on one of the perilous trails crossing the Himalayan mountains Sheep are used for pack animals on account of their surefootedness
3. Session of Buddhist lamas in a temple courtyard. Any lama from the ranks is privileged to ask questions of the high lamas pertaining to Buddhist scripture and catechism
4. Lingerh Lamutenzhu at the time he became Dalai Lama, religious and secular ruler of Tibet, in 1939, at the age of five
5. Hokeo, a typical medium-size Tibetan town
6. Tibetan warrior with foxskin hat

have only to attend a roll-call in the morning and in the evening The theatrical troupes that tour Tibet are mainly recruited from the peasants When their tour is finished the actors return to their crops and their cattle

Dress.—The dress of both sexes and of all classes in Tibet may conveniently be described here. It consists of a very full gown with a high collar and long sleeves In the summer this is usually of the ordinary Tibetan cloth among the peasantry, and of silk among the wealthier classes. The winter gown is sometimes of sheepskin, sometimes of cloth lined with lambskin or wadded cotton Tied tightly round the waist with a woollen or cotton band, it is puffed out above, and in the capacious pocket thus formed are carried drinking cups and other odds and ends. For laymen the robe reaches to the knee, for priests and women to the ankle. In central Tibet, and in parts of eastern Tibet, the women wear aprons, woven in varied colours, and often so broad that they nearly meet at the back Shirts are of cotton or silk; trousers differ greatly in shape from the European pattern, and are of silk or cloth. The boot is of cloth, felt or leather, and of various colours. It rises to the knee, with a slit behind the knee, and is tied with gay-coloured woollen garters 3ft. or 4ft. long.



BY COURTESY OF THE UNITED CHRISTIAN MISSIONARY SOCIETY

A TIBETAN WOMAN IN EVERYDAY COSTUME

Men's hats are of various kinds, but are usually fur-trimmed in winter. The women of Tibet, especially those who rank among the upper classes, make no small display of dress and ornaments The chief ornament is the head-dress; those of the upper classes are bedecked with pearls, turquoises and corals on a wooden frame Men, and particularly shepherds and herdsmen, adorn their hair with rings of silver and ivory It is only in a few districts that men wear necklaces Ear-rings are very common, and among the official classes universal. The official ear-ring is of a standard pattern Long and narrow, it hangs from a gold ring with a pearl in the middle attached to the left ear. For the rest it is a string of turquoises, except that an inflexible rule requires the elongated lower end to be not a true turquoise, but an imitation. In the right ear a rough turquoise is worn, and this by all classes, official and unofficial, rich and poor.

Shepherds and Herdsmen.—The shepherd and grazier class are hardy and independent. Those in the uplands (and many shepherds live at high altitudes) descend to lower levels once a year to sell their products and buy barley, wheat, tea, turnips and woollen cloth, such necessities as cannot be obtained away from cultivated regions The shepherd, like the cultivator, is frequently in the employ of, or under contract to, one of the nobility or landed gentry. The Pa-lha household, for instance, owns some 20,000 sheep altogether, which are grazed in scattered grazing grounds within 50m. of Gyantse.

The butter of sheep and goats is consumed by poor people only. The gentry and the richer people generally eat only the butter from the *dri*, or female yak, and the cross-breeds between the yak and the ordinary cattle The women take their share of the work. In addition to the milking and buttermaking, they grind the barley and perform the varied duties round the tents The children help them in this, some going out with the sheep and goats, but not much with the yaks till they are 12 or 13 years old.

The Women.—The position of women in Tibet deserves special mention. Compared with those of other eastern races, they hold, and have always held, a remarkably high status. In olden days when the country was split up into a number of principalities, each ruled by its own chief, the ruler was occasionally a woman Even in modern days, chiefs, ministers and officials of all grades consult their wives in their official work In religious doings, however, the position of women is lower For instance, of the three forms of blessing accorded by the Dalai Lama to different supplicants (touching the head with both his hands, with one hand, and merely with a tassel) the last and lowest form is the one used for all women, excepting only one This solitary exception is Dor-je Pa-mo, the sole female incarnation in Tibet. She is one of the highest of all the incarnations, and is the head of a monastery (not a nunnery) at Sam-ding on the Yam-dro lake.

Tibetan women are physically strong They perform heavy manual tasks. When not tanned by exposure to the elements, they are often fair, and those of the upper classes take great care of their complexions Throughout Tibet it is a general custom for women to smear caoutchouc on their faces Rough pads of felt which have been soaked in a red colouring matter are used. In addition to the head-dress, which has been described above, numerous ornaments are worn, rings, ear-rings, necklaces and girdles The women lay charm boxes on the chest immediately below the throat These usually contain a small image of a deity and a talisman specially written for the wearer by a Lama.

Marriage.—Although the Tibetan woman enjoys a great measure of independence, she usually has little or no share in the choice of her husband. A son is consulted by his father as to the bride proposed for him, but the parents consult a daughter hardly at all The preliminaries attaching to a wedding, and the wedding ceremony, vary somewhat according to the district and the rank of the bride and bridegroom. The horoscopes of the pair must agree, and an auspicious day be fixed for the exchange of presents to take place as well as for the actual ceremony. The ceremony itself is attended by prayers, blessings, the exchange of ceremonial scarves, and feasting. The priests of the unreformed, *i.e.*, Red Hat, sect are permitted to marry. A Lama's wife, however, is not known by the same designation as the wife of a layman, but as "proprietress." Thus is the idea conveyed that the Lama and his belongings are in her charge, so that he is free to devote himself to religion

Monogamy, polygamy and polyandry are all common in Tibet, especially the first Polygamy is practised among those whose wealth suffices to support more than one wife. Polyandry is found among the herdsmen and the farmers Where it holds, the husbands are brothers Having married one of the brothers in a family the wife marries also all the other brothers who are younger, but not any that are older than he

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HISTORY

Legendary.—Prior to the seventh century of the Christian era, Tibetan history is wrapt in myth and legend, helped out from time to time by sidelights from contemporary Chinese history According to native tradition the Tibetan race was descended from a monkey into whose body had entered the Compassionate Spirit, known as *Chen-re-si* in Tibet and *Avalokitesvara* in India This spirit, with a she-devil, produced the first Tibetan offspring.

The early legendary kings of this country commence with Nya-tri Tsen-po, said to have been the fifth son of the Indian King Prasenajit of Kosala He fled north of the Himalaya into Tibet, where he was elected king by the twelve chiefs of the tribes of southern and central Tibet. He took up his residence in the Yar-lung country south of Lhasa. The first king and his six successors are known as the seven celestial *ri*; the next series consists of six kings known as the earthly *leh*; and they are followed by eight terrestrial *de*. This threefold succession is apparently an imitation of the ancient legend of heavenly, earthly and human rulers, which was carried into Persia and China, and from the latter country into Japan and Tibet The kings were followed by four rulers simply called *tsen*, *i.e.*, "mighty."

The king next in order was Lha-to To-ri Nyan-tsen. It was during his reign that the first Buddhist objects are reputed to have reached Tibet, probably from Nepal. They are said to have fallen from heaven into his palace during his eighth eth year. The fourth of his successors was Nam-ri Song-tsen, who died in 630. During his reign the Tibetans obtained their first knowledge of arithmetic and medicine from China; the prosperity and pastoral wealth of

the country were so great that "the king built his palace with cement moistened with the milk of the cow and the yak"

The Early Kings.—With his illustrious son Song-tsen Gam-po the real Tibetan history commences He came to the throne when but thirteen years old, and reigned for many years He pushed forward the Buddhist influence in Tibet, and introduced an alphabet, basing it mainly on the Indian alphabet then used in Kashmir.

As a conqueror he extended his sway from the still unsubdued Kiang tribes of the north to Ladak in the west, and in the south he carried his power through Nepal to the Indian side of the Himalaya. How far southward this dominion at first extended is not known; but in 703 Nepal and the country of the Brahmans rebelled, and the Tibetan king, the third successor of Song-tsen Gam-po, was killed while attempting to restore his power. It is noteworthy that nothing is said of this Tibetan rule in India, except in the Chinese annals, where it is mentioned until the end of the monarchy in the 10th century, as extending over Bengal to the sea—the Bay of Bengal being called the Tibetan Sea.

Mang-song Mang-tsen, the second son and successor of Song-tsen Gam-po, continuing the conquests of his father, subdued the Tatars around the Koko Nor (*Nor* is Mongol for *Lake*) in 663, and attacked the Chinese. After some adverse fortune the latter took their revenge and penetrated as far as Lhasa, where they burnt the royal palace Tsuk-tsen, the grandson of Mang-song and second in succession from him, promoted the spread of Buddhism Tsuk-tsen married a Chinese princess who gave birth in 730 to Ti-song De-tsen, one of the three most illustrious monarchs of his country, partly on account of his conquests and partly because of the strenuous efforts he made in favour of Buddhism during his reign of forty-six years (743–789).

His son and successor Mu-ni Tsen-po tried to force equality of wealth and position upon his subjects After his third experiment, he was poisoned by his mother.

Nothing of importance occurred during the following reigns, until that of Kal-pa-chen, who won glory by his care for the translations of the Buddhist scriptures which he caused to be completed, and rewritten more accurately. In this reign a severe struggle took place with China, peace being concluded in 821. The line of kings ending with Ral-pa-chen is known as the "Religious Kings" (Chò-gyal), because they promoted Buddhism and were believed to be Incarnations of Chen-re-si, the patron deity of Tibet And the greatest of them were Song-tsen Gam-po, Ti-song De-tsen, and Ral-pa-chen

The proselytizing zeal of King Ral-pa-chen was too vigorous for many of his people. When forty-eight years of age (A D. 838) he was assassinated at the instigation of his own brother Lang-dar-ma, who was at the head of the anti-Buddhist party And now, as the chroniclers tell us, "The religious law broke like a rotten rope The peace of Tibet became as a lamp without oil. Evil arose like a storm; the good intentions were forgotten as a dream"

Lang-dar-ma was himself assassinated after a reign of only three years by a priest of the persecuted religion, who gained admittance to the King's presence under the pretext of showing him a new dance. The dance is represented in Tibetan religious plays to this day, in memory of this priestly retribution.

The Kingdom Divided.—Meanwhile, the kingdom was divided into eastern and western between Lang-dar-ma's two sons, the nation was disunited, and its glory among foreign nations waned In 928 no one could be found at the Court of China who could read a Tibetan letter, which had been brought there by four priests.

The second western king, Pal Kor Tsen, left two sons, the latter of whom, Kyi-dé Nyi-ma-gön, went to Nga-ri, of which he made himself master and founded the capital, Pu-rang. He left three sons, of whom the eldest declared himself king of Mang-yül, the second seized Pu-rang, and the youngest Dé-tsuk-gön, became king of the province of Shang-shung.

The revival of Buddhism began with the two sons of the last-named, the elder of whom became a monk. The younger, Kor-ré, inherited his father's throne, and was followed in his authority by twenty successors. Ta-shi Tsek-pa, the elder of Pal Kor Tsen's sons, had three sons, Pal-dé, O-dé and Kyi-dé, each of whom with their descendants, made themselves masters of different districts Thus the process of decentralization spread The kingdom was split up among a number of chieftains (some of them women), who built forts on hills and ridges overlooking their subjects on the plains below And thus came into use the Tibetan saying.—

The fort on the hill,
The fields on the plain

The fort protected the villagers and the villagers fed the fort

Indian Religious Teachers.—Meanwhile, Buddhism was slowly reviving In A D. 1013, the Indian pundit Dharmapala came to Tibet with several of his disciples In 1042, a still greater came, Atisha, who left his monastery, Vikrama Sila, when 59 years of age, and came to Tibet, where he died fourteen years later He founded the Kar-ma-pa sect of Tibetan Buddhism, and wrote a number of works. He translated many other works, relating principally to Tantrik theories and practices Atisha is known in Tibet as "the Precious Lord" (Cho-wo Rim-po-ché).

Mongol and Chinese Influence.—The priests steadily increased their power during the twelfth and thirteenth centuries One of the chief among them was the high priest of the large monastery of Sa-kya, south-west of Shi-ga-tse in central Tibet. The grandson of the great Mongol conqueror, Jenghiz, invited the prelate of Sa-kya, known as the Sa-kya Pandita, to his court (1247). Five years later Kublai Khan, who had conquered the east of Tibet, and ascended the throne of China, invited to his court the Pandita's nephew, Pak-pa Gyal-tsen He remained twelve years with the emperor, and at his request framed for the Mongol language an alphabet imitated from the Tibetan, which, however, did not prove satisfactory, and disappeared after eighty-five years without having been very largely used In return for his services, Kublai invested Pak-pa with sovereign powers over (1) Tibet proper, comprising the thirteen districts of Ü and Tsang, (2) south-eastern Tibet (Kam) and (3) Am-do, a province in north-eastern Tibet From this time the Sa-kya-pa Lamas became the rulers of Tibet, and remained so, at least nominally, under 21 successive Lamas during seventy years (1270–1340)

When the power of Sa-kya began to wane, that of the rival monasteries of Dri-kung, Pak-dup and Tsal increased largely It was at this troubled epoch that Chang-chup Gyal-tsen, better known as Pak-mo-du from the name of his native town, appeared on the scene. He subdued Tibet proper and eastern Tibet, and established a dynasty which furnished twelve rulers in succession, lasting till 1635, when the king of the Tsang province brought it to an end The latter was subdued a few years later by Gushi Khan, the chief of the Eleut Mongols. This dynasty of Pak-mo-du, known also as the Si-tya dynasty, brought prosperity.

Rise of the Yellow Hats.—An admixture of Buddhism and Animism, and the lax priestly discipline that resulted, failed to satisfy the minds of its more ardent followers Reform came from within In A.D. 1358 there was born in Am-do one who was destined to play a large part in the national life of Tibet. He was known as Tsong Ka-pa, "The Man from the Land of Onions" His disciples, known as the Yellow Hats and thus distinguished from the Red Hats of the existing priesthood, were forbidden to marry or drink wine, and a stricter code of morals was instituted He founded the large monasteries at Gan-den and Se-ra, which with Dre-pung are the three strongest religious bodies in Tibet.

Tsong Ka-pa's successor was Gan-den Trup-pa, who founded the great monastery of Tashi-Lhünpo, which in the seventeenth century became the residence of a Grand Lama—known to Europeans and Americans as the Tashi Lama—the second Grand Lama of the Yellow Church

Gan-den Trup-pa died in 1474, but his spirit was believed to have entered the body of a baby boy born two years later. This child became his successor, and thus there came into force the system of priestly incarnation. There are nowadays some seven or eight hundred incarnate Lamas.

The second incarnation, and thus the third in the list, was Sönam Gya-tso, who spread the faith through Mongolia. From a Mongol chieftain he received the title of *Dalai Lama Vajradhara*, "The All-embracing Lama, the Holder of the Thunderbolt." And thus the title, Dalai Lama, came into use, and continues to-day.

THE RULE OF THE DALAI LAMAS

The fifth was Lob-sang Gya-tso, who in his contest with the older Church, received help from the Eleut Mongols to such good effect that he was established in 1641 as the Ruler over the whole of Tibet

The Potala Palace, emblem of sovereignty, had been built by the great king, Song-tsen Gam-po, but destroyed during subsequent wars The fifth Dalai Lama's chief Minister built the great stone palace on a larger scale, which with but few additions, stands to this day It is nine hundred feet in length, and higher than St. Paul's Cathedral in London, but harmonious in line and colour.

The fifth Dalai Lama visited the Emperor of China at Peking. He was received as an independent sovereign, for the Lama's position, backed by Mongol support, and his religious authority among both Mongols and Manchus ensured for him the highest treatment at the hands of the Manchu Emperor and Court.

It was during the early life of this Priest King that the first European entered Tibet. His name was Antonio de Andrada, a native of Portugal He did not reach Lhasa or Shigatse The first Europeans to enter Lhasa were two Jesuit fathers, Grueber, an Austrian and D'Orville, a Belgian, who left Peking in 1661, travelled by the Koko Nor to Lhasa, stayed there a month, and then came to Nepal. In Lhasa they witnessed the rule of the fifth Dalai Lama, whom Grueber styles "the devilish God-the-Father who puts to death such as refuse to adore him" But among Tibetans the fifth is accounted as the greatest of all their Dalai Lamas The present day administration of Tibet dates in large measure from his reign, and stories are told not only of his ability but also of his benevolence.

The Great Fifth, as he is generally known, died in 1680, but Sang-gye Gya-tso was unwilling to desist from his task He concealed the death and ruled in his master's name In due course, however, a successor, who had received the name of Tsang-yang Gya-tso, succeeded to the headship of Tibet.

The new Dalai was entirely unorthodox He wrote light verse too which remains popular to this day among Tibetans

But his own contemporaries did not view Tsang-yang Gya-tso in that light Many Tibetans, Mongols and Chinese doubted whether he could be a real incarnation of the divine spirit of Chen-re-si which dwelt in all true Dalai Lamas The Chinese and Mongols removed him from Lhasa on the understanding that he was to visit Peking and put him to death at Nag-chu-ka, ten days' journey north of Lhasa Dissensions among the people followed, and the Chinese were able to increase their hold over Tibet, always to China a matter of prime importance by reason of the religious authority exercised by the Dalai Lama in Tibet, Mongolia and Manchuria.

During the early years of the eighteenth century the Chinese established a representative known as Amban, and later on two such representatives, in Lhasa These intervened in Tibetan administration. In 1750, the Ambans killed the Tibetan Regent. The people in their turn massacred the Chinese in Lhasa The Emperor Chien-lung dispatched an army, restored Chinese authority, and strengthened the power of the Ambans. But Lhasa is so far from the Chinese frontier that it was an uphill fight

Gurkha Invasion.—In 1788 the Gurkhas, who had recently gained the ascendancy throughout Nepal, occupied some Tibetan districts near the Nepal frontier Three years later they captured Shi-ga-tse. The Chinese Government, now thoroughly aroused, dispatched an army, composed partly of Chinese and partly of Tibetans, under Chinese leadership This army marched through Tibet in the arctic cold of winter, defeated the Gurkhas decisively during the spring of 1792, and dictated terms of peace within a short distance of Katmandu, the Gurkha capital. Suspecting also that the British, who were by then established in India, had helped the Gurkhas, the Chinese closed Tibet as far as possible to foreign influence. It was decreed that all foreign questions should be dealt with by the Ambans, not by the Tibetan Government.

In 1841, a force of 5,000 Dogras, mountaineers from Kashmir, invaded western Tibet, but were defeated by the Tibetans and almost exterminated A battle was fought at 15,000 feet above sea level in the depths of winter, and the great cold contributed largely to the defeat of the Dogras.

Another Gurkha invasion occurred in 1855, and this was more successful The resulting treaty empowered the Gurkhas to establish an Agency in Lhasa and other centres, gave them an annual subsidy of ten thousand rupees, the right of free trade in Tibet, and the right of extra-territoriality In return the Gurkha Government undertook to aid Tibet if the latter were attacked by another nation

EXPLORATION

There is no gradual blending of the climates and physical conditions of India and Tibet, such as would tend to promote intercourse between the inhabitants of these neighbouring regions. On the contrary, there are sharp lines of demarcation, both in the mountain barrier which is scalable at comparatively few points, and also in the social aspects and conditions of life on either side. No great armies have ever crossed Tibet to invade India.

Jesuit and Capuchin Visitors.—It was no easy matter for the early European travellers to explore Tibet. Friar Odoric of Pordenone is supposed to have reached Lhasa *c.* 1328, but this visit is doubtful. The Jesuit Antonio de Andrada, a native of Portugal (1580–1634), travelling from India, appears to have entered Tibet on the west, in the Manasarowar Lake region. In 1661 Grueber and D'Orville, as mentioned before, reached Lhasa. The extracts from Grueber's narrative, given by Athanasius Kircher in his *China illustrata* (Amsterdam, 1667), are accompanied by a good drawing of the Potala. During the first half of the 18th century various Capuchin friars appear to have passed freely between Calcutta and Lhasa (1708), by way of Nepal. They even founded a mission in Lhasa, which, after failing at first, was more firmly established in 1715.

In 1716 two Jesuits, P. Ipolito Desideri, of Pistoia, and P. Freyre, a Portuguese, reached Lhasa by way of Kashmir. The long journey from Kashmir was taken by Lake Manasarowar and the valley of the Tsango-po Desideri remained at Lhasa till April 1721, witnessing the capture of Lhasa successively by Dzungar and Chinese Of the moderation of the latter, and their abstinence from all outrage or plunder, he speaks highly. He left a large MS. volume of his observations. The next European visitor was Samuel Van de Putte, of Flushing, an LL.D. of Leiden, whose thirst for travel carried him through India to Lhasa (1730), where he is said to have resided a long time

In 1745 the Capuchin mission finally collapsed after a revival had been attempted in 1741 by a party under Orazio della Penna The collapse appears to have been due to lack of funds rather than Tibetan opposition. We possess some of the results collected by this mission in an excellent short treatise on Tibet by P. Orazio himself, as well as in the *Alphabetum Tibetanum* of the Augustine monk A Georgi (Rome, 1762). Some fifty volumes, the relics of the mission library, were in 1847 recovered from Lhasa by Brian Hodgson, through the courtesy of the Dalai Lama himself, and were transmitted as an offering to Pope Pius IX

First English Visitation.—The first Englishman to enter Tibet was George Bogle, a writer of the East India Company, in 1774, on an embassy from Warren Hastings to the Tashi Lama. In 1783 Lieut Samuel Turner was despatched on a mission similar to that of Bogle, and reached Shigatse In 1811–1812, an English traveller, Thomas Manning, reached Lhasa. Having resided some years at Canton, Manning went to Calcutta, bent on reaching the interior of China through Tibet, since from the seaboard it was sealed After reaching Lhasa he stayed there about five months, and had several interviews with the Dalai Lama, but was compelled to return to India He never published anything regarding this journey, but some years after his death extracts from his scanty and eccentric private diary were published. These, however, do not yield much information.

The Abbé Huc states that William Moorcroft, an Englishman who made a journey into Tibet in the neighbourhood of Lake Manasarowar in 1812, and another into Kashgar in 1824, lived in Lhasa for twelve years disguised as a Muslim

Exclusion of Europeans.—During the 19th century Europeans were systematically prevented from entering the country, or speedily expelled if found in it. In 1844–1846, however, the

French missionaries, Evariste Régis Huc and Joseph Gabet, made their way to Lhasa from China. They travelled via Sining fu, and arrived in Lhasa on the 29th of January 1846. On the 15th of March they were sent off under escort by the rugged road to Szechuen Huc's book, *Souvenirs d'un voyage*, etc., is a most delightful book of travel. The brothers Henry and Richard Strachey visited Manasarowar Lake in 1846 and 1848 respectively. In 1866 the Abbé Desgodins travelled through portions of eastern Tibet and reached Cham-do (in Kam)

Indian Explorers.—From 1863 onwards a number of Indian explorers were sent by the Government of India into Tibet, for the purpose of surveying the country and collecting information about its inhabitants They carried prayer wheels, but instead of prayers these contained rolls of blank paper on which observations were noted. They carried also Tibetan rosaries by the beads of which each hundred paces were counted The work was dangerous and difficult, but the results were on the whole remarkably accurate The best known of these men were Pandit Nain Singh, Pandit Krishna, originally known as A.-K (from the first and last letters of his name transposed) and U-gyen Gya-tso, or U.-G Nain Singh reached Lhasa in the course of two remarkable journeys. In the first, after an ineffectual attempt by Nepal, he travelled by the Manasarowar Lake, and the road thence eastward, parallel to the course of the Tsangpo, reaching Lhasa on the 10th of January 1866, and leaving it on the 21st of April 1867. On the second journey (1874) he started from Ladak, crossing the vast and elevated plateau by the Tengri Nor and other great lakes, and again reaching Lhasa on the 18th of November.

In 1878 A.-K also visited Lhasa, stayed a year, and afterwards continued into Tsaidam, not returning to India till 1882. U-gyen Gya-tso, a Tibetan of Sikkim, who was originally a teacher of Tibetan in a Darjeeling School, secured permission in 1879 from the Tashi-lhunpo authorities for Sarat Chandra Das, Bengali schoolmaster at Darjeeling, to visit that monastery, where his name was entered as a student. This was the opportunity for a series of valuable exploratory journeys through the Tibetan provinces adjoining the Indian and Nepalese frontiers. Sarat also brought back from his journeys a large number of interesting books in Tibetan and Sanskrit, some of which were edited and published by him, with the assistance of U-gyen Gya-tso and other Tibetans But these explorations, and particularly those of Sarat, when discovered by the Tibetans, incensed them still further, and deepened their distrust of the strong Power that came nearer and nearer and now explored their country in secret

The Russian explorer Prjevalsky, although he did not penetrate far into Tibet, did much towards determining the conformation of its north-eastern and eastern mountain systems His fourth journey, between November 1883 and October 1885, covered part of northern Tibet, and established the true character of Tsaidam.

Recent Exploration.—Between 1889 and 1892, W. W. Rockhill, an American possessing great qualifications for Tibetan exploration by reason of a fair knowledge of the language and history of the country, coupled with the instincts and training of a scientific explorer, made two journeys through the north-eastern and eastern districts of Tibet. His record of these has added to the world's knowledge both of the country and its people.

In 1889 Prince Henri d'Orleans and M. Bonvalot; in 1891 two Englishmen, Capt. Bower and Dr. Thorold; the following year Miss Taylor, a solitary Englishwoman who came to within 150 miles of Lhasa, and in 1893, two other Frenchmen, MM Dutreuil de Rhins and Fernand Grenard, all entered Tibet. They were followed by Mr. and Mrs. Littledale, accompanied by Mr. Fletcher, in 1895; by Capt Deasy a year later, by Capt Welby and Lieut. Malcolm in the same year, and by Rijnhart, a Dutch missionary, in 1898 and by Sir Aurel Stein. These all explored different tracts in the great unexplored regions, and many brought back knowledge of the flora and fauna All, or nearly all, endeavoured to reach Lhasa, but none succeeded, so thorough were the precautions taken by the Tibetans to guard against such an event The Littledales came the nearest, being stopped 80 miles north of the Forbidden City. De Rhins and Rijnhart lost their lives, being murdered, as is believed, by the people of the country

Dr. Sven Hedin, a Swede, has made three important journeys in Tibet and has traversed the country, north, south and west, surveying a great deal of unexplored country. His attempt to reach Lhasa, as that of all Europeans during these days of Tibetan hostility, was frustrated by Tibetan watchfulness But his careful and detailed maps and lake soundings, and his scientific observations, hydrographic, geological and meteorological, have placed him in the forefront of modern explorers. (X.)

MODERN HISTORY

In 1774 and 1783 Warren Hastings, the far-sighted Governor-General of India, had established transient connection with the Tashi Lama From 1892 onwards the Government of India made attempts to open up relations with the central Tibetan Government. But the latter declined, for they feared and distrusted the Power whose strength and influence were steadily extending in the territories on their southern frontier A treaty made in 1890 between India and China was repudiated by the Tibetans.

In 1903, as a result of continued disputes, and in particular from the fear of Russian penetration, the Indian Government despatched a mission with an armed escort to Tibet The Tibetans, however, refused to negotiate, and the Chinese were powerless In 1904 the mission advanced further into the country. It was opposed, and fresh troops were sent, so that it became a military expedition It withstood the rigours of the climate, dispersed without much difficulty the Tibetan levies, who were untrained and poorly armed, and succeeded in reaching Lhasa. Lt.-Col (now Sir Francis) Younghusband, the political representative with this force, effected a treaty there in September 1904 with the Tibetan delegates, the Dalai Lama and his entourage having fled to Mongolia After modification by a Convention with China in 1906, the main terms of the Lhasa treaty were.—

(a) The opening of two fresh marts to foreign trade, one at Gyantse between India and Lhasa, and one at Gartok in western Tibet.

(b) The abolition of trade dues between Tibet and India.

(c) Tibetan territory not to be ceded, leased, etc., to any Foreign Power.

(d) An indemnity of two-and-a-half million rupees (£166,000).

Chinese Suzerainty.—The Anglo-Russian Convention of 1907 recognized Chinese suzerainty over Tibet, and stipulated that neither Russia nor Britain should interfere in the internal administration of Tibet, seek concessions there, take any part of the revenue, or depute representatives to Lhasa. But, as a result of the Russian Revolution, this Convention is believed to be no longer in force

The Chinese Government were alarmed by the British Expedition to Lhasa in 1904, fearing a repetition and the establishment of British power there. The Peking Convention of 1906 and the Anglo-Russian of 1907 placed them in a strong position. Tibet was enfeebled by the British attack, and perhaps somewhat mazed by the crowd of events. So China organized a military Expedition of her own, which eventually, in February 1910, reached Lhasa.

The Dalai Lama and his Government fled again, this time to Darjeeling in India. Here the British Government treated them hospitably, and being on Indian soil, they were safe from personal attacks by the Chinese, who contented themselves with consolidating their position in Tibet While observing strict neutrality as regards Tibet, Britain took occasion to inform China that she would tolerate no interference with the Himalayan States, Nepal, Sikkim and Bhutan.

Recent Developments.—Tibet's deliverance, however, was near at hand In 1911 the Chinese Revolution broke out, disorder among the Chinese troops ensued, and the Tibetans were able to drive them out of Lhasa, and to recapture most of their country. The Dalai Lama and his Ministers returned to Lhasa. They were now hostile to China, and friendly to Britain In 1917 the Chinese attacked again, but were defeated, and the Tibetans pushed them back more or less to the positions which had been held since 1720

During 1912 Russia, by a treaty with Mongolia, gained further influence in that country. The following year a conference was

held in India by Britain, China and Tibet to discuss the political status of Tibet, but achieved no decisive result.

Then followed the World War. The Tibetan Government offered a thousand soldiers to fight on the British side, a striking change from their former attitude of hostility.

In 1920 Mr (afterwards Sir Charles) Bell, the British representative in Tibet, was deputed to Lhasa at the request of the Tibetan Government, the first white man to be invited to Lhasa. As a result of his visit the growing friendliness between the two nations was still further strengthened. In 1922 the Forbidden City of Lhasa was linked with India by telegraph. The Dalai Lama died Dec. 1933 and his successor was enthroned on Feb. 22, 1940, with Chinese support, since Chinese-Tibetan relations have been improving. The temporal Tashilhama died in 1937.

Mount Everest.—Permission was obtained for the Royal Geographical Society of England to despatch a climbing expedition to Mount Everest through Tibetan territory. Three such expeditions followed, in 1921, 1922 and 1924 respectively. The last attained to within 800 feet of the summit. Mallory and Irvine, two of the climbers, lost their lives in the last attempt. Since 1912, Tibet has been politically independent of China.

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TIBETAN ART. Tibetan art is to a large extent a continuation of the mediaeval Buddhist art of Behar and Orissa, the dominions of the Pala kings, which were the strongholds of Indian Buddhism during the 11th and 12th centuries. The conservatism which is so marked a feature of Tibetan art is due to the peculiar character of that rude and uncultivated country, which Buddhism reached, late and in a very decadent form, in the 7th century A.D. The barbarians beyond the mountains were all the more willing to receive the pious images, so accurately representative of the religious spirit, which the missionaries brought from India, because they had no local artistic tradition to set up against them. All that they could do was to have copies made of the original models, which were deeply venerated, and then in turn to copy them for themselves. Of all the copies thus made, the most servile were the reproductions of paintings. This was due to purely technical reasons; the copies were executed by anonymous artisans by means of transfers. It is thus extremely difficult for the historian of art to decide the date of paintings of this kind. The bronzes are less puzzling, since many of them are cast by the method *à cire perdue*, and consequently have more originality and indeed individuality. Architecture, although to a large extent determined by the climate and the nature of the soil, shows Indian and Chinese influences. Though situated between these two countries of ancient and highly developed civilisation, and subjected to their influence, Tibet, as the great refuge of Indian Buddhism, enjoyed so great a religious prestige that it exported certain aspects of its religious art to the China of the Ming and Tsing emperors.

Temple Banners (thang-Ka).—These paintings are for the most part reproduced by means of transfers, a method used in embroidery. The transfers are applied on a piece of cotton, canvas, or more rarely silk, which has first been treated with a coating made of a mixture of glue and chalk-dust, completely smoothed by rubbing with the polished part of a sea shell. Thin silks which will not take a coating of this kind are given to experienced craftsmen who copy direct from the model without using a transfer.

Attempt at Chronological Classification.—It will be seen from the description of technical processes given above that it is an extremely difficult matter to date a Tibetan painting, unless the subject of the picture gives some chronological indication. The main interest of a study of Tibetan paintings thus resides in a just appreciation of the antiquity of the subject represented rather than of that of the painting. One of the most ancient subjects is that treated by the somewhat rare paintings which represent the Bodhisat Siddharta, the future Buddha Śâkya-muni, in the form of a young man. This is probably a pictorial representation of the celebrated statue which Sarat Chandra Das saw in the principal temple of Lhasa, this statue will be dealt with later in the section dealing with sculpture. There are certain pictures representing the life of the Buddha Śâkya-muni, some of the many reproductions of which are to be seen in various European museums, which are derived from Indian originals of the 9th and 10th centuries. Some of the pictures representing the birth of the Bodhisat are strongly reminiscent of Indian models. The compositions based on ancient originals deal only with the principal episodes in the life of the Buddha. Taking their inspiration from these models, Tibetan artists of about the middle of the 18th century composed an abundantly illustrated life based on a biography dating from 1734. In these more modern pictures, however, the scenes, of which there is an infinite variety, are all represented round a central figure of the Buddha. In short, Tibetan illustrations of the life of the Buddha may be traced to two sources, the first very ancient (9th to 10th centuries), the second composed entirely by a Tibetan lama of the 18th century. The paintings of the second series show elements derived from Chinese landscape painters in the representations of scenery; rocks are rendered by the superposition of uniform coats of blue and green, separated by gold lines. Other compositions unmistakably go back to Indian originals. Among these are the representations of the 84 great sorcerers, whose cult had been spread by means of Lamaism beyond the borders of Tibet itself. The method of representing the eighty-four sorcerers was already fixed in the 13th century, for M. P. Pelliot has discovered pictures representing them in a cave of Tuen-Huang (province of Kan-su in Western China) which was decorated during the Mongol period. The Tibetan representations of these great magicians (Musée Guimet) are clearly derived from the great Indian tradition.

The representations of the Bodhisats are directly reminiscent of the artistic traditions which were prevalent in Orissa in the time of the Pala kings, who were the last champions and patrons of Indian Buddhism. A Tibetan painting discovered at Tuen-Huang by Sir Aurel Stein, which is probably the most ancient extant Tibetan picture (*c.* 10th century) represents Avalokiteśvara, whose mission it is to liberate humanity from the Eight Great Perils. This painting, which is now in the British Museum, shows a definite affinity with an Avalokiteśvara in the Fine Arts Museum of Boston which A. K. Coomaraswamy believes to be an Indian work of the Pala or Sena period (12th century). So great is the conservatism of Tibetan artists that very little difference can be observed between the 10th century painting discovered by Sir Aurel Stein and a similar composition of modern date which was brought from Tibet by Jacques Bacot and is now in the Musée Guimet. (*See* INDIAN AND SINHALESE ART AND ARCHAEOLOGY.)

The influence of the Indian tradition—it is possible to go further and say of the Ajantâ tradition—is particularly marked in a painting in the Musée Guimet representing the Bodhisats Avalokiteśvara and Kshitigarbha seated in an attitude of royal ease.

Tibetan artists never introduced any innovations in the representation of the fierce, terrible and threatening deities which derive from Śiva (*Mahâkâla*). Divinities of this kind are not to be found in the most ancient compositions which depict episodes from the life of the Buddha Śâkya-muni; the most that appears from time to time is a genius (*yaksha*) subduing heretics. All other paintings, whether their subjects are Bodhisats or saints, include representations of fierce deities, often accompanied by their female counterparts. Pictures of this kind already existed in India, but the Tibetans greatly developed the cult of these deities of Saivite origin. The Manchu Emperors who ruled over China in the 18th century appear to have had a special taste for pictures of this kind, and Tibetan Buddhic art had great vogue at Peking at the end of that century. Paintings ordered by the Emperor Chien-lung and executed at Peking under direction of the Grand Lama of Peking are extant. One of them represents the fierce goddess Śridevî (*Lha-mo*); it is carried out in the purest Tibetan style

except that there are certain details of execution which are clearly Chinese, especially in the treatment of the mule on which the goddess is mounted and the emblems with which the frame of the picture is adorned This is a good example of Lamaist painting dated 1777, which, though executed in China, shows, with the exception of certain details, all the characteristics of Lamaist works of art. An inscription in four languages, Chinese, Mongol, Manchu and Tibetan, says: "In the forty-second year of Chien-lung, an Imperial decree was issued ordering the lchang-skya-hu-tog-thu (Grand Lama of Peking) to draw holy images, following the text of the sacred books, in order to do homage to the auspicious goddess Śrîmatî (Śrîdevî) . . " A considerable number of religious pictures were executed during the reign of the Emperor Chien-lung by Tibetan lamas at Pekin, and special mention should be made of the paintings showing definite Tibetan characteristics which represent the divinities of Confucianism and Taoism

To return to the normal work of Tibetan artists, it is necessary to mention a number of paintings representing the saints of Indian Buddhism and Lamaism The clearly marked Indian influence visible in the pictures of the group of the great sorcerers has already been mentioned; the same influence, becoming gradually attenuated, may be seen in the series of pictures showing the life of some great saint, such as the famous Atiśa, who died in A.D. 1058 (Pl. II, fig 1.), or the lchang-skya Rol-pa'i rdo-ye (Lahtavasjra) (1736–95), the same who had the picture of the goddess Śrîdevî painted at the order of the Emperor Chien-lung The latter is not an ancient composition; both the subject and the painting itself are modern, and show the characteristic Tibetan architecture of the monasteries of Dgah-ldan and Bra-śis lhun-po (Tachilhunpo), placed on rocks treated in a way which shows Chinese influence (*see* at the top and in the middle the monastery of Brag-dkar [White Stone]) The saint, who is seated in the European fashion in the middle of the picture on the right, carries the book and sword, the attributes of his patron the celebrated reformer Tsong Kha-pa (A.D. 1355–1417) These attributes are also those of Manjuśri, the Bodhisat of transcendental wisdom, who inspired Tsong Kha-pa It is for this reason that a magic representation of Manjuśri appears in the centre of the painting under the aspect of the fierce Yamântaka with the head of a bull Maitreya, the future Buddha, is shown in a medallion placed in the upper part of the picture on the left. The same himself appears, after his death (at the top of the picture on the right) in the trifoliate niche of a *stupâ*; he is being mourned by his disciples, and divinities are rising from the clouds to receive him. The painting showing the learned Atiśa (11th century) is less elaborate, and is clearly derived from a more ancient original

Tibetan artists sometimes use a technique similar to that of wax painting; some remarkable examples of this method are to be seen in R Pfister's collection It is a highly successful attempt to find relief from the monotony of the flat tones of tempera painting; the faces stand out remarkably clearly, and the floral decorations show great originality in the choice of colours. The painting is unfortunately damaged by the imprints of the hands and feet of the Grand Lama of Bra-śis lhun-po (Tachilhunpo) The painting represented in Plate II, fig 3, shows the fifth Dalai-Lama Ngag-dbang Blo-bzang-rgya-mcho (1617–80); special note should be taken of the delicacy of the floral decoration

The Tibetans also have a special fondness for paintings representing particularly venerated places. One of these pictures shows, in a sort of rough perspective, the principal religious edifices of Lhasa; in the centre the Potala, in the lower part the great temple (Jo Khang), in the upper part the monasteries of Sera and Depong, which are two miles away from Lhasa, and a number of small shrines treated in the minutest detail.

Bon-po Paintings.—Before leaving the subject of Tibetan painting, it is fitting to mention the paintings which appear in the temples of the Bon-po, the followers of the pre-Buddhic religion of Tibet The rare specimens of Bon-po painting which we have had an opportunity of studying are, as far as the legends represented are concerned, nothing more than imitations of Lamaist paintings. The trained eye can, however, clearly distinguish between Bon-po and Buddhist paintings Bon-po paintings scarcely ever contain a large-scale figure of the hero of the legend the episodes of which are represented by the picture Thus the paintings illustrating the legend of the Bon-po prophet Gśen-rab-mi-bo (Ollone collection) consist only of a series of miniature scenes

Buddhic Sculpture.—According to legend, the most ancient Buddhic sculpture which was imported into Tibet came from Magadhâ, but it is said to have reached Tibet through China, having been brought by the princess of Wen-tcheng, who was related to the Emperor Tang Tai-tsong and married the 1st Buddhist king of Tibet, Srong bcan sgam-po (7th century A.D.). This statue still exists in the Jo-Khang of Lhasa, and forms, together with another statue of the monastery of Kum-bum and the famous image of the Santal temple at Peking, one of a triad celebrated in the Buddhist world The Lhasa statue is probably of the same type as that which is preserved in the temple of Seryo in Japan A distinguishing feature of this work of art is the characteristic drapery with its close folds A statuette in the Musée Guimet, though a comparatively modern work (18th century) (Pl I, fig 6) recalls these ancient originals Most of the Tibetan statues to be seen in Europe are modern, but it is possible to trace back their origin, through a number of modifications, to Indian sculptures executed at the time of the Pala kings of Bengal (11th to 12th centuries A.D.). The traces of Chinese influence which may here and there be noted are to be attributed to the Tang or even the Sung period. These statuettes, most of which are cast by the process known as *à cire perdue*, represent only a portion of the whole production of the skilled Tibetan metal-workers There are also a number of bronze statues 10 or 12 metres high representing the Bodhisat Avalokiteśvara with 11 heads Occasional examples are found which have no counterpart in the Buddhic world, such as the Bodhisat who is shown making a mystic gesture which is nowhere else represented (Pl I, fig 8) Of three representations of the same divinity, one may show Chinese and one Indian influence, while the third is purely Tibetan. This applies to three representations of Manjuśri which are preserved in the Musée Guimet, the first figure, which is brandishing a sword, is in the classical Indian style, the second, which is loaded with ornaments and is heavy of aspect, is Tibetan, while the third is a young Chinese prince, carelessly seated in an attitude of royal ease, his hand resting on a book. The statuettes of saints are in some cases actual portraits (Pl I, fig 3)

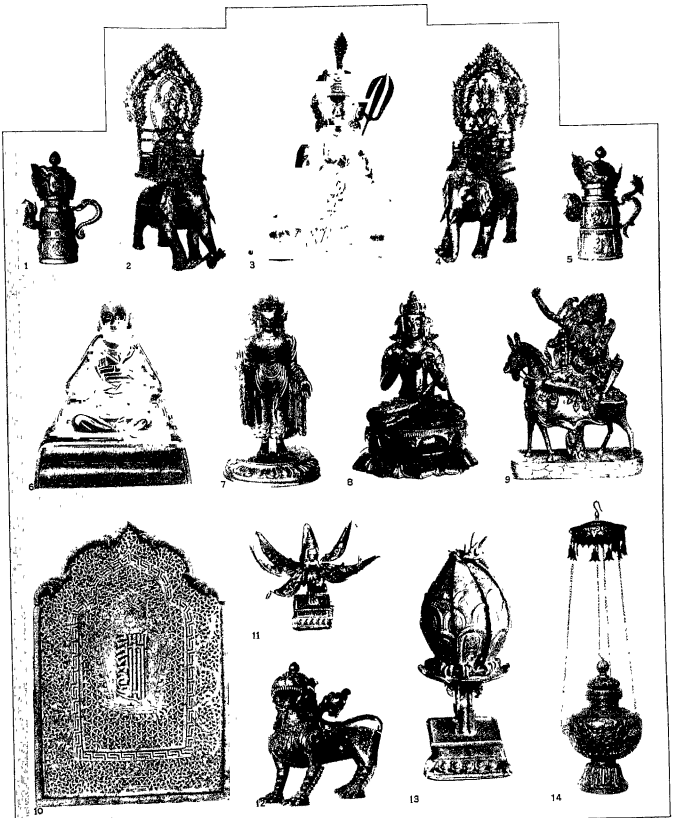
Wood-carving.—The finest examples of Tibetan craftsmanship are the bronzes and brasses, but there are also some fine statues carved in wood. The wood-carvers, however, excel most of all in the execution of low reliefs adorning the rectangular pieces of wood which are used to cover the sacred books. These reliefs show extraordinary technical skill

Bon-po Sculptures.—Very few Bon-po sculptures have as yet been studied They are very bad specimens, and are influenced by late Chinese statuary.

Iron Work; Gold- and Silversmiths' Work.—Some of the Tibetan metal workers are magnificent artists. Some of the designs of iron work are as delicate as lace; dragons, volutes and geometrical patterns are mingled in detailed and balanced designs ornamenting saddles, pen-cases, quivers and clasps for reliquaries (central motif: daśkâro vaśi). Some of the reliquaries are carried out in beautiful repoussé work in silver and sometimes, also in gold. Beautiful brass vases and censers are also executed in repoussé work. The designs on these vases are sometimes Indian and sometimes Chinese in character. Damascene work is very much used for the decoration of pen-cases. Tibetan jewellery, heavily set with turquoises, includes earrings, necklaces and bracelets (*See* Silversmiths' and Goldsmiths' Work)

Architecture.—The available information concerning Tibetan architecture is very incomplete No complete studies of monasteries with plans have been made except in the case of Kum-bum. *Stûpas* of the Tibetan type have a characteristic form of their own, the base is raised to such a height that it sometimes shelters a little shrine, the bulb-shaped dome is sometimes very small, and the discs of the parasols, which are very close together, form a cone surmounted by the crescent and the disc The base and the disc are of masonry, and the upper part of gilded copper. The

TIBETAN ART



BY COURTESY OF (1-5, 12) MRS ALEXANDER SCOTT, (6 10, 14) THE CONSERVATOR OF THE MUSÉE GUIMET, (11, 13) BUMMER GERARD

EXAMPLES OF TIBETAN ART

1 Religious vessel of gold, silver and copper used only by holy Lamas 2 Samantabhadra Bodhisattva, Genius of Goodness, on his vehicle, the elephant Made of bronze and gilded. 3 Statuette of Padma Sambhava, the Buddhist pandit who came to Tibet from India in the 8th century, and translated parts of the Buddhist scriptures into the Tibetan language 4 Another view of Samantabhadra Bodhisattva on his elephant 5. A religious vessel of gold, silver and copper inlaid with turquoise and showing Chinese influence. 6 Figure of the Lama Jigs-med-rgya-mcho 7. Figure of Bodhisattva wearing a diadem of five Dhyani-Buddhas. 8 The Bodhisattva Siddhārtha (Gotama Buddha), founder of Buddhism, in characteristic teaching attitude. 9 Figure of Lha mo. 10. Delicately carved religuary gateway Tibetan design 11. The Bronhyd Lotus, the perfect eight-leaved lotus flower with silver urn in centre. The lotus represents the heart of beings and the urn holds the source of organic life 12. Bronze statuette of Nepalese lion (inscribed under neck). 13 The lotus shows Fig 11., with all petals closed. 14. A Buddhist incense burner with pierced cover

TIBETAN ART

BY COURTESY OF (1, 2) O. BIANCHEDI, (3) M. E. PFISTER

TIBETAN PAINTINGS

1. Painting of the learned Atisa. Figure of naked heruka near the halo, together with the figures of a monk-scholar and of a layman-scholar, are surrounded by miniature scenes of the principal events of his life. At the top of picture (to the right of the aureole) he is seen setting as mediator between two armies about to fight
2. Representation of Lchang-skya Rol-pa'i rdo-rje. Chinese influences shown by architecture of the monastery and by costumes of the monks. The saint carries a book and sword, attributes of his patron, the celebrated reformer, Tsong Kha-Pa
3. Painting of the fifth Dalai Lama Ngag-dbang Blo-bzang-rgya-mcho. He carries the thunderbolt and bell of the Buddha Vajradhara. Disciples and seven jewels are picturesquely grouped at bottom of picture

temples (*cf* plan of Jo Khang in Waddell's *Lhasa and its Mysteries*) are frequently built on a rectangular ground plan with a sort of ambulatory between the outside wall and the chapels opening on the main temple. The main temple altar is at the end opposite to the entrance, and the principal temple is roofed with Chinese pavilions. The monotony of the massive structure of the palaces and castles is relieved by plaster-work of violent colours such as deep vermilion, large tapestries representing religious subjects are hung out on solemn occasions. (*See* also INDIAN ARCHITECTURE.)

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TIBETAN LANGUAGE. The language of Tibet is known as "the speech of Bod or Tibet" namely *Bod-skad* (pronounced Bho-ka), while the vernacular is called *Phal-skad* or "vulgar speech," in contradistinction to the *rje-sa* or "polite respectful speech" of the educated classes, and the *ch'os-skad* or "book-language," the literary style in which the scriptures and other classical works are written.

It comprises several dialects classed into three groups: (1) the central or the dialects of Lhasa and the central provinces of Ü and Tsang (including Spiti) which is the *lingua franca* of the whole country, (2) the western dialects of Ladak, Lahul, Baltistan and Purig, and (3) the eastern dialects of the province of Khams. Many sub-dialects of Tibetan are spoken in the frontier Himalayan districts and states outside Tibet. The Takpa of Tawang in the eastern Assam Himalayas appears to form a transition between the central and the Sifan group of dialects on the Chinese frontier, which includes the Minyak, Sungpan, Lifan and Tochu dialects. On the north bordering on Turkestan the dialect of the nomadic Hor-pa tribes is much mixed with Turkic ingredients.

Tibetan is allied to the Burmese languages, and forms with the latter the "Tibeto-Burman" family.

Writing.—Notched sticks (*shing-chram*) and knotted cords were in current use. On the eastern frontier the medicine-men or *tombo* of the Moso have a peculiar pictoral writing, which is known in Europe from J. Bacot's work, *Les Mo-So* (Leyden, 1913). It undoubtedly contains survivals of a former extensive system superseded by the alphabetic writing introduced from India. The close resemblance of the Tibetan characters "with heads" to the Gupta inscriptions of Allahabad shows them to have been derived from the monumental writing of the period; and the other Tibetan letters came from the same Indian character in the style in which it was used in common life. The Tibetan half-cursive was further developed into the more current "headless" (*u-med*) characters, of which there are several styles. The ancient manuscripts discovered by Sir Aurel Stein in Khotan include very early Tibetan documents.

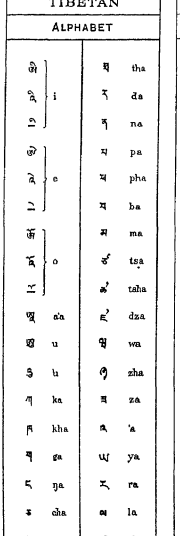
The language was first reduced to writing with the assistance of Indian Buddhist monks in the middle of the 7th century A.D. by Thonmi, a Tibetan layman. The letters, which are a form of the Indian Sanskrit characters of that period, follow the same arrangement as their Sanskritic prototype. The consonants, 30 in number, which are deemed to possess an inherent sound *a*, are the following: *ka, k'a, ga, nga, ca, ča, ja, nya, ta, t'a, da, na, pa, p'a, ba, ma, tsa, ts'a, dza, wa, z'a, za, 'ha, ya, ra, la, s'a, sa, ha, a*; the so-called Sanskrit cerebrals are represented by the letters *ta, t'a, da, na, s'a*, turned the other way. *Ya*, when combined as a second consonant with *k-, p-, m-*, is written under the first letter. *Ra*, when combined as second letter with *k-, t-, p-*, is written under the first, and when combined with another consonant as first letter over the second. The vowels are *a, i, u, e, o*, which are not distinguished as long or short in writing, except in loan words transcribed from the Sanskrit, etc., though they are so in the vernaculars in the case of words altered by phonetic detrition. By adding to the bases form-words as prefixes, suffixes or infixes, the Tibetan language has developed a considerable grammatical system. Agglomerations of consonants are often met with as initials, giving the appearance of telescoped words—an appearance which historical etymology often confirms. Many of these initial consonants are silent in the dialects of the central provinces, or have been resolved into a simpler one of another character. The language is much ruled by laws of euphony. Among the initials, five, viz., *g, d, b, m, 'h*, are regarded as prefixes, and are called *so* for all purposes, though they belong sometimes to the stem. As a rule none of these letters can be placed before any of the same organic class. Post-positions, *pa* or *ba* and *ma*, are required by the noun (substantive or adjective) that is to be singled out, *po* or *bo* (masc.) and *mo* (fem.) are used for distinction of gender or for emphasis. The cases of nouns are indicated by suffixes, which vary their initials according to the final of the nouns. The plural is denoted when required by adding one of the several words of plurality. When several words are connected in a sentence they seldom require more than one case element, and that comes last. There are personal, demonstrative, interrogative and reflexive pronouns, as well as an indefinite article, which is also the numeral for "one." The personal pronouns are replaced by various terms of respect when speaking to or before superiors and there are many words which are only employed in ceremonial language. The verb, properly a kind of noun or participle, has no element of person, and denotes the conditions of tense and mood by an external inflection, or the addition of auxiliary verbs and suffixes when the stem is not susceptible of inflection, so that instead of saying "I go" a Tibetan says "my going." The chief differences between the classical language of the Tibetan translators of the 9th century and the vernacular, as well as the language of native words, existed in vocabulary, phraseology and grammatical structure, and arose from the influence of the translated texts.

Tones.—Tones in Tibetan have developed on the same lines as in Chinese. Thus intransitive bases seem to have begun only with soft consonants, and it is doubtful whether the parent tongue possessed hard consonants at all; while transitive bases were formed by hardening of the initial consonants and at the same time pronouncing the words in a higher tone, and these two latter changes are supposed to have been indicated by a prefix to the base-word. Many of these old soft initial consonants which are now hardened in the modern dialects are preserved in classical Tibetan, *i.e.*, in Tibetan of the 7th to the 9th century A.D.

See Sarat Chandra Das' *Tibetan English Dictionary with Sanskrit synonyms* (1902); V. C. Henderson, *Tibetan Manual* (1903), and Sir C. A. Bell, *Grammar of Colloquial Tibetan* (Calcutta, 1919), and *English-Tibetan Colloquial Dictionary* (1920); also vol. iii. of the *Linguistic Survey of India* (1908). As separate publications there are several vocabularies of Chinese and Tibetan, Mongol and Tibetan, Chinese, Manchu, Mongol, Oelöt, Tibetan and Turkish, Tibetan, Sanskrit, Manchu, Mongol and Chinese.

TIBETO-BURMAN LANGUAGES. The Tibeto-Burman family comprises dialects spoken from Tibet in the north to Burma in the south, and from the Ladakh wazarat of Kashmir in the west to the Chinese provinces of Sze-ch'uen and Yünnan in the east. In the first place we have the various Tibetan dialects, spoken all over Tibet and in the neighbouring districts of India and China. The Himalayan dialects are spoken in the southern Himalayas, from Lahul in the west to Bhutan in the east. East of Bhutan, to the north of the Assam valley, a third small group, the North Assam group, consists of three dialects. A fourth group, the Bodo group, comprises a series of dialects from Bhutan in the north to the Tippera state in the south, which at one time extended over most of Assam west of Manipur and the Nāgā hills, and even far into Bengal proper. To the west of the Bodos, and in the neighbourhood of the Nāgā hills is a fifth group, the so-called Nāgā group. It comprises dialects of very different kinds. Some of them approach Tibetan and the dialect of the North Assam group. Others lead over to the Bodo languages, and others again connect the Nāgā dialects with their Tibeto-Burman neighbours to the south and east. To the south of the Nāgā hills, in the long chain of hills extending southwards, is a sixth group, the Kuki-Chin dialects. The old Meithei language of Manipur lies midway between this group and the easternmost branch of the Tibeto-Burman family, the Kachin group, in the tract of country to the east of Assam and to the north of Upper Burma, including the headwaters of the Chindwin and the Irrawaddy. The Kachin and the Kuki-Chin gradually and finally merge into Burmese, the language of the ancient kingdom of Burma.

The dialects spoken in the Himalayas and in Assam can be viewed as a double chain connecting Tibetan with Burmese, the two principal languages of the family. In the first place the Kachin group runs from the easternmost Tibetan dialects in Sze-ch'uen down to the Burmese of Upper Burma. The second chain has a double beginning in the north, one line through the North Assam group, the Nāgā, Bodo and Kuki-Chin groups, another line pro-



THE SYMBOLS OF THE TIBETAN ALPHABET

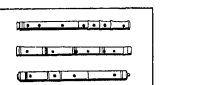
THE SYMBOLS OF THE BURMESE ALPHABET

ceeding from Tibetan through the Himalayan and Bodo groups into Kuki-Chin, finally merging into Burmese.

The Tibeto-Burman languages are closely related to Chinese and Tai, more closely to the former than to the latter. The agreement is apparent in the phonetical system, in vocabulary and in grammar. The principal point in which they differ is the order of words. The Tibeto-Burman family arranges the words of a sentence in the order of subject, object, verb, while the order in Chinese and Tai is subject, verb, object: Together all these languages form one great family, now called Sino-Tibetan.

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TIBIA, a pipe played by means of a reed mouthpiece, extensively used in classic Rome. The tibia, often mistranslated "flute," was identical with the aulos (*q.v.*) of the Greeks, and it may be regarded as the prototype of our clarinet or oboe (*qq v*)



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART

THE TIBIA, A REED INSTRUMENT OF ANCIENT ROME

TIBULLUS, ALBIUS (*c* 54–19 B.C.), Latin elegiac poet The information which we possess about him is extremely meagre. Besides the poems themselves—that is to say, the first and second books—we have only a few references in later writers and a short *Life* of doubtful authority. We do not know his prænomen, his gentile name has been questioned; nor is his birthplace ascertained. His station was not improbably that of a Roman knight (so the *Life* affirms); and he had inherited a very considerable estate. But, like Virgil, Horace and Propertius, he seems to have lost the greater part of it in 41 amongst the confiscations which Antony and Octavian found expedient to satisfy the rapacity of their victorious soldiery. Tibullus's chief friend and patron was M. Valerius Messalla Corvinus, himself an orator and poet as well as a statesman and a commander Messalla, like Maecenas, was the centre of a literary circle in Rome; but the bond between its members was that of literature alone They stood in no relations to the court; and the name of Augustus is not once to be found in the writings of Tibullus. About 30 B.C. Messalla was despatched by Augustus to Gaul to quell a rising in Aquitania and restore order in the country, and Tibullus may have been in his retinue On a later occasion, probably in 28, he would have accompanied his friend who had been sent on a mission to the East, but he fell sick and had to stay behind in Corcyra Tibullus had no liking for war, and though his life seems to have been divided between Rome and his country estate, his own preferences were wholly for the country life His first love, the subject of book i, is called Delia in the poems, but we learn from Apuleius (*Apol.* 10) that her real name was Plania Delia seems to have been a woman of middle station. It is impossible to give an exact account of the intimacy The poems which refer to her are arranged in no chronological order. Now she appears as single, now as married; but we do not hear anything either of her marriage or of her husband's death. It is clear, however, that it was the absence of her husband on military service in Cilicia which gave Tibullus the opportunity of making or renewing the acquaintance. It was not dropped when he returned. It was not difficult to deceive the simple soldier; and Delia was an apt pupil in deception—too apt, as Tibullus saw with dismay when he found that he was not the only lover. His entreaties and appeals were of no avail; and after the first book we hear no more of Delia. In the second book the place of Delia is taken by Nemesis, which is also a fictitious name. Nemesis (like the Cynthia of Propertius) was a courtesan of the higher class; and she had other admirers besides Tibullus. He complains bitterly of his bondage, and of her rapacity and hardheartedness. In spite of all, however, she seems to have retained her hold on him until his death. Tibullus died prematurely, probably in 19, and almost immediately after Virgil. His death made a deep impression in Rome, as we

learn from his contemporary Domitius Marsus and from the elegy in which Ovid (*Amores*, iii. 19) has enshrined the memory of his predecessor.

The character of Tibullus is reflected in his poems Though not an admirable it is certainly an amiable one. He was a man of generous impulses and a gentle unselfish disposition. He was loyal to his friends to the verge of self-sacrifice, as is shown by his leaving Delia to accompany Messalla to Asia, and constant to his mistresses with a constancy but ill deserved His tenderness towards them is enhanced by a refinement and delicacy which are rare among the ancients Horace and the rest taunt the cruel fair with the retribution which is coming with the years. If Tibullus refers to such a fate, he does it by way of warning and not in any petty spirit of triumph or revenge. Cruelly though he may have been treated by his love, he does not invoke curses upon her head He goes to her little sister's grave, hung so often with his garlands and wet with his tears, and bemoans his fate to the dumb ashes there Tibullus has no leanings to an active life: his ideal is a quiet retirement in the country with the loved one at his side. He has no ambition and not even the poet's yearning for immortality As Tibullus loved country life, so he clung to its faiths, and in an age of crude materialism and the grossest superstition, he was religious in the old Roman way As a poet he reminds us of Collins and Longfellow. His clear, finished and yet unaffected style made him a great favourite with his countrymen and placed him, in the judgment of Quintilian, at the head of their elegiac writers And certainly within his own range he has no Roman rival For natural grace and tenderness, for exquisiteness of feeling and expression, he stands alone. He has far fewer faults than Propertius, and in particular he rarely overloads his lines with Alexandrian learning. But, for all that, his range is limited; and in power and compass of imagination, in vigour and originality of conception, in richness and variety of poetical treatment, he is much his rival's inferior. The same differences are perceptible in the way the two poets handle their metre. Tibullus is smoother and more musical, but liable to become monotonous; Propertius, with occasional harshness, is more vigorous and varied. It may be added that in many of Tibullus's poems a symmetrical composition can be traced, although the symmetry must never be forced into a fixed and inelastic scheme.

The third book, which contains 290 verses, is by a much inferior hand The writer calls himself Lygdamus and the fair that he sings of Neaera. He was born in the same year as Ovid, but there is nothing Ovidian about his work He has a good many reminiscences and imitations of Tibullus and Propertius; and they are not always happy. The separation of the fourth book from the third has no ancient authority. It dates from the revival of letters, and is due to the Italian scholars of the 15th century. The fourth book consists of poems of very different quality. The first is a composition in 211 hexameters on the achievements of Messalla, and is very poor The author was certainly not Tibullus

The value of the short *Vita Tibulli*, found at the end of the Ambrosian, Vatican and inferior mss , has been much discussed. There is little in it that we could not at once infer from Tibullus himself and from what Horace says about Albius, though it is possible that its compiler may have taken some of his statements from Suetonius's book *De poetis* It is another moot question of some importance whether our poet should be identified with the Albius of Horace (*Od* i. 33; *Epist* i 4), as is done by the Horatian commentator Porphyrio (A.D. 200–250) in his *Scholia*. Porphyrio's view has been examined by Postgate (*Selections from Tibullus*, appendix A). If it is rejected the authority of the *Life* is considerably impaired. Delia's name (from δῆλος) is a translation of Plania. As regards her station, it should be noticed that she was not entitled to wear the *stola*, the dress of Roman matrons (i 6, 68). Her husband is mentioned as absent (i. 2, 67 *seq.*). Lygdamus is probably the real name of the author of the first six elegies in book iii., but little further is known about him. His elegies and the other poems in the third book ("third" and "fourth" books) appear to have been known to Ovid. There are agreements much too close to be accidental Most scholars since Lachmann have condemned the "Panegyric on Messalla." It is an inflated and at the same time tasteless declamation, entirely devoid of poetical merit. The language is often absurdly exaggerated, *e.g.*, 190 *seq* The author himself seems to be conscious of his own deficiences (1 *seq.*, 177 *seq*) Like so many of his contemporaries, he had been reduced to poverty by the loss of his estates (181 *seq*). Sulpicia was the daughter of Servius Sulpicius (iii 16; iv. 10, 4), and she seems to have been under the tutelage of Messalla, her uncle by marriage (Haupt, *Opuscula*, iii. 502)

MANUSCRIPTS.—The two best mss. of Tibullus are the Ambrosianus (A), of date about 1374, and the Vaticanus (V), of the 15th century. Besides these we have a number of extracts from Tibullus in *Florilegium Parisanum*, an anthology from various Latin writers which probably goes back to the 11th century, and the *Excerpta frisingensia*, preserved in an 11th-century ms. now at Munich, unfortunately very few in number. Also excerpts from the lost *Fragmentum cuiacianum*, made by Scaliger, and now in the library at Leyden It only contained the part from iii 4, 65 to the end. The *Codex cuiacianus*, a late ms. containing Catullus, Tibullus and Propertius, is still extant.

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TIBUR: *see* TIVOLI.

TIBURTINA, VIA, an ancient road of Italy, leading E.N.E. from Rome to Tibur (18 mi.). Though it afterwards became an important thoroughfare, the first portion of it always retained its original name. (*See* VALERIA, VIA.)

TICHBORNE CLAIMANT, THE. Roger Charles Tichborne (1829–1854), whose family name became a household word on account of an attempt made by an impostor in 1868 to personate him and obtain his heritage, was born at Paris on Jan. 5, 1829, the eldest son of James Francis Doughty-Tichborne (who subsequently became 10th baronet and died in 1862) by Henriette Felicité, natural daughter of Henry Seymour of Knoyle, in Wiltshire.

He sailed in March 1853 from Le Havre for Valparaiso, whence he crossed the Andes, reaching Rio de Janeiro in 1854. In April of that year he sailed from Rio in the "Bella" and was lost at sea, the vessel foundering with all hands. His insurance was paid and his will proved in July 1855. The baronetcy and estates passed in 1862 to Roger's younger brother, Sir Alfred Joseph Doughty-Tichborne, who died in 1866. The only person unconvinced of Roger's death was his mother the dowager Lady Tichborne, from whom every tramp sailor found a welcome at Tichborne park. She advertised largely and injudiciously for the wanderer, and in Nov. 1865 she learned, through an agency in Sydney, that a man "answering to the description of her son" had been found in the guise of a small butcher at Wagga Wagga, in Queensland. Lady Tichborne "acknowledged" him as her son when he reached Paris in 1867.

Other members of the family, however, obtained evidence that the claimant was identical with Arthur Orton (1834–1898), the son of a Wapping butcher, who had deserted a sailing vessel at Valparaiso in 1850, and had received much kindness at Melipilla in Chile from a family named Castro, whose name he had subsequently elected to bear during his sojourn in Australia. An ejectment action against the trustees of the Tichborne estates

(to which the heir was the 12th baronet, Sir Henry Alfred Joseph Doughty-Tichborne, then two years old) finally came before the court of common pleas on May 11, 1871.

During a trial that lasted over 100 days over 100 persons swore to the claimant's identity, the majority of them—and they were drawn from every class—being evidently sincere in their belief in his cause But the evidence of the Tichbornes finally convinced the jury, who declared that they wanted no further evidence Orton was arrested on a charge of perjury and was brought to trial at bar before Chief Justice Cockburn in 1873

The indiscretion of his counsel, Edward Kenealy, the testimony of his former sweetheart, and Kenealy's refusal to put the Orton sisters in the box, proved conclusive to the jury, who, on the 188th day of the trial, found that the claimant was Arthur Orton Found guilty of perjury on two counts, he was sentenced on Feb 28, 1874 to 14 years' penal servitude.

Orton died in obscure lodgings in Marylebone on April 2, 1898 (T. S.)

See J. Brown, *The Tichborne Case compared with previous impostures* (1874).

TICINO, a wedge-shaped Swiss canton, driven into Italy Its northern boundary runs along the Lepontine-Adula alps, and its southern tip reaches beyond Lago di Lugano almost to Como. Historically, it represents early Swiss conquests from the duchy of Milan (*see* SWITZERLAND. *History*) loosely amalgamated to form one of the six cantons admitted to the Confederation in 1803. It is inhabited by Italian-speaking Catholics (*see* below). Its dominant physical features are the three river systems occupying steep-sided valleys which extend from a mountain frontier and drain southwards to Lago Maggiore. The most important system is the river Ticino, which rises in the canton southwest of St Gotthard, flows towards that mass through the Val Bedretto, and then swings round at Airolo to a southeast course through Valle Leventina; near Biasca it receives the left-bank Brenno from the Val Blenio, the combined stream flows through the wide, low valley—the Riviera—until slightly above Bellinzona, where it receives another large left-bank affluent which has drained the southeast slopes of the Adula group and reaches the Ticino via the Valle Mesolcina; the main stream curves again below the junction and enters the lake from the east. The Ticino receives no important right-bank tributaries, and the western part of the canton is drained largely by the Maggia and by its numerous right-bank tributaries, which receive torrent water from the western frontier. Between the Ticino and the Maggia is the Valle Verzasca, which is practically a single stream system; the separate mouths of the three rivers lie close to one another at the head of the lake

The remainder of the canton lies south-southeast of this and consists of a triangular fragment of broken hill country, with a complicated drainage reaching the irregularly shaped Lago di Lugano

Its total area is 1,086 sq.mi., of which approximately three-quarters are reckoned as "productive" (forests covering about 375 sq mi.), while of the remainder 28.6 sq mi. consists of lakes, chiefly parts of Maggiore and Lugano; 13 sq.mi. are occupied by glaciers. The canton is fifth in point of size, but only the much larger Valais and Vaud exceed its vine-growing area. The highest points are the Basòdino (10,749 ft.), near the western border, southeast of the source of the Ticino, and the Rheinwaldhorn (11,175 ft.) in the Adula alps.

The amount of lowland is small, and occurs only in the lower river valleys and near the lakes. The lowest commune (699 ft.) is Vira (Locarno) on Lago Maggiore.

The main St. Gotthard railway traverses the canton for about 75 mi. from Airolo, at the southern mouth of the tunnel, via Valle Leventina, Bellinzona, Lugano to beyond Mendrisio. Locarno is connected with this line; another follows the eastern shore of Lago Maggiore, and light railways ascend Valle Maggia to Bignasco, Valle Blenio to Acquarossa, and Valle Mesolcina to Mesocco; the latter two are electric railways. Mountain railways for the ascent of Monte S. Salvatore (3,002 ft.) from Lugano, and of Monte Generoso (5,581 ft.) from Capolago, have also been constructed in the extreme south of the canton.

In 1941 the population was 165,334 and in 1930 it was 159,223, of whom 145,347 were Italian-speaking, 11,662 German-speaking, and 1,278 French-speaking. The highest commune, Bosco-Vallem, near the western border and reached by the V. di Campo, had many German-speaking inhabitants, the result of an early movement eastward from Valais There were in all 145,859 Catholics, 8,178 Protestants and 239 Jews.

In 1888 the diocese of Lugano (since joined to Basle) was created to replace the former purely Italian control over the canton by the dioceses of Milan and Como. Bellinzona (pop., 1941, 10,952) was the permanent political capital after 1881; formerly Lugano (pop., 1941, 17,025) and Locarno (pop, 1936, 6,575) alternated with it at six-year intervals Mendrisio (pop., 1936, 3,904) is the only other large settlement.

The canton has 261 communes and eight administrative districts, its constitution dates back to 1830, but the later political disturbances which characterize the canton have caused, and still cause, considerable modifications. The legislature (*Gran consiglio*) is composed of 65 members elected (since 1892) in the proportion of one to every 1,500 of the Swiss inhabitants. The executive (*Consiglio di stato*) of five members, is elected directly by the people Both bodies hold office for four years. Any 5,000 electors have the right (facultative referendum) of claiming a popular vote as to bills passed by the legislature, while the same number of electors have the right of "initiative" in legislative matters, though 7,000 signatures are required in case of a proposal to revise the cantonal constitution.

History.—The canton is made up of all the permanent conquests (with one or two trifling exceptions) made by different members of the Swiss confederation south of the main chain of the Alps.

From an historical point of view Italian Switzerland falls into three groups: (1) the Val Leventina conquered by Uri in 1440 (previously held from 1403 to 1422), (2) Bellinzona (previously held from 1419 to 1422); the Riviera and the Val Blenio, all won in 1500 from the duke of Milan by men from Uri, Schwyz and Nidwalden, and confirmed by Louis XII of France in 1503; (3) Locarno, Val Maggia, Lugano and Mendrisio, seized in 1512 by the confederates when fighting for the Holy League against France, ruled by the 12 members then in the league, and confirmed by Francis I in the treaty of 1516 These districts were governed by bailiffs holding office two years and purchasing it from the members of the league; each member of group 3 sent annually an envoy, who conjointly constituted the supreme appeal in all matters.

This government was very harsh and is one of the darkest pages in Swiss history. Yet only one open revolt is recorded—that of the Val Leventina against Uri in 1755. In 1803 all these districts were formed into one canton—Ticino—which became a full member of the Swiss confederation. After 1830 the local history of the canton was disturbed by friction between the Radical and Ultramontane parties.

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TICINO (Ger. *Tessin*, anc. *Ticinus*), a river of Switzerland and north Italy, which gives its name to the Swiss canton of Ticino (*q v.*), and gave it in classical times to the town of Ticinum (Pavia). It rises at the foot of the Gries pass to the west of Airolo; from Airolo to the Lago Maggiore its valley bears the name of Val Leventina, and is followed as far as Bellinzona by the St. Gotthard road and railway. It flows through Lago Maggiore, leaving it at its south end at Sesto Calende, and thence flows S S.E. into the Po, which it joins a little way south of Pavia.

TICINUM, an ancient city of Gallia Transpadana (mod. *Pavia, q.v.*), founded on the banks of the river of the same name (mod. *Ticino*) a little way above its confluence with the Padus (Po). Its importance in Roman times was due to the extension of the Via Aemilia from Arminum to the Padus (187 B.C.), which it crossed at Placentia and there forked, one branch going to Mediolanum and the other to Ticinum, and thence to Laumellum whence one branch went to Vercellae (and thence to Eporedia and Augusta Praetoria) and the other to Valentia (and thence to Augusta Taurinorum or to Pollentia). At Ticinum a triumphal arch was erected in honour of Augustus and his family; in the 4th century A.D. there was a manufacture of bows there. It was pillaged by Attila in A.D 452 and by Odoacer in 476, but rose to importance as a military centre in the Gothic period. At Dertona and here the grain stores of Liguria were placed, and Theodoric constructed a palace, baths and amphitheatre and new town walls.

From this point, navigation on the Padus began. Narses recovered it for the eastern empire, but after a long siege, surrendered it to the Lombards in 572. The regular ground plan of the central portion of the modern town, a square of some 1,150 yd., betrays its Roman origin.

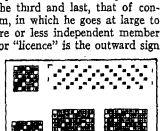
TICKELL, THOMAS (1686–1740), English poet and man of letters, the son of a clergyman, was born at Bridekirk near Carlisle in 1686. In 1715 Tickell brought out a translation of the first book of the *Iliad* contemporaneously with Pope's version. Addison's reported description of Tickell's version as the "best that ever was in any language" roused the anger of Pope, who assumed that Addison himself was the author, or had at any rate the principal share in the work. Addison gave Tickell instructions to collect his works, which were printed in 1721 under Tickell's editorship.

In 1724 Tickell was appointed secretary to the lords justices of Ireland—a post which he retained until his death, which took place at Bath on April 23, 1740.

TICKER, a small printing machine operated by telegraph (*q.v.*), by means of which information is given from an exchange or trading centre as to the prices of securities and commodities Besides the "stock" ticker there are similar machines which furnish quotations upon various commodities such as grain, coffee and sugar. Sometimes important news is sent over the machine. (*See* TELEGRAPH)

A man in the exchange sits at a keyboard, carrying upon it all the letters and forms used in quotations. As he reads the quotations he perforates a moving tape by striking the keys just as in operating a typewriter. This tape passes through a transmitter which operates a large number of line relays and sends the signals to the local and distant points. The instrument has been in use many years and was one of the first devices to receive the attention of Thomas A. Edison.

TICKET-OF-LEAVE, in the English penal system, a document or "pass" granted under the Penal Servitude acts, and handed to a convict who has completed the second stage of his sentence and is about to enter the third and last, that of conditional liberation or semi-freedom, in which he goes at large to earn his own livelihood as a more or less independent member of the community. The "ticket" or "licence" is the outward sign of "remission" gained by industry and good conduct in prison and it may be forfeited for disobedience or neglect of certain conditions endorsed upon the licence. The term is not used in the U.S. where it is replaced by the parole system.



VARIOUS TYPES OF TICKING

Top left, ordinary three-leaf twill; top right, "Arrow head" twill; left bottom and centre, four- and five-thread straight twills; right bottom, five-thread steen twill

TICKING. A strong linen, cotton or union fabric usually woven in stripes of colour; blue and red with white being the most common. The name is derived from a word "tick," common in various forms to many languages, signifying a case or sheath Its original use was to enclose feathers, flocks or the like for beddings, but its use has been extended to include the covering for mattresses, and for awnings and tents. In some qualities it is also used as a foundation for embroidery.

White, gray or brownish warp threads are usually flax, while the coloured threads are often cotton The weft is flax or tow. The warps of many of the cheaper kinds are made entirely of cotton, and jute is used for weft in the cheapest grades.

A feather tick should be made of fine flax yarns set closely, and there should also be a large number of weft threads per inch.

TICKLEGRASS (*Agrostis hiemalis*), a North American grass, called also hair-grass, found widely throughout the continent and in various districts occurring in weed-like abundance. The name is applied also to the somewhat similar witch-grass (*Panicum capillare*), a common North American weed with hair-like flowering branches, and to some other grasses. At maturity the fruiting panicle breaks away and is blown about as a tumble-weed (*q.v.*)

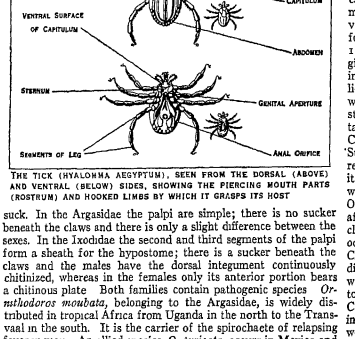
TICKNOR, GEORGE (1791–1871), U.S. author and educator, was born in Boston, Mass., Aug. 1, 1791. He was educated at home by his father until he was 14, at which time he entered Dartmouth university as a junior, graduating two years later. In 1813 he was admitted to the bar, but within a year he had decided against the legal profession as a life work, and in 1815 he sailed for Europe to pursue his studies, remaining until 1819. He spent the first two years at Göttingen, and at the end of that time was appointed to the newly created Smith professorship of French and Spanish languages and literatures at Harvard. He devoted the remaining two years of his European trip, therefore, largely to visiting other countries on the continent in order to study their languages and literatures at first hand. In 1819 he returned to the U.S. to take the chair at Harvard and to become, as well, professor of belles-lettres at that university These two positions he held until 1835, and during his 16 years at Harvard was responsible for notable improvements in the university's curriculum. In his own department, he innovated the study of contemporary writers, particularly writers in the Romance languages, the language and literature curriculum having previously been confined almost exclusively to the classical authors; and he was the first to suggest that Harvard be organized on departmental lines, a suggestion which was adopted some years later during Charles William Eliot's presidency. From 1835–38 he travelled in Europe and from his return until 1849 worked on his monumental *History of Spanish Literature* (3 vols., 1849), the first comprehensive study of Spanish literature to be published. The book went into four editions in English and was translated into Spanish, French and German. Ticknor was a founder of the Boston Public library and on his death left to it his large and valuable collection of books on Spanish literature. In addition to his principal work, he was the author of a number of others, of which the chief was a biography (1864) of William H. Prescott, the historian

Ticknor died in Boston, Jan. 26, 1871.

TICKNOR, WILLIAM DAVIS (1810–1864), U.S. publisher, was born in Lebanon, N.H., Aug. 6, 1810. Having spent some years as a clerk in a brokerage office and as a bank teller in Boston, he entered the publishing business in 1832 as a partner of John Allen, who retired in 1833, leaving the business to Ticknor. The company operated under various names during Ticknor's lifetime, eventually becoming Ticknor and Fields, and was one of the most important publishing houses in the United States. The firm published the *Atlantic Monthly* and the *North American Review*, in addition to the works of such writers as Whittier, Longfellow, Thoreau, Holmes, Lowell, Hawthorne, Emerson, Browning, Tennyson and DeQuincey. Ticknor was one of the first American publishers to pay foreign authors for their writings, and his example was instrumental in persuading other publishers in both England and the United States to do the same. He died April 10, 1864, in Boston.

TICKS, the name for Acari, of the order Arachnida (*q.v.*), of the families Ixodidae and Argasidae. They have on the head

a median probe, armed with recurved teeth, which projects forwards Ticks are of relatively large size, female specimens of some species measuring half an inch or more in length when distended after being gorged with blood. The mouth parts consist of two small retractile mandibles, a pair of short palpi and the toothed probe or hypostome. By means of the hypostome ticks pierce the skin and adhere to the host whose blood they



THE TICK (HYALOMMA AEGYPTUM), SEEN FROM THE DORSAL (ABOVE) AND VENTRAL (BELOW) SIDES, SHOWING THE PIERCING MOUTH PARTS (ROSTRUM) AND HOOKED LIMBS BY WHICH IT GRASPS ITS HOST

suck. In the Argasidae the palpi are simple; there is no sucker beneath the claws and there is only a slight difference between the sexes. In the Ixodidae the second and third segments of the palpi form a sheath for the hypostome; there is a sucker beneath the claws and the males have the dorsal integument continuously chitinized, whereas in the females only its anterior portion bears a chitinous plate Both families contain pathogenic species *Ornithodoros moubata*, belonging to the Argasidae, is widely distributed in tropical Africa from Uganda in the north to the Transvaal in the south. It is the carrier of the spirochaete of relapsing fever in man An allied species, *O. turicata*, occurs in Mexico and Texas, where it is a pest to mankind and to poultry. *Argas miniatus* is the carrier of the spirochaete causing spirillosis in fowls in Rio de Janeiro and New South Wales. Among the Ixodidae several forms are injurious to man and domestic animals. *Dermacentor venustus* is the carrier of the human disease known as Rocky Mountain spotted fever. *Dermacentor reticulatus*, widely distributed in Europe, Asia and America, infects dogs with the hematozoon causing biliary fever. The same disease results in South Africa from the bite of *Haemaphysalis leachi*. *Amblyomma hebraeum*, the bont tick of the Cape Colonists, infects sheep with the sporozoon causing heartwater sickness, and in Europe sheep are inoculated with the same disease by *Rhipicephalus bursa*. The coast fever in cattle in South Africa is conveyed by *Rhipicephalus appendiculatus* and *R. simus*. *Margaropus annulatus* is the carrier of the germ causing the cattle disease known as Texas or red water fever in America, South Africa and Australia. With one or two exceptions, no species of tick is confined to a particular host, and reptiles are infested as well as mammals. The bite of some ticks may produce a peculiar tick paralysis which disappears with the removal of the tick.

TICONDEROGA, a village in the township of Ticonderoga, Essex county, New York, U.S.A., on the outlet of Lake George, 100 mi. by rail N. by E. of Albany. Population in 1950 was 3,510 by the federal census. Ticonderoga is served by the Delaware and Hudson railway. The water from Lake George falls there about 222 ft., providing water power, and among the manufactures are paper pulp, fine grade paper and graphite. Commanding a portage on the line of water communication between Canada and the English colonies, Ticonderoga was a place of considerable strategic importance during the Seven Years' War. On an eminence overlooking the present village and Lake Champlain the French began building a fort of earth and timber in 1755 and called it Fort Carillon. On July 8, 1758, less than 4,000 French-men were confronted at Fort Carillon by about 6,000 British regulars and 10,000 provincials under Lieut. General James Abercrombie and Brigadier General George A. Howe, but Howe, the controlling spirit of the British force, had been killed on July 6, and Abercrombie retreated, after an ineffective attack which cost him nearly 2,000 men killed or wounded Ticonderoga challenges Albany's claim as the burial place of Lord Howe. The famous Scottish ghost story of Duncan Campbell of Inverawe came to its climax at this battle when that gallant commander of the Black Watch regiment was mortally wounded. Tennyson's poem "Ticonderoga" deals with this legend. In 1758, however, when Montcalm had gone to Quebec to oppose Wolfe and a force of only 400 men was left at Ticonderoga, Lord Amherst with 11,000 men invested it, and on July 26 the garrison blew up and abandoned the fortifications. The fort was renamed Ticonderoga. On May 10, 1775, a small expedition under Ethan Allen, a backwoods strategist untrammelled by military pedantry, captured the fort by ruse instead of costly assault, securing large military stores for the relief of Cambridge. When the American expedition against Canada was driven back from Quebec they garrisoned Ticonderoga so strongly that the British commander, Carleton, shrank from attacking it. In 1777, however, Burgoyne's counter invasion from Canada arrived before the fort and occupied the precipitous Sugar Loaf Hill which commanded the fort. The garrison, already reduced in numbers and supplies, felt compelled to evacuate it and on July 6 the British occupied it. Burgoyne, pressing onwards to the Hudson, was driven to surrender at Saratoga in October; Ticonderoga was abandoned by the British immediately after this disaster, but was reoccupied by them in 1780. After the close of the war it was allowed to fall into ruins. In 1909, on the occasion of the tercentenary celebration of the discovery of Lake Champlain, the restoration of the fort was begun under the direction of the owner of the site. The settlement of this region was begun soon after the close of the Seven Years' War, and the township of Ticonderoga was set apart from the township of Crown Point in 1804. The village of Ticonderoga was incorporated in 1889. The name "Ticonderoga" is a corruption of an Indian word said to mean "place between two lakes."

TICUNAN, a small group of tribes of South American Indians, constituting an independent linguistic stock. The Ticunas and their related tribes lived in western Brazil, on the lower Yavary river and on the main Amazon for some distance below the junction of the two streams.

TIDAL POWER. The idea of utilizing the rise and fall of the tides for power purposes has long attracted the attention of inventors, and many ingenious schemes have been suggested. So far, however, the only practicable method is based on the use of one or more tidal basins, separated from the sea by dams or barrages, and of hydraulic turbines through which the water is passed on its way between basin and sea or between one basin and another.

Types of Schemes.—Briefly outlined the more promising of the schemes of tidal power development are as follows:—

(*a*) A single tidal basin is used, divided from the sea by a dam in which are placed the turbines. The basin is filled through sluices during the rising tide. At high tide these are closed When the tide has fallen through about one-half its range, the turbine gates are opened and the turbines operate on a more or less constant head until low tide or slightly after. If A be the surface area of the basin in square feet; if H ft. be the tidal range; if a constant working head of h ft. be adopted; and if the turbines operate until low tide; the volume of water used during the falling tide will be $A\ (H-h)$ cu.ft., and the energy available in the water will be

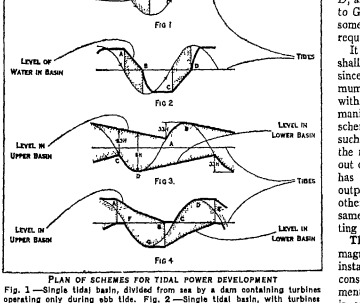
$$64A\ (H-h) \times h, \text{ ft.lb. per tide.}$$

This expression is a maximum when $h=H\div 2$, that is, when the working head is one-half the tidal range, and then equals 16 AH^2 foot-pounds.

If A is in square miles, and if the efficiency of the turbines is 75%, the output in h.-p.-hours per tide is given by

$$\frac{0{\cdot}75\times64\,(5280)^2AH^2}{4\times33000\times60}=169\,AH^2.$$

The cycle of operations is shown in fig 1 where AB denotes the working period and CD the period of replenishment of the basin. The sine curve represents the level of the sea outside the basin Owing to the great variation in the rate of efflux of the water, in this constant-head method of operation, the power output varies very largely during the falling tide. This variation may be reduced considerably by allowing the turbines to operate on a more or less constant fall of level in the basin as shown by the straight full line AB. By this method of operation the necessary turbine capacity for a given output may be greatly reduced. By extending the working period beyond low tide, as indicated by the light line AE, a greater amount of energy may be developed per tide and the idle period is diminished, but at the expense of an appreciably greater variation in head. The most efficient combination of working period and of working heads can only be determined by detailed examination of the particular site, and with a knowledge of the exact form of the tidal curve.



PLAN OF SCHEMES FOR TIDAL POWER DEVELOPMENT

Fig. 1.—Single tidal basin, divided from sea by a dam containing turbines operating only during ebb tide. Fig. 2.—Single tidal basin, with turbines operating on rising and falling tides. Fig. 3.—Two tidal basins with turbines in dividing walls. Fig. 4.—Two tidal basins with turbines installed in walls dividing sea from each basin. The heavy lines show the water level in the basin at any instant, and the light lines show the sea level at the same instant. The shaded areas represent the working heads when the turbines operate

(*b*) A single tidal basin is used, with the turbines operating on both rising and falling tides The cycle of operations is indicated in fig 2. The working period per complete tide now extends from A to B and from C to D. Slightly before low water, at B, the basin is emptied through sluice gates, and at D, a little before high water, the basin is filled through the sluice gates With a working head equal to one-half the tidal range, the period of operation is approximately 60% greater than in system (*a*) with operation down to low tide, and the work done is some 60% greater.

(*c*) Two basins of approximately equal areas are used, with turbines in the dividing wall. Each basin communicates with the sea through suitable sluice gates In one of these basins called the upper, the water level is never allowed to fall below one-third of the tidal range, while in the lower basin the level is not allowed to rise above one-third of the tidal range. The working head then varies from 0·53 H to 0·80 H, with a mean of approximately 0·66 H, and operation is continuous as indicated in fig. 3 which shows the cycle of operations. Between A and B, the upper basin is filled from the sea through appropriate sluice gates, and the lower basin discharges into the sea from C to D. For a given total basin area and a given tidal range the output is only about one-half that obtained in system (*a*) and one-third that obtained in system (*b*), so that except where the physical configuration of the site is particularly favourable the cost per h.p. is likely to prove very high

(*d*) Two tidal basins of approximately equal areas are used. Turbines are installed in the walls dividing the sea from each basin. Fig. 4 shows the cycle of operations From A to B the upper basin discharges through its turbines into the sea. From B to E the sea enters the lower basin through its turbines. The upper basin is filled from the sea through its sluice gates between C and D, and the lower basin is emptied through its sluice gates from F to G. The head varies from 0·25 H to 0·62 H, and the output is some 25% greater than in system (*c*) but the number of turbines required is much greater.

It is possible to arrange in each of these systems that the head shall be maintained constant during any one working period, but since this means that the working head is then limited to the minimum obtaining during that period, a loss of energy is involved, with a great additional cost of construction and complication in manipulation and with little compensating advantage. For any scheme of development involving the use of a tidal estuary of such types as are found in the Severn or Dee, the cost of any of the multiple basin systems would appear to put them definitely out of court. A scheme involving operation only on a falling tide has the disadvantage that the output is only about 60% of the output theoretically possible with double-way operation On the other hand the output per unit of turbine capacity is sensibly the same, while it enables a much more efficient type of turbine setting to be used, and halves the number of sluice gates.

The Severn Scheme.—Up to 1928 no tidal scheme of any magnitude had been constructed. The possibilities of such an installation on the estuary of the Severn are, however, now under consideration by a committee appointed by the British Government. This would consist of a single tidal basin of about 2 sq.m. in area formed by a barrage probably in the neighbourhood of Sudbury, along with a storage reservoir some 500ft. above sea-level and about 5m away above the Wye valley. It is estimated that the scheme would be capable of developing some 500,000h.p. over a 10-hour working day throughout the year.

Fundy Bay Scheme.—Two schemes, each of the two-basin type, have been suggested for utilizing the tides in the Bay of Fundy (*q.v.*). From one of these, at Passamaquoddy Bay, where the average spring tidal range is 23·2 ft., it is estimated that from 500,000 to 700,000 h.p can be generated. The other, which is a smaller but relatively less costly scheme, is at Hopewell at the head of Shepody Bay, and utilizes the estuaries of the Petitcodiac and Memramcook rivers as the two tidal basins. Here the spring tidal range is 45·5 ft. and the available power about 200,000 h.p. Both schemes have been before the New Brunswick Government.

Aber-Vrach Scheme.—A combined tidal and river-power scheme to which the French Government is giving financial assistance is projected at Aber-Vrach on the coast of Brittany. For the tidal station a barrage 490ft long is to be constructed in the estuary. Four turbines connected to synchronous generators are to be installed, each capable of developing 1,200h.p., under the maximum head available at spring tides. The turbines are to operate both on the ebb and flow tides. This station will work in conjunction with an auxiliary water-power station some 4m. away on the river Diouris. The river is to be dammed at this point, forming a fresh water reservoir from which turbines having a maximum capacity of 2,700h.p. are to be supplied. Electrically driven centrifugal pumps of a capacity of 3,200h.p. will also be installed.

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(A. H. G.)

TIDES. (1). The word "tide" refers to those alternating relative motions of the matter of a planet, satellite or star, which are due to the gravitational actions of external bodies. In this class of motions we have two terrestrial examples besides the

familiar tides of our oceans and seas; these are earth-tides and atmospheric tides Earth-tides consist in the alternating slight change of shape of the solid body of the earth due to the gravitational action of the moon and sun, and atmospheric tides to the alternating slight motions of the atmosphere which are due to the same cause There is, however, a still wider use of the word It is based on descriptive and kinematical, instead of on causal and astronomical ideas, and takes for criterion that the motions in question shall have certain features in common with ocean-tides. This extension includes those "long" waves of the sea which are sometimes caused by earthquakes, the effects on the sea of variable atmospheric pressure, as well as the oscillations of the water of lakes known as "seiches."

ORDINARY TIDES

General Description of Phenomena.—(2). At most seaside places the water reaches its highest level approximately twice a day, the average interval between two successive high waters being 12 hr 25 min, though this interval varies considerably during the course of a week At certain places in the East Indian Seas two successive high waters are separated by an interval of 12 hr., while at certain places in the China Sea the interval is often over 24 hr. At places on the shores of the oceans the time taken by the tide in rising is about equal to the time taken in falling on the same day, but in estuaries the tide usually rises quicker than it falls At certain places, such as Southampton, England, the high waters are often doubled, *i.e.*, the water reaches a maximum height, falls a little and then rises to a maximum again. At other places the low waters are often doubled As we go along any stretch of coast the time of high water generally becomes progres- [illegible]

[illegible] 50 ft while at certain islands of the Pacific and over most of the Mediterranean the range never exceeds 2 ft. At many places outside the Atlantic the heights of two successive high or low waters are markedly different, a phenomenon known as *diurnal inequality*.

At a place in a strait or narrow sea the tidal current usually flows for about 6 hr 12 min. in one direction, and then for about the same time in the opposite direction. At the reversal of such a current we have the state of rest usually called *slack water*. In estuaries the current generally flows down-stream for a greater length of time than it flows up-stream. At a place in the open sea the direction of the current often takes all points of the compass, making the complete revolution in the tidal period. During this period there are usually two times of maximum current and two intermediate times of minimum current. The times of maximum current are separated by about half the tidal period and the directions of maximum current are nearly directly opposite; similarly for the two minimum currents. There is no fixed general relation between the time of high water and the time of maximum current. If the current flows directly in and out of a bay it will reach its inward maximum nearly a quarter period before high water at the head of the bay, so that slack water is simultaneous with high water. On the other hand, in an estuary the current continues to flow up-stream for some considerable time after high water and to run down-stream similarly after low water. When the current is directed towards land or up an estuary it is called the *flood* current; when it runs away from land or down an estuary it is called the *ebb* current. The speeds of tidal currents vary greatly from place to place; *e.g*, in the Mersey at Liverpool the maximum current reaches 7 knots, while in the North Sea it rarely exceeds 1 knot. At some distance up certain rivers—as, for example, the Severn—the rising water spreads over the flat sands in a roaring surf and travels up the river almost like a wall of water. This phenomenon is called a *bore*. Near a headland separating two bays there is sometimes a very swift current termed a *race*.

Tidal Observation.—(3) Complete investigation of the laws of tidal oscillation demands that the height of the water should be measured at times other than those of high and low water. The simplest sort of observation is to note the height of the water on a graduated staff fixed in the sea, with such allowance for wave motion as may be possible But when extensive observations are to be made an automatic and continuous *tide-gauge* is generally used. A well or tank is built on the shore, communicating by a pipe with the sea at some depth below lowest low water mark. A float rests on the surface of the water in the well and hangs by a light wire or chain. This wire is wrapped round a wheel and imparts to it a rotation proportional to the rise and fall of the tide Through a simple gearing this wheel drives another by which the range is reduced to a convenient extent. A fine wire wound on the final wheel of the train drags a pencil to and fro proportionately to the tidal oscillations. The pencil is lightly pressed against a drum which is driven by clockwork so as to make one revolution per day. The pencil leaves its trace or tide-curve on paper wrapped round the drum. A number of attempts have been made to construct a self-registering gauge which, when placed on the sea-floor, will give a continuous record of the pressure of the water above it. From such a record it is of course easy to deduce a record of the tidal elevation

Tidal currents have mostly been measured by noting the distance moved by a floating log in a definite interval of time But series of observations at frequent intervals, especially of currents below the surface, are usually made by *current-meters*. One of the commonest of these, the Ekman meter, registers the mean speed and direction of the current during the interval of time it is in operation, the former by a small propeller actuating a revolution-counting apparatus, and the latter by a vane attached to an apparatus dropping shot into sectorial boxes on a compass-card Owing chiefly to the difficulty of keeping a meter fixed relatively to the sea-floor, the accurate measurement of currents is a matter of great difficulty.

Astronomical Correlation.—(4). The times of high water are found to bear an intimate relation to the positions of the moon and sun The period of 12 hr. 25 min. is half that of the moon's apparent revolution round the earth. The length of time between the moon's crossing of the meridian of a place and the next high water at that place is known as the *lunitidal interval*, or the *high water interval*, for the place. Similarly, the length of time between the moon's crossing of the meridian and the next low water is called the *low water interval* For London Bridge the average value of the lunitidal interval is 1 hr 31 min. In many cases, including those of British waters, the chief variation in the lunitidal interval is associated with the phase of the moon. The average value of the lunitidal interval on the days of new and full moon is known as the *establishment of the port*. For London Bridge the establishment is 1 hr 58 min.

The range of tide may be similarly correlated. In British waters it reaches its maximum a day or so after new and full moon and its minimum a day or so after the quarters. In these circumstances the maximum tides are known as *spring tides* and the minimum tides as *neap tides*. About the time of the equinoxes spring tides are generally larger and about the time of the solstices they are generally smaller than usual. The average interval between new or full moon and the next following spring tide is known as the *age of the tide* at the place in question. At certain places in Canadian waters the chief variation in the range of tide is associated with the varying distance of the moon from the earth, while at others it is associated with the varying declination of the moon. The diurnal inequality is always associated with the declination of the moon or sun. But the most complete correlation between the tides and astronomical variables is provided by the harmonic methods.

TIDE-GENERATING FORCES

(5). The moon attracts every particle of the earth and ocean. By the law of gravitation the force acting on any particle is directed toward the moon's centre, and is jointly proportional to the masses of the particle and of the moon, and inversely proportional to the square of the distance between the particle and the moon's centre. If we imagine the earth and ocean subdivided into a number of small particles of equal mass, then the average, both as to direction and intensity, of the forces acting on these particles, is equal to the force acting on that particle which is at the earth's centre. If every particle of the earth and ocean were being urged by equal and parallel forces there would be no cause for relative motion between the ocean and the earth Hence it is the departure of the force acting on any particle from the average which constitutes the tide-generating force. Now it is obvious that on the side of the earth toward the moon the departure from the average is a small force directed toward the moon; and on the side of the earth away from the moon the departure is a small force directed away from the moon All round

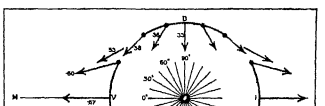


FIG. 1.—TIDE-GENERATING FORCE

the sides of the earth along a great circle perpendicular to the line joining the moon and earth the departure is a force directed inward toward the earth's centre. Thus we see that the tidal forces tend to pull the water toward and away from the moon, and to depress the water at right angles to that direction. In fig. 1 this distribution of forces is illustrated graphically. The relative magnitudes of the forces are given by the numbers on the figure, M being in the direction of the moon. The separate attractions of the moon at the earth's centre and at a point on the earth's surface are each inversely proportional to the square of the moon's distance, so that the difference between the two, which gives the tide-generating force, is approximately inversely proportional to the cube of the moon's distance.

The vertical component of the tide-generating force coincides in direction with the gravitational force of the earth itself, and thus acts as a very slight modification of weight. This component does not tend to alter the position of equilibrium which the water would take up in the absence of any disturbance from an extra terrestrial body. The effective tide-generating forces, therefore, are the horizontal components of those indicated in fig. 1.

Equilibrium-form of Tide.—(6). For many purposes it is convenient to specify the distribution of tide-generating forces at any instant by reference to a fictitious tide in an ocean covering the whole earth If the earth carried such an ocean and were to remain at rest, and if the tide-generating forces were to remain constant, there would be an invariable elevation of water at each point of the ocean-surface and no tidal currents. If the distribution of forces were the same as that of the actual tide-generating forces at any definite instant, then we might use the consequential elevation of water as a specification of these forces This distribution of fictitious tidal elevation is known as the *equilibrium-form of the tides.* It is a real and accurate specification of the actual tide-generating forces at any instant, and when the equilibrium-form is stated for every instant we have a complete specification of these forces. In this equilibrium-form the inclination, to the horizontal, of the surface of the water would be always such that the consequential differences of pressure produced horizontal forces balancing the tide-generating forces. It is therefore clear that the surface of the water would slope upward from DD toward the points V and I, the water being raised by a maximum amount at V and I and depressed by a maximum amount along the great circle through DD. The surface of the water would be that of a nearly spherical surface of revolution. The volume of this surface of revolution would be the same as that enclosed by the surface of the undisturbed ocean. Owing to the motion of the moon relative to the earth, this surface of revolution moves over the earth so that V is always directly under the moon and I always directly opposite, while owing to the varying distance of the moon the surface of revolution changes slightly in shape.

The tide-generating forces due to the sun's gravitation may be similarly specified. The sun's mass is nearly 27,000,000 times the moon's mass and the sun's distance is about 390 times the moon's distance. Consequently the sun's tide-generating forces are to those of the moon in the ratio of $27{,}000{,}000$ to 390^2, *i.e.* 460 or 1/2.17. This means that at corresponding points of the two spheroids representing the lunar and solar equilibrium-forms the tidal elevations on the average will be in the ratio of 2.17 to 1

Harmonic Constituents.—Dynamical considerations make it important to analyse the tide-generating forces into the sum of a number of constituent distributions, each of which is a harmonic function of the time. This means that at any point of the earth's surface we must represent the sum of the two varying elevations due to the two moving equilibrium-spheroids as the sum of a number of terms of the form $H_0\cos n(t-\tau_0)$, where t denotes the time, n is an angular speed, H_0 a length and τ_0 a constant. The quantity n is called the *speed* of the corresponding constituent; it is the same for all points of the earth's surface. The length H_0 is called the *amplitude* of the constituent, H_0 and τ_0 are constant at any one place but vary over the earth's surface. The angle $n(t-\tau_0)$ is called the *phase* of the constituent at time t.

If the moon moved with constant angular speed in the plane of the earth's equator and at a constant distance from the earth, we should have, at any place, equilibrium high water occurring regularly at intervals of time equal to 12 hr. 25 min., with a maximum range of elevation at the equator and a zero range at the two poles. The rise and fall of the water would be approximately harmonic with the speed of $2(\gamma-\sigma)$, where γ denotes the angular speed of the earth's rotation and σ the mean motion of the moon, and the equilibrium-tide would be represented very approximately by a single harmonic constituent. But the fact that the moon does not move as here supposed causes many modifications. Let us still suppose the moon to move in the equator but take into account the elliptic inequality in her distance. This distance D may be expressed approximately in the form

$$D_0[1-\alpha\cos\{(\sigma-w)(t-\tau')\}],$$

where w denotes the motion of the lunar perigee, τ' is a constant and α is a small number. The departure from sphericity of the equilibrium-spheroid is proportional to $1/D^3$ and therefore contains a factor $[1+3\alpha\cos\{(\sigma-w)(t-\tau')\}]$. The equilibrium-elevation at any place would therefore vary with the time according to the factor

$$\cos\{2(\gamma-\sigma)(t-\tau_0)\}[1+3\alpha\cos\{(\sigma-w)(t-\tau')\}]$$

or

$$\begin{aligned}\cos\{2(\gamma-\sigma)(t-\tau_0)\}&\\ +\tfrac{3}{2}\alpha\cos\{(2\gamma-3\sigma+w)t-2(\gamma-\sigma)\tau_0+(\sigma-w)\tau'\}&\\ +\tfrac{3}{2}\alpha\cos\{(2\gamma-\sigma-w)t-2(\gamma-\sigma)\tau_0-(\sigma-w)\tau'\}&\end{aligned}$$

so that we should have two new harmonic constituents The moon's motion, however, also varies in her elliptic orbit, increasing and decreasing with the reciprocal of her distance and this causes the period of the equilibrium-tides to increase and decrease with their range. On this account there is reinforcement of the constituent of speed $2\gamma-3\sigma+w$ as compared with that of speed $2\gamma-\sigma-w$.

If the moon moved with constant angular speed in a parallel of latitude other than the equator, consecutive high waters would be unequal except at the equator, and we should require the introduction of a new constituent of speed $(\gamma-\sigma)$ with an amplitude vanishing at the equator. Also, the amplitude of the original constituent of speed $2(\gamma-\sigma)$, would be less than when the moon was in the equator Since the declination of the moon changes, this new constituent also requires modification If its amplitude could be regarded as changing harmonically with speed σ it would be replaced by two harmonic constituents of equal amplitude and speeds $\gamma-\sigma+\sigma$ Owing to the fact that this is not quite so, the amplitude of the constituent of speed $\gamma-2\sigma$ is a little greater than that of speed γ. Also, the changing declination of the moon causes the amplitudes of the semidiurnal constituents to vary, but it is sufficiently accurate to take mean values in all cases except that of speed $2(\gamma-\sigma)$. As the effect is to make the speed and range of tide increase or decrease together, we get a new constituent of speed $2(\gamma-\sigma)+2\sigma$ The daily mean level in the equilibrium-form depends upon the particular curve of the spheroid which passes over the place On this account the changing declination of the moon introduces a constituent of speed 2σ.

The amplitudes of all the constituents depending on the inclination of the moon's orbit to the equator vary with the position of the node on the ecliptic. As the monthly mean level at any place also depends on the inclination of the moon's orbit to the equator, we have a small constituent with a speed N· equal to that of revolution of the moon's nodes. The speeds of the constituents of solar origin may be similarly determined.

Species.—The constituents fall into three species; a *semidiurnal species* containing the constituents of speeds approximately equal to 2γ, a *diurnal species* containing the constituents of speeds approximately equal to γ, and a *long period species* containing constituents of speeds small compared with γ Each constituent has a recognized symbol and name:

Semidiurnal Species

Symbol	Name	Speed	Coefficient
M_2	Principal lunar	$2(\gamma-\sigma)$	.454
S_2	Principal solar	$2(\gamma-\eta)$	.211
N_2	Larger lunar elliptic	$2\gamma-3\sigma+w$	.088
K_2	Luni-solar	2γ	.058

Diurnal Species

Symbol	Name	Speed	Coefficient
K_1	Luni-solar	γ	.265
O_1	Larger lunar	$\gamma-2\sigma$	.189
P_1	Larger solar	$\gamma-2\eta$	.088

Long Period Species

Symbol	Name	Speed	Coefficient
Mf	Lunar fortnightly	2σ	.078
Ssa	Solar semi-annual	2η	.036
—	Nineteen yearly.	N·	.033

In this table η denotes the mean motion of the sun and the coefficients have been calculated as will be explained in §7 below.

Imagine an equilibrium-surface corresponding to each separate harmonic constituent. For a constituent of the semidiurnal species there will be two maximum and two minimum elevations on the equator, occurring alternately and equally spaced. Along any meridian the elevation will steadily decrease away from the equator, reaching zero values at the poles. For a constituent of the diurnal species the elevation will be zero along the equator and at the two poles, but along any other parallel of latitude there will be one maximum and one minimum equally spaced. At any one time all the maxima and minima will lie on two meridians, a maximum changing into a minimum and *vice versa* on crossing the equator For both species the motion of the surface relative to the earth will be one of uniform rotation round the earth's axis with the speed given in the table For a constituent of the long period species, the corresponding surface at any one time will be symmetrical about the earth's axis, and its motion will be a harmonic pulsation with the speed given in the table.

(7) For the dynamical theory we require a *mathematical expression* of the geographical distribution of the equilibrium-form in each species of constituent, and for the theory of earth-tides we require the distribution of the generating forces inside the earth as well as over its surface For this purpose we use the *potential* of the forces, *i c*, a quantity possessing magnitude only, whose space-rate of increase in any direction gives the component of force in that direction. For points on the earth's surface the space-rate of change of potential is proportional to the corresponding inclination of the equilibrium-surface. Let O and C denote the centres of the earth and moon respectively and let P denote a point at which the potential is to be calculated Let $OC=D$, $OP=r$, $CP=R$, angle $COP=\delta$ and let M denote the mass of the moon and Γ the constant of gravitation. Then the moon's attraction at O has a magnitude $\Gamma M/D^2$ and is directed along OC. This is the average force over the whole body of the earth, and a uniform distribution of this magnitude has a potential

$$\frac{\Gamma M}{D^2} r\cos\delta. \qquad (1)$$

The complete potential at P, due to the moon's attraction, is $\Gamma M/R$ and to get the potential V of the tide-generating forces we have to subtract (1) We therefore have

$$V=\Gamma M\left(\frac{1}{R}-\frac{r}{D^2}\cos\delta\right)$$

and the principal variable part of this reduces to

$$V=\frac{\Gamma M}{D^3} r^2(\tfrac{3}{2}\cos^2\delta-\tfrac{1}{2}). \qquad (2)$$

If E denotes the mass of the earth, a its radius and g the acceleration of its gravity, we have $g=\Gamma E/a^2$, so that (2) may be written as

$$V=\tfrac{3}{2}g\frac{M}{E}\frac{a^2}{D^3}r^2(\cos^2\delta-\tfrac{1}{3}). \qquad (3)$$

Fig. 1 has been constructed from the expression (3). Let λ denote the latitude of a point on the earth's surface and ϕ its longitude measured eastward from some meridian, also let Δ denote the declination of the moon and a the hour-angle west of the meridian $\phi=0$. Then (3) may be reduced to

$$V=\tfrac{3}{2}g\frac{M}{E}\frac{a^3}{D^3}r^3\tfrac{1}{2}\{\cos^2\Delta\cos^2\lambda\cos 2(a+\phi) +\tfrac{1}{2}\sin 2\Delta\sin 2\lambda\cos(a+\phi) +\tfrac{1}{3}(\sin^2\Delta-\tfrac{1}{3})(\sin^2\lambda-\tfrac{1}{3})\} \qquad (4)$$

The first term of (4) gives rise to the semidiurnal species, the second term to the diurnal species and the third term to the long period species. On substituting for D, a and Δ from the theory of the motion of the moon, the constituents of the three species take the respective forms

$$gHC\frac{r^2}{a^3}\cos^2\lambda\cos(nt+2\phi-\epsilon)$$

$$gHC\frac{r^2}{a^3}\sin 2\lambda\cos(nt+\phi-\epsilon)$$

$$gHC\frac{r^2}{a^3}\tfrac{3}{2}(\sin^2\lambda-\tfrac{1}{3})\cos(nt-\epsilon)$$

Here $H=\frac{3}{2}\frac{M}{E}\frac{a^4}{D_0^3}=1.8$ ft.,

D_0 being the mean value of D, ϵ denoting a constant for each constituent, and C the numerical coefficient whose value is given in the table of constituents (G. H. Darwin, *Brit. Assoc. Report* [1883], A T. Doodson, *Proc. Roy Soc.*, A [1921]). A similar analysis applies to the solar constituents, and the value of H

will be .460×1.8 ft., but in the table of constituents the solar coefficients have been multiplied by .460 so as to make the coefficients themselves give the relative order of magnitude of both lunar and solar constituents

In certain circumstances the equilibrium-form of tide provides an approximation to the actual tide But, while retaining the slope of elevation as given by the above formulae, it is clearly necessary to arrange that the total volume of water may remain unchanged. This requires that a constant depending on the distribution of land and water be added to the functions of position in the above formulae, a process known as the "correction for continents." For the long period constituents the correction has been carried out and found to be of little consequence (H. H. Turner, *Proc. Roy. Soc* 40). But for the true equilibrium-form we require to take account of another circumstance not allowed for in the above It is that the elevated water itself produces a disturbance in the earth's gravitational field, and the resulting modification may be important So far it has only been numerically evaluated for an ideal ocean covering the whole earth, and in this case the effect is a uniform multiplication by the factor 1.12 (W. Thomson and P. G. Tait, *Natural Philosophy*, Arts 815, 817 [1879–83]). The complete determination of even the equilibrium-form for the actual oceans is as yet an unsolved problem.

Over a region of small lateral extent the equilibrium-surface at any time may be regarded as sensibly a plane But for a landlocked sea the condition that the total volume of water remains constant, requires its surface, whenever plane, to pass through the centroid of its area It follows that for a small landlocked sea there is no rise and fall of the corrected equilibrium-tide at the centroid of its area.

DYNAMICAL THEORY

Equations of Motion.—(8) We shall again take a to denote the radius of the earth and g the acceleration of its gravity on its surface But we shall now denote position on the surface of the earth by the co-latitude θ and east longitude ϕ so that $\theta=\frac{1}{2}\pi-\lambda$. Let h denote the depth of the ocean at any point, so that h is a function of θ, ϕ Also, let ζ denote the elevation of the free surface at any point above its mean level, and u, v the southward and eastward components of tidal current, so that these quantities are functions of θ, ϕ as well as of the time t Then the *equation of continuity*, which expresses that the volume of any mass of water remains constant, may be written in the form—

$$\frac{1}{a\sin\theta}\left\{\frac{\partial}{\partial\theta}(h\sin\theta u)+\frac{\partial}{\partial\phi}(hv)\right\}+\frac{\partial\zeta}{\partial t}=0 \qquad (1)$$

This equation may be derived by expressing that the net rate at which a volume of water enters the sides of a vertical column standing on the element of sea-floor $a\sin\theta\delta\theta\delta\phi$ is equal to the rate of increase of volume at the top of this column In Cartesian co-ordinates, with u, v in the directions of x, y respectively, the equation of continuity takes the form—

$$\frac{\partial}{\partial x}(hu)+\frac{\partial}{\partial y}(hv)+\frac{\partial\zeta}{\partial t}=0, \qquad (1.1)$$

but if the elevation is more than a small fraction of the depth of the sea, this equation must be replaced by—

$$\frac{\partial}{\partial x}\{(h+\zeta)u\}+\frac{\partial}{\partial y}\{(h+\zeta)v\}+\frac{\partial\zeta}{\partial t}=0. \qquad (1.2)$$

Along a *coastline* the equation—

$$(\text{depth})\times(\text{current normal to coast})=0 \qquad (2)$$

will be satisfied

The *acceleration* of a particle of water will consist of two parts, one due to the rate of change of the current relative to the earth and the other to the earth's rotation. It we take Ω to denote the angular speed of rotation of the earth then the vertical component at a place of colatitude θ is $\Omega\cos\theta$, and this we shall denote by ω. The second part of the acceleration will be given by multiplying the current by 2ω and turning it through a right angle to the left. The Cartesian components of acceleration take the form—

$$\frac{\partial u}{\partial t}-2\omega v, \qquad \frac{\partial v}{\partial t}+2\omega u$$

but when it is necessary to allow for the very rapid spatial variations of current these must be replaced by—

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}-2\omega v, \qquad \frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+2\omega u.$$

It is the kinematical characteristic of tidal motion (referred to in §1) that vertical accelerations are relatively small, and it is a dynamical consequence of this that the pressure-intensity at any point depends only on the depth, according to the principles of hydrostatics. We therefore see that the southerly and easterly horizontal pressure-gradients at any place will be given by the formulae—

$$g\rho\frac{1}{a}\frac{\partial\zeta}{\partial\theta}, \qquad g\rho\frac{1}{a\sin\theta}\frac{\partial\zeta}{\partial\phi}$$

and this at whatever depth these gradients may be required If we denote by $g\bar{\zeta}$ the potential V of the tide-generating forces, then the southerly and easterly horizontal components of these forces will be—

$$g\frac{1}{a}\frac{\partial\bar{\zeta}}{\partial\theta}, \qquad g\frac{1}{a\sin\theta}\frac{\partial\bar{\zeta}}{\partial\phi}$$

per mass The southerly and easterly components of force per mass of water are therefore—

$$\frac{g}{a}\frac{\partial}{\partial\theta}(\zeta-\bar{\zeta}); \qquad \frac{g}{a\sin\theta}\frac{\partial}{\partial\phi}(\zeta-\bar{\zeta})$$

and the *dynamical equations* may be written—

$$\left.\begin{aligned}\frac{\partial u}{\partial t}-2\Omega\cos\theta v&=-\frac{g}{a}\frac{\partial}{\partial\theta}(\zeta-\bar{\zeta})\\ \frac{\partial v}{\partial t}+2\Omega\cos\phi u&=-\frac{g}{a\sin\theta}\frac{\partial}{\partial\phi}(\zeta-\bar{\zeta})\end{aligned}\right\} \qquad (3)$$

In Cartesian co-ordinates the dynamical equations take the form—

$$\left.\begin{aligned}\frac{\partial u}{\partial t}-2\omega v&=-g\frac{\partial}{\partial x}(\zeta-\bar{\zeta})\\ \frac{\partial v}{\partial t}+2\omega u&=-g\frac{\partial}{\partial y}(\zeta-\bar{\zeta}).\end{aligned}\right\} \qquad (3.1)$$

The form of these equations shows that for the oscillatory motion of the tides the current-components u, v will be the same at all depths

In this argument a number of factors have been left out of account. When frictional forces have to be allowed for, the current-components will not be the same at all depths, and in the equation of continuity u, v must be interpreted as mean values from sea-floor to sea-surface, while frictional terms must be added to the dynamical equations. The sea-floor may itself be subject to a small variable elevation, say ζ_0, due to earth-tides, and if we then take ζ to denote the elevation of the sea-surface relative to the floor, the equations (1), (1.1) will stand, but in the formulae for pressure-gradients ζ must be replaced by $\zeta+\zeta_0$. The displacements of water and solid earth will themselves create a disturbance in the gravitational forces, and on this account a term $\bar{\zeta}_0$ must be added to $\bar{\zeta}$.

Harmonic Motions.—(9) Suppose now that—

$$\zeta=H_0\cos n(t-\tau_0)$$

as in a single harmonic constituent, H_0, τ_0 being functions of θ, ϕ but not of t Then the solution of the equations (1), (2) and (3) of §8 will be of the form—

$$\zeta=H_0\cos n(t-\tau),$$
$$u=U\cos n(t-\tau_1), \qquad v=V\cos n(t-\tau_2),$$

where H, U, V, τ, τ_1, τ_2 are all functions of θ, ϕ but are independent of t These expressions represent a *harmonic constituent*

of the tides themselves as distinct from one of the equilibrium-form. At any place the elevation and current-components vary harmonically with the same speed as the equilibrium-form The functions H and τ, so that the actual tidal elevation will be quite different from the equilibrium-elevation If $\tau_1 = \tau_2$ for any place, the current at the place will flow in one line only, but in general τ_1 and τ_2 will not be the same and consequently the currents will be rotatory. Any number of independent solutions of the equations (1), (2) and (3) may be superposed by simple addition, and it follows that for any constituent in the equilibrium-form there will be a constituent of equal speed in the actual tides. These constituents are known by the symbols and names already given for the equilibrium-form, and by methods of analysis (§21) they may be disentangled from the observations of elevations and currents taken at any one place. The dynamical theory here sketched forms the basis of the *harmonic analysis* of tidal observations, a process which has been carried out for the elevations at more than a thousand stations scattered round the coasts of all the oceans and seas, and for the elevations and currents at a few stations away from the shore in certain shallow seas.

For most places the constituent of largest amplitude is the principal lunar semidiurnal constituent M_2, as would be expected from the equilibrium-form When this is the case we may regard the M_2 elevation as approximately the average tidal elevation at the place in question, and the other constituents as producing inequalities. Where S_2 is the predominating constituent the average interval between successive high waters will be 12 hr. Where M_2 is the largest constituent and S_2 comes next, as in British waters, we have the phenomenon of *spring* tides and *neap* tides. Spring tides occur when the phases of M_2 and S_2 are the same so that S_2 reinforces M_2, and neap tides occur when there phases differ by 180° so that S_2 counterbalances M_2 as far as it can. The phase of S_2 gains on that of M_2 at the rate $2(\sigma - \eta)$, so that the interval between successive spring tides is half a synodic month. While S_2 reinforces M_2 the period of the resultant tide is less than the average, and we have the phenomenon known as *priming*, whereas while S_2 partly counterbalances M_2 the period of the resultant tide is longer than the average and we have the phenomenon known as *lagging*. In the equilibrium-form it is easily seen that spring tides occur at new and full moon and neap tides at the quarters, but in the actual tides these phenomena usually occur a day or two later. Where M_2 is the largest constituent and N_2 comes next, as in certain Canadian waters, we have a phenomenon similar to springs and neaps, except that it depends on the distance of the moon from the earth. Since the phase of M_2 gains on that of N_2 at the rate $\sigma - w$, the period from one reinforcement to the next is an anomalistic month. In the equilibrium-form the reinforcement occurs at the time of lunar perigee, but this is not usually the case in the actual tides Where M_2 is the largest constituent and K_2 comes next we have a similar phenomenon depending on the declination of the moon. The presence of the diurnal constituents gives rise to the *diurnal inequality*, and when the combined diurnal constituents exceed the combined semidiurnal constituents we may have only one high water in the day. Since the period of the M_2 constituent is equal to the interval between two successive culminations (upper or lower) of the mean moon over any meridian, it follows that M_2 high water at any place will always occur at the same interval after a culmination over a definite meridian.

There are other and older methods of describing the chief characteristics of the tides at any place, besides that of specifying the harmonic constituents, though in general they are less satisfactory. The *non-harmonic constants* for a particular place consist of such quantities as the average of all high water intervals, the average of all low water intervals, the average high water interval at springs, the average range, the average range at springs, and the average range at neaps. When one or two harmonic constituents predominate their constants may often be roughly determined from nonharmonic constants.

Geographical Distribution of M_2 Constituent.—(10). We shall now indicate the distribution of the principal lunar semidiurnal constituent M_2 as it has been revealed by harmonic analysis. Considering first the coasts of the *Atlantic*, there is a steady progression from South Africa to Nova Scotia, rapid in the Gulf of Guinea, slower round Cape Verde and again rapid from Ireland to Iceland. Over much of the eastern coast of the United States the M_2 constituent is almost simultaneous, and then along the coast of South America the progression is again northwards The amplitude is greatest on the coasts of Europe and least in the West Indies On both sides of the English channel and south Irish sea there is a progression away from the Atlantic, with amplitudes which reach values greater than at places on the open Atlantic. Round the North sea there is a progression southward along the coasts of Scotland and England, and northward along the continental coasts, the amplitude being very small at the southwest corner of Norway. Up the St Lawrence there is a progression away from the Atlantic. Considering next the *Indian ocean* we exclude the Bay of Bengal and the Arabian sea There is then a progression from Madagascar round by Somaliland, Ceylon, Sumatra and Java to Australia, the amplitudes being small. Along the east coast of the *Pacific* there is a progression both northward and southward away from lower California, the southerly progression being very rapid round the Central American bay. Following the northerly progression round the northern and western boundaries of the ocean we come across a number of stretches, along each of which the constituent is nearly simultaneous. One is along the Kurile Islands and another from the south of Japan to the northwest of New Guinea; another is from the southeast of New Guinea to the north of New Zealand Along the east coast of Japan there is a relatively slow southerly progression, and along the east coast of New Zealand there is a relatively slow northerly progression. Over the Southern ocean the amplitudes are small. In the great oceans away from the continental shores our direct observational knowledge is limited to the islands.

Distribution of Elevation Away from Shore.—(11). A convenient method of describing the distribution of the elevation in a harmonic constituent over an area of the sea is to give on a map the *cotidal* and *co-range* lines. A cotidal line is one through all points of the sea with the same value of τ, and a co-range line is one through all points with the same value of H The records from accurate observations of elevations away from the shore, however, are so scanty that they do not form a sufficient basis for a description of the distribution of a harmonic constituent. To give such a description we must have recourse to theory, and when the currents have been well observed this theory is supplied by the fundamental dynamical equations. These equations connect the elevation-gradients with the currents and the external forces, including those of friction. From a knowledge of the currents and a law for the frictional forces the elevation-gradients can be calculated. When the elevation is also known at a particular point, the directions of the cotidal and co-range lines and also the distance apart of neighbouring members of these lines can be calculated Such conditions are fulfilled for many coasts. If the elevation-gradients can be calculated along a line which passes through one or more points at which the elevation is known, it is clear that methods can be devised by which the elevation can be calculated all along the line. In this way the distribution over the North sea and northern part of the Irish sea as shown in fig 2 have been determined (J. Proudman and A. T. Doodson, *Merseyside* [1923], *Phil. Trans.*, A [1924])

Tides in small seas open to the ocean, are usually such that the actual elevation-gradients are large compared with those of the equilibrium-form, for the equilibrium range of M_2 only changes by 1.6 *ft.* from the equator to the poles. It follows that over such seas the direct effect of the generating forces is negligible, and this means that the tides of these seas are maintained by those of the oceans. It is on the water of the great oceans that the gravitational forces of the moon and sun generate the greater part of the tides To simplify the argument we shall first neglect frictional forces; although often important near land,

these forces are not as a rule predominant. The dynamical equations then express that the direction of the acceleration is the same as that of the downward surface-gradient, and this is perpendicular to the surface contour line. Now at the times of maximum and minimum current the acceleration is perpendicular to the current. We therefore see that at these times the surface contour lines have the direction of the current

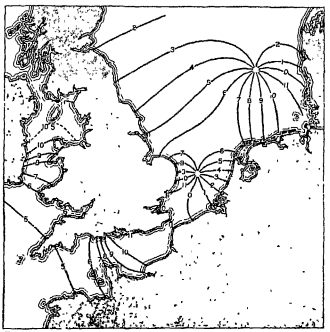


FIG. 2.—COTIDAL LINES FOR M_2 CONSTITUENT IN BRITISH SEAS. NUMBERS GIVE GREENWICH MEAN LUNAR TIME OF HIGH WATER

But the cotidal lines are given approximately by the surface contour lines about the time of the mean level, and the co-range lines are given approximately by the surface contour lines about the time of high water. If high water occurs at maximum or at minimum current, it follows that the cotidal lines will have the direction of the current at the time of mean level, and that the co-range lines will have the direction of the current at high

$$-nU\sin\nu t = -g\frac{\partial\zeta}{\partial x}, \qquad 2\omega U\cos\nu t = -\frac{\partial\zeta}{\partial y}$$

Suppose that at a certain point $\zeta = 0$, always, and take this point for origin $x = y = 0$. Then over a region in which the currents are sensibly uniform we have—

$$\zeta = \frac{U}{g}\sqrt{(n^2+4\omega^2)}\cos n(t-\tau),$$

where—

$$\cos n\tau = \frac{-2\omega y}{\sqrt{(n^2x^2+4\omega^2y^2)}}, \qquad \sin n\tau = \frac{nx}{\sqrt{(n^2x^2+4\omega^2y^2)}}.$$

Over a region where these formulae hold, the cotidal lines radiate from a point and the co-range lines are similar and similarly situated ellipses with this point as centre. Such a point is called an *amphidromic point*, and fig. 2 provides two examples in the North sea

The *frictional resistance* of the sea floor will be directly opposite to the current and its M_2 constituent will have a magnitude approximately proportional to the square of the speed of the M_2 current When the current at any place reaches a maximum, so that the acceleration in this direction is zero, the frictional forces must be balanced by a surface-gradient sloping downward in the direction of the current. For a given current the magnitude of the slope will be inversely proportional to the depth of the sea, so that the effects of friction will be greatest in shallow water Suppose that the conditions are such that in the absence of friction the maximum current and zero elevation would be simultaneous, as occurs in the broadest part of the Irish sea. Then, *owing to friction*, these will be at the time of maximum current a downward gradient in the direction of the current. It follows that mean level will occur progressively later in the direction of the current, and therefore that there will be a progression of high water in this direction

Next suppose that the depth increases away from the shore and that the currents are parallel to the shore. Also, suppose that the surface-gradients parallel to the shore are zero at the same time T along a line perpendicular to the shore, as occurs in the North sea between the Forth and the Humber Then in the absence of friction the currents would reach their maximum at the time T, but owing to friction they must have a backward acceleration at this time, and this acceleration will increase towards the shore It follows that the currents will reach their maximum somewhat before the time T, and that the effect will increase toward the shore We thus see that the inshore currents will turn earlier than those in the offing

Dynamical Explanation of Actual Tides.—(12). Now consider a sea or ocean, and imagine definite limiting vertical sections transverse to the channels which connect it with other seas or oceans Then the tides of this body of water are determined by the equations formulated above, when either the elevations or the normal currents are known functions of time over the limiting sections In explaining the tides in any particular basin it is therefore necessary to assume, either from observation or from other theory, the tidal conditions over the limiting sections The problem of determination is a purely mathematical one, but hitherto it has only been solved for those seas which are of elongated shape and fairly narrow. The simplifying principle concerning the tides of such basins is that the transverse components of current are usually negligible, so that the actual currents are nonrotatory and parallel to the general direction of the basin.

We will now illustrate this "narrow sea theory" by giving a general explanation of the M_2 constituent in the *English channel* As the direct action of the generating forces may be neglected, the tides of the channel are maintained by those of the Atlantic and North sea In the first place we shall leave out of account both the dynamical effects of the earth's rotation and the forces of friction Imagine a fixed material barrier s placed directly across the Strait of Dover so as to cut off the currents in that strait. Under these conditions the tides of the channel would consist of a longitudinal standing oscillation (a seesaw motion) maintained by the tides of the Atlantic and illustrated in fig 3, 8 hour and 11 hour.

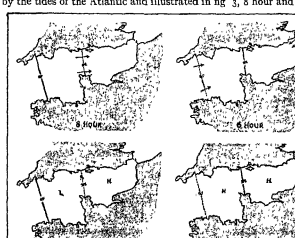


FIG 3.—(8) IMAGINARY BARRIER ACROSS STRAIT OF DOVER. (m) LINE FROM BOURNEMOUTH TO CHERBOURG, (w) LINE FROM CORNWALL TO BRITTANY

There would be a nodal line m from the neighbourhood of Bournemouth to that of Cherbourg along which there was never any tidal elevation. Along a line w from Cornwall to Brittany there would be no currents, and we shall take the vertical section through this line to form the western limit of the channel. The positions of the lines m and w are determined by the distribution of depth in relation to the period At 8 o'clock in lunar time the surface of the water would be everywhere level, with currents everywhere towards the east, these currents being zero at e and w, and reaching a maximum at m. Three lunar hours later, *i.e.*, at 11 o'clock, there would be high water everywhere between m and e and low water everywhere between m and w At 2 o'clock the conditions of 8 o'clock would be reversed, while at 5 o'clock the conditions of 11 o'clock would be reversed. The range of tide would increase steadily from zero at m to maxima at e and w, that at e being greater than that at w on account of the convergence of the channel. Next let us treat the case in which there is no elevation along w so that this line becomes a node. With the barrier at e there would then be no tides at all, but now let us remove this barrier

so that the tides will be entirely maintained by the actual currents in the Strait of Dover Again they will consist of a longitudinal standing oscillation but as illustrated in fig. 3, 6 hour and 9 hour (two connected half see-saws) At 6 o'clock the surface will be level, and the currents will be directed inward toward *m* from both sides, being strongest in the Strait of Dover Three lunar hours later, *i.e.*, at 9 o'clock, there would be high water all over the channel between *e* and *w*, the elevation reaching a maximum near *m* and being zero at *w* and near *e* At 12 o'clock the conditions of 6 o'clock would be reversed, while at 3 o'clock the conditions of

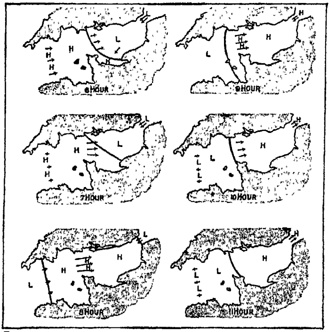


FIG. 4.—M_2 CONSTITUENT OF TIDES OF ENGLISH CHANNEL, (H) INDICATES THAT SURFACE IS ABOVE MEAN LEVEL, (L) THAT SURFACE IS BELOW MEAN LEVEL, LINES SHOW SURFACE AT MEAN LEVEL, ARROWS SHOW CURRENTS

9 o'clock would be reversed. This time the line *m* would be near a loop and *e* near a node Now superpose these two standing oscillations We have the M_2 constituent of the channel-tides as it would be in the absence of the dynamical effects of the earth's rotation and the force of friction. The effect of the earth's rotation is to cause an acceleration to the left of the current and proportional to the speed of the current, and when the current does not rotate this means that there must be a downward surface-gradient to the left of the current and proportional to the speed of the current. On allowing for this effect we arrive at the six diagrams of fig 4, the letter H indicating that the water is above mean level and the letter L that the water is below mean level The lines drawn across the diagrams of fig 4 separate the regions of H from those of L, and are thus the contour lines at mean level Three lunar hours after the times indicated on each diagram these lines will be lines of either high or low water, and therefore cotidal lines. On collecting these lines on to one diagram we have an arrangement of cotidal lines approximating to that shown in fig. 2.

GEOMETRICALLY SIMPLE BASINS

Narrow Basins.—(13) In order to elucidate the general characteristics of tides, it is advisable to study the mathematical problems presented by the solution of their determining equations when the conditions are ideally simple We begin by considering a channel of *uniform rectangular section* and neglect both the dynamical effects of the earth's rotation and the force of friction Let x be measured along the length of the channel and y transversely. Then the equations become—

$$\left.\begin{aligned}&\frac{\partial}{\partial x}(hu)+\frac{\partial}{\partial y}(hv)+\frac{\partial\zeta}{\partial t}=0,\\&\frac{\partial u}{\partial t}=-g\frac{\partial}{\partial x}(\zeta-\bar{\zeta}),\qquad\frac{\partial v}{\partial t}=-g\frac{\partial}{\partial y}(\zeta-\bar{\zeta})\end{aligned}\right\}\qquad(1)$$

If ζ is independent of y these equations will be satisfied by $v=0$ and values of u and ζ which are also independent of y

First suppose that the basin is closed at $x=0$ and communicates with the sea at $x=a$. At $x=a$ suppose that $\zeta=H\cos(nt-\epsilon)$, where H is a constant. Then, if $\bar{\zeta}$ may be neglected, we have to satisfy the equations—

$$\frac{\partial}{\partial x}(hu)+\frac{\partial\zeta}{\partial t}=0,\qquad\frac{\partial u}{\partial t}=-g\frac{\partial\zeta}{\partial x}\qquad(2)$$

with $u=0$ at $x=0$ and $\zeta=H\cos(nt-\epsilon)$ at $x=a$. In the case of uniform depth these equations and conditions possess the solution—

$$\zeta=H\frac{\cos\kappa x}{\cos\kappa a}\cos(nt-\epsilon)$$

$$u=\frac{\kappa g}{n}H\frac{\sin\kappa x}{\cos\kappa a}\cos(nt-\epsilon-\tfrac{1}{2}\pi)$$

where $\kappa=n/\sqrt{(gh)}$, as is easily verified If κa is less than $\frac{1}{2}\pi$ the elevation will everywhere have the same phase as at the open end and the [illegible]

If $\kappa a=\frac{1}{2}\pi$ the formulae for ζ and u becomes infinite and we have the phenomenon of *resonance*. These conditions illustrate to some extent the very large tides of the *Bay of Fundy*, but of course there are many respects in which any actual conditions deviate from those underlying the above equations. For instance, the tides at the mouth of a gulf are not themselves entirely independent of the dimensions of the gulf. The case of resonance corresponds to the coincidence of the nodal line with the place at which a definite amplitude of elevation is prescribed

When the *depth varies* as the distance from the closed end we may take $h=h_0x/a$, where h_0 is the depth at the open end. On eliminating u between the two equations (2) we have—

$$\frac{\partial}{\partial x}\left(x\frac{\partial\zeta}{\partial x}\right)+k\zeta=0,$$

where $k=n^2a/gh_0$, and the solution may be written—

$$\zeta=\frac{J_0(2k^{\frac{1}{2}}x^{\frac{1}{2}})}{J_0(2k^{\frac{1}{2}}a^{\frac{1}{2}})}H\cos(nt-\epsilon),$$

where $J_0(\ )$ denotes Bessel's function of zero order. The profile of the elevation for a particular time is a wave-form of decreasing amplitude, the greatest height being at $x=0$, and the succeeding minima and maxima being -0.40, and 0.30 of this greatest value. The effect of decreasing depth toward the head of a gulf is thus to produce an increase in the range of tide at the head The effect of decreasing breadth is of the same kind and more pronounced, but even when taken together the resulting multiplication is by a very moderate factor The primary cause of the pronounced amplification observed in some gulfs and estuaries is resonance.

To illustrate *seiches in lakes* suppose that there is a closed end at $x=a$ as well as at $x=0$. Then for uniform depth a solution is given by—

$$\zeta=H\cos\kappa x\cos(nt-\epsilon)$$

$$u=\frac{\kappa g}{n}H\sin\kappa x\cos(nt-\epsilon-\tfrac{1}{2}\pi)$$

providing that κa is an exact multiple of π, say $N\pi$. The periods T are then given by—

$$T=\frac{2\pi}{n}=\frac{2\pi}{\kappa\sqrt{(gh)}}=\frac{2}{N}\frac{a}{\sqrt{(gh)}},$$

for $N=1, 2, 3, \cdots$. When $N=1$, we have the *uninodal* seiche; the node is in the middle of the basin, where $\kappa x=\frac{1}{2}\pi$, and the amplitude of the elevation reaches maxima at the two ends When $N=2$, we have the *binodal* seiche in which nodes occur where $\kappa x=\frac{1}{4}\pi$ and $\frac{3}{4}\pi$. When $N=3$, we have the *tri-nodal* seiche in which nodes occur where $\kappa x=\frac{1}{6}\pi$, $\frac{3}{6}\pi$, $\frac{5}{6}\pi$ In the bi-nodal seiche the motion in each half of the lake is the same as that of a uninodal seiche in a lake of half the length, while in the tri-nodal seiche the motion in each third of the lake is the same as that of a uninodal seiche.

Next consider a basin of *parabolic* longitudinal section such that $h=h_0(1-x^2/a^2)$, h_0 being thus the maximum depth. It is easily verified that the equations are satisfied by—

$$\zeta=H\frac{x}{a}\cos(nt-\epsilon),\qquad u=\frac{g}{na}H\cos(nt-\epsilon+\tfrac{1}{2}\pi)$$

where $n^2=2gh_0/a^2$, and in fact the formula represents the slowest free oscillation. It will be noted that the vanishing depth at either end of the basin causes no excessive multiplication of range

When $a=50$ miles, $h=500$ feet, we find $a/\sqrt{(gh)}=35$ minutes.

Now consider the production of *tides* in a *rectangular lake* of uniform depth by the direct action of the generating forces of the moon or sun It will be convenient to measure x from the middle of the lake so that the ends are given by $x=\pm\frac{1}{2}a$. Take $\zeta=Ax\cos(nt-\epsilon)$, where A is a numerical coefficient. Then the solution of the equations and conditions is given by—

$$\zeta = \frac{g}{\kappa}\frac{\sin\kappa x}{\cos\kappa a}\cos(nt-\epsilon)$$

$$u = \frac{g}{n}A\left(\frac{\cos\kappa x}{\cos\kappa a}-1\right)\cos(nt-\epsilon+\tfrac{1}{2}\pi).$$

There is a nodal line across the middle of the lake and the distribution of elevation is skew-symmetrical on either side. Also, the currents reach their maximum on the nodal line. For very small values of κa the above expressions practically reduce to—

$$\zeta = Ax\cos(nt-\epsilon)$$

$$u = \tfrac{n^2}{h}A(a^2-x^2)\cos(nt-\epsilon+\tfrac{1}{2}\pi)$$

and the e-evation has its equilbrium-form. The nature of the phenomenon of r sonance is illustrated by taking $\kappa a = \frac{1}{2}\pi$, when the above expressions .or ζ and u become infinite This means that the period of the disturbin g forces is equal to that of a free oscillation or seiche, but such a relation would not hold for the ordinary tides in any actual lake. Taking $a = 50$ miles, $h = 500$ feet, $n = 2\pi/$day, $\kappa a = 0$ 50, and for such a lake the equilibrium-form would provide a very good approximation to the forced tides.

Long Canals.—(14). Next consider a canal of uniform breadth lying *along a meridian* from pole to pole For a semidiurnal constituent we have for the equilibrium-form—

$$\zeta = CH\sin^2\theta\cos(nt-\epsilon)$$

and therefore the corrected equilibrium-form is given by—

$$\zeta = -\tfrac{1}{2}CH\cos 2\theta\cos(nt-\epsilon).$$

Take the depth h to be uniform and suppose the breadth to be sufficiently small for the transverse current v to be negligible. Then the equations may be written in the form—

$$\frac{h}{a}\frac{\partial u}{\partial\theta}+\frac{\partial\zeta}{\partial t}=0, \qquad \frac{\partial u}{\partial t}=-\frac{g}{a}\frac{\partial}{\partial\theta}(\zeta-\overline{\zeta})$$

and the corresponding solution is given by—

$$\zeta = -\tfrac{1}{2}CH\frac{\cos 2\theta}{1-n^2a^2/4gh}\cos(nt-\epsilon)$$

$$u = -\tfrac{1}{2}CH\frac{na}{h}\frac{\sin 2\theta}{1-n^2a^2/4gh}\cos(nt-\epsilon-\tfrac{1}{2}\pi)$$

as is easily verified. The phase of the elevation is everywhere either the same as, or directly opposite to, that of the corrected equilibrium-form, also, the elevation is symmetrical about the equator and there is a node in latitude 45° N. or S The maximum current is greatest under the nodes and takes zero values at the poles and equator The distribution on each side of the equator is similar to that of a uninodal seiche in a lake of uniform section. The range of tide depends on the quantity $n^2a^2/4gh$, and when this quantity is unity we have the phenomenon of resonance. The equation $n^2a^2=4gh$ gives a critical value of n or period T_0 for any depth, or a critical depth h_0 for any value of n. We may then write—

$$\zeta = \frac{\overline{\zeta}}{1-h_0/h}=\frac{\overline{\zeta}}{1-T_0^2/T^2}$$

For depths or periods less than the critical ones the phase of the elevation will be directly opposite to that of the corrected equilibrium-form, while for depths or periods greater it will be the same. For the elevation to assume its equilibrium-form it is necessary for the depth or the period to become infinite Taking $a = 4{,}000$ miles, $T = \frac{1}{2}$ day, we find $h_0 = 14$ miles; while taking $a = 4{,}000$ miles, $h = 2$ miles, we find $T_0 = 32$ hours.

Considering next a canal of uniform breadth encircling the earth along a *parallel of latitude*, the equilibrium-form for a semidiurnal constituent is given by $\zeta = CH\sin^2\theta\cos(nt+2\phi-\epsilon)$. Taking the depth to be uniform and again neglecting the transverse component of current, the equations reduce to—

$$\frac{h}{a\sin\theta}\frac{\partial v}{\partial\phi}+\frac{\partial\zeta}{\partial t}=0, \qquad \frac{\partial v}{\partial t}=-\frac{g}{a\sin\theta}\frac{\partial}{\partial\phi}(\zeta-\overline{\zeta}).$$

It is easily verified that the solution is given by—

$$\zeta = \frac{\overline{\zeta}}{1-n^2a^2\sin^2\theta/4gh}, \qquad v = -\tfrac{1}{2}na\sin\theta\frac{\zeta}{h}.$$

The motion consists of a wave travelling round the earth with the same speed as the equilibrium-form, and in fact the phase of the elevation is everywhere either the same as, or else directly opposite to, that of the equilibrium-form. At any place the west-going current reaches its maximum at the time of high water.

Broad Basins.—(15). Returning to seas over which we may neglect the curvature of the earth, take a *channel* whose section is uniform along its length, but whose depth may vary from side to side Let us examine the possibility of an exact solution in the form of a wave progressing along the channel with a zero transverse component of current. The equations of free motion become

$$h\frac{\partial u}{\partial x}+\frac{\partial\zeta}{\partial t}=0, \qquad \frac{\partial u}{\partial t}=-g\frac{\partial\zeta}{\partial x}, \qquad 2\omega u=-g\frac{\partial\zeta}{\partial y}$$

and for a solution of the required type we take—

$$\zeta = Z\cos(nt-\kappa x), \qquad u = U\cos(nt-\kappa x)$$

where n and κ are constants and Z, U are functions only of y. On substituting we deduce—

$$h=\frac{n^2}{g\kappa^2}, \qquad \frac{dZ}{dy}=-\frac{2\omega\kappa}{n}Z.$$

These show that the type of wave under examination (called a "Kelvin-wave") can only exist if the depth be uniform, and that then—

$$\zeta = He^{-2\omega\kappa y/n}\cos(nt-\kappa x), \qquad u=\frac{g\kappa}{n}\zeta.$$

The narrow sea theory is thus never an accurate theory when the depth is not uniform For such a channel, however, it is still possible to find an accurate solution representing a wave with straight transverse cotidal lines. When a transverse component v of current is admitted the equations of free motion become—

$$h\frac{\partial u}{\partial x}+\frac{\partial}{\partial y}(hv)+\frac{\partial\zeta}{\partial t}=0,$$

$$\frac{\partial u}{\partial t}-2\omega v=-g\frac{\partial\zeta}{\partial x}, \qquad \frac{\partial v}{\partial t}+2\omega u=-g\frac{\partial\zeta}{\partial y},$$

and at the sides of the channel we must have $hv\to 0$. For a wave of the type to be examined we take—

$$\zeta = Z\cos(nt-\kappa x),$$

$$u = U\cos(nt-\kappa x), \qquad v = V\sin(nt-\kappa x),$$

where again n and κ are constants and Z, U, V are functions only of y. On substituting into the dynamical equations we have—

$$U=\frac{n\zeta}{n^2-4\omega^2}\left(\kappa Z+\frac{2\omega}{n}\cdot\frac{dZ}{dy}\right)$$

$$V=\frac{-n\zeta}{n^2-4\omega^2}\left(\frac{dZ}{dy}+\frac{2\omega}{n}\kappa Z\right)$$

and then, on substituting into the equation of continuity, we have—

$$\frac{d}{dy}\left(h\frac{dZ}{dy}\right)+\left(\frac{n^2-4\omega^2}{g}-\kappa^2h+\frac{2\omega\kappa}{n}\cdot\frac{dh}{dy}\right)Z=0.$$

For each of an infinite number of definite relations between n and κ this equation possesses a solution such that $hV\to 0$ at the sides. It follows that waves with straight transverse cotidal lines are possible in spite of the variable depth In them the principal axes of the current-ellipses are parallel and perpendicular to the sides of the channel, and the time of the maximum longitudinal component of current coincides with that of high water at the same place.

From a mathematical point of view, the basin just considered is analogous to a *circular basin* in which the depth is either uniform or a function only of the distance from the centre. Using polar co-ordinates, r, θ, with the pole at the centre, and letting now u and v denote radial and transverse components of current, we examine a solution of the form—

$$\overline{\zeta} = \overline{Z}\cos(ns-s\theta-\epsilon), \qquad \zeta = Z\cos(ns-s\theta-\epsilon)$$

$$u = U\cos(ns-s\theta-\epsilon-\tfrac{1}{2}\pi), \qquad v = V\cos(ns-s\theta-\epsilon)$$

where n and s are constants and $\overline{Z}$, Z, U, V are functions only of r The constant s will be either a positive or a negative integer, including zero, so that we have a wave progressing round the centre of the sea in either direction, or a standing oscillation. The principal axes of the current-ellipses will be along and perpendicular to the radii. Proceeding as before we obtain—

$$\left\{\frac{1}{r}\frac{d}{dr}\left(rh\frac{d}{dr}\right)-\frac{2\omega}{n}\cdot\frac{s}{r}\cdot\frac{dh}{dr}-\frac{s^2h}{r^2}\right\}(Z-\overline{Z})+\frac{n^2-4\omega^2}{g}Z=0.$$

When $\overline{Z}$ is given so that $\overline{Z}$, n, s are known, this differential equation and the coastal conditions determine Z uniquely, unless n and s happen to be connected as in a possible free motion For free tides in the case of uniform depth, the solution of this equation, finite at the centre of the circle, is $Z = HJ_s(\kappa r)$, where $\kappa^2=(n^2-4\omega^2)/gh$, and H is arbitrary The distribution of elevation in free tides is given by—

$$\zeta = HJ_s(\kappa r)\cos(ns-s\theta-\epsilon)$$

providing that—

$$\kappa aJ_s'(\kappa a)-\frac{2\omega s}{n}J_s(\kappa a)=0,$$

where a denotes the radius of the circular coastline. The equation gives an infinite number of relations between n and s. For given values of h,

n and ω there is a definite infinite sequence of possible periods, with a longest period but with no shortest period (H Lamb, *Hydrodynamics*, Art. 210). The corresponding oscillations are known as "free oscillations of the first class," and so long as the depth is uniform no other free oscillations are possible But when the depth is not uniform there may be, in addition to an infinite sequence of oscillations of the first class analogous to those just investigated, another infinite sequence called "oscillations of the second class" These have a definite shortest period but no longest period (*Ibid*, Art 212)

The mathematical relationships evolved in the two preceding examples of small seas still obtain for an *ocean* in which the depth is a function only of latitude and the coastlines, if any, lie along parallels of latitude. For semidiurnal constituents we have—

$$\zeta = CH\sin^2\theta\cos(nt+2\phi-\epsilon)$$

and we therefore seek a solution of the form—

$$\zeta = CHZ\cos(nt+2\phi-\epsilon)$$

where Z is a function only of θ Proceeding as in the previous examples we obtain—

$$\left\{\frac{d}{d\theta}\left(\frac{h\sin\theta}{n^2-4\Omega^2\cos^2\theta}\frac{d}{d\theta}\right)+\frac{4\Omega}{n}\frac{d}{d\theta}\left(\frac{h\cos\theta}{n^2-4\Omega^2\cos^2\theta}\right)\right.$$
$$\left.-\frac{4h}{\sin\theta}\frac{1}{n^2-4\Omega^2\cos^2\theta}\right\}(Z-\sin^2\theta)+\frac{a^2\sin\theta}{g}Z=0$$

This differential equation, together with the condition $hU\to 0$ at the coastlines, or that the motion remains finite at the poles, determines Z uniquely unless n has one of the values appropriate to free tides The motion consists of a wave travelling round the earth like the equilibrium-form In fact, at any place the phase of the elevation is always either the same as or else directly opposite to that of the equilibrium form. The

7,260	14,520	29,040	58,080
−7·4	−1·8	11·3	1·9
−2·4	−1·8	11·1	1·9
17·59	14 52	12 1	9 24
38 34	26 54	18.40	12 55

gives the ratio of the range of the M_2 constituent on the equator to the corresponding range in the equilibrium-form, when the mutual gravitation of the elevated water is neglected, as in the equations above (H. Lamb, *Hydrodynamics*, Art. 221) The third row gives the same ratio when the mutual gravitation of the elevated water is allowed for The fourth and fifth rows relate to free oscillations of the first class in the expressions for which t and ϕ enter only through the factor $\cos(nt+2\phi-\epsilon)$, and in the calculation of which the mutual gravitation of the elevated water has been taken into account. The fourth row gives in hours and minutes the longest periods of free waves travelling westward, while the fifth row gives similarly the longest periods of free waves travelling eastward. The shortest periods of the oscillations of the second class are all longer than a day. Numerical evaluations of forced tides in a polar or zonal ocean indicate that the actual tides cannot be regarded as derived from tides generated primarily in the Southern ocean (G R. Goldsbrough, *Proc Lond. Math. Soc* (1923), and *Proc. Roy Soc* A(1927)).

(16) The above examples exhaust all the instances in which complete solutions of the dynamical equations may be obtained in a simple form, when the effects of the earth's rotation are taken into account But for seiches, of which the periods are small compared with a day, the effects of the earth's rotation are not important, and when these effects are neglected simple solutions are possible for certain other basins. Consider the *rectangular basin* of uniform depth h bounded by the lines $x=0$, $x=a$, $y=0$, $y=b$ It is easily verified that the equations of free motion are satisfied by—

$$\zeta = H\cos\frac{r\pi x}{a}\cos\frac{s\pi y}{b}\cos(nt-\epsilon),$$

where—

$$\frac{n^2}{gh}=\left(\frac{r^2}{a^2}+\frac{s^2}{b^2}\right)\pi^2$$

r and s are any integers, and H is arbitrary. But the cases in which neither r nor s is zero are probably illustrative of very few actual seiches and the cases in which r or s is zero have already been considered. Analogous to the rectangular basin is the *sectorial basin* whose depth is a function only of the distance from the apex, and whose coastlines are given by $r=a$, $\phi=0$, $\phi=\alpha$ in polar co-ordinates. Again taking u and v to denote radial and transverse components of current, it is easily verified that for uniform depth the equations of free motion are satisfied by—

$$\zeta = HJ_{s\pi/\alpha}(\kappa r)\cos\frac{s\pi\theta}{\alpha}\cos(nt-\epsilon)$$

where s is any integer, κ is such that—

$$J'_{s\pi/\alpha}(\kappa a)=0, \qquad \text{and} \qquad n^2/gh=\kappa^2.$$

Also analogous to these results are expressions for free tides in an *ocean* bounded by meridians and parallels of latitude on a *non-rotating earth* when the depth is a function only of latitude (H. Lamb, *Hydrodynamics*, Art 201) But the solution for the forced tides in such an ocean has only been given in certain special cases (J Proudman and A. T Doodson, *Mem. Nat R.A.S Geophys Supp* (1927)). The *elliptic basin* of uniform depth possesses types of free motion which are analogous to those of the circular basin The Bessel's functions and trigonometrical functions of the circular basin are replaced by Mathieu functions (H Jeffreys, *Proc Lond. Math. Soc* (1923)).

When the earth's rotation is taken into account, the simplest problem not already mentioned is that of the reflection of a Kelvin-wave at the head of a broad *rectangular gulf* of uniform depth For a given depth and period, such a wave can be reflected into one of the same type travelling in the opposite direction, if the breadth of the gulf is not greater than a certain amount (G I Taylor, *Proc. Lond. Math Soc* (1920)). The complete solution then shows a wave progressing toward the head of the gulf on the one side, continuing round the head and then away from the head on the other side There are a number of amphidromic points on the medial line of the gulf In the northern hemisphere the progression is such that the coast is always on the right. This arrangement may be compared with the cotidal lines shown in fig. 2 for the North sea.

The solution for the rotating *rectangular basin* has been given for the case of uniform depth, but is expressed by formulae very much more com-

GENERAL DYNAMICAL QUESTIONS

(17) The *observed tides* on many coasts of the world are very much larger than their equilibrium-forms, and this has usually been attributed to the magnifying effect of shallow seas. But the examples quoted in §13 show that mere diminution of depth, even to vanishing point, is not in itself a necessary source of much magnification, so that some form of resonance is required On the one hand, with midocean tides of the equilibrium order of magnitude, it is possible to have resonance on the continental shelf, if its breadth and depth are suitably related On the other hand, It is also possible to have a considerable degree of resonance in the main oceans themselves, as is shown by the last of the examples quoted above (§16).

All the examples of forced tides for which formulae are quoted above are such as to tend to their equilibrium-forms when their *periods* tend to become *infinite* This, however, is due to the special simplicity of the examples considered and is not a general property of forced tides, when the effects of the earth's rotation are taken into account but those of friction are neglected On taking $\bar\zeta$, $\bar u$, $\bar v$ to be independent of time, the general equations give—

$$\frac{\partial}{\partial\theta}(h\sin\theta u)+\frac{\partial}{\partial\phi}(hv)=0,$$

$$2\Omega\cos\phi v=\frac{g}{a}\cdot\frac{\partial}{\partial\theta}(\zeta-\bar\zeta), \quad 2\Omega\cos\theta u=-\frac{g}{a\sin\theta}\cdot\frac{\partial}{\partial\phi}(\zeta-\bar\zeta).$$

These two dynamical equations show that the current will be directed along the contour lines of $\zeta-\bar\zeta$. On substituting for u, v into the equation of continuity, we find—

$$\frac{\partial}{\partial\theta}(h\sec\theta)\frac{\partial}{\partial\phi}(\zeta-\bar\zeta)-\frac{\partial}{\partial\phi}(h\sec\theta)\frac{\partial}{\partial\theta}(\zeta-\bar\zeta)=0,$$

which shows that $\xi - \bar{\xi}$ must be a function of $\hbar\sec\theta$, or the depth of the ocean measured parallel to the earth's axis We therefore see that steady currents are possible if there are any closed contour lines of $\hbar\sec\theta$, and the actual oceans do contain such contour lines The problem of specifying the nature of the solution of the dynamical equations for the case of forced long period tides is further complicated by the possibility of resonance with the free oscillations of the second class The effects of friction are sufficient to make any forced periodic tide conform to its equilibrium-form if its period is sufficiently long, but a criterion of this length has not yet been satisfactorily evolved If tidal motion were everywhere non-turbulent, friction would have no appreciable influence on a constituent whose period was less than a year It is known, however, that the resultant motion in shallow seas is turbulent, and it is probable that even in midocean the forces of friction are not less than those calculated on the hypothesis of turbulence.

The total rate of *dissipation of energy* by friction in the actual semi-diurnal tides has been estimated at about 2×10^{9} horsepower (H Jeffreys, *Phil. Trans.* A [1920]) The chief contributory areas were found to be the Bering sea, the Yellow sea, Malacca strait and the Northwest passage, the dissipation in the great ocean basins being supposed negligible in comparison The problem of estimating the length of time required to destroy the total energy in any constituent, at the rate at which energy is actually being dissipated in that constituent, turns largely on the amount of magnification of tides in shallow seas If, in midocean, the semidiurnal constituents were of their equilibrium order of magnitude then the time required would be only about two days (H. Jeffreys, *Nature* [1923])

Compound Constituents.—For an exact discussion of tidal

[illegible]

$$\cos(n_1t-e_1)\cos(n_2t-e_2)$$

or

$$\tfrac{1}{2}\cos\{(n_1+n_2)t-e_1-e_2\}+\tfrac{1}{2}\cos\{(n_1-n_2)t-e_1+e_2\}.$$

These represent constituents of speeds n_1+n_2 and n_1-n_2 When the primary constituents are M_2 and S_2 they are denoted by MS_4 and MS_6 respectively. Since the force of friction at the sea-floor is not proportional to the speed of the current, there is also a frictional origin of compound constituents

To examine the matter further we take a *canal of uniform breadth* and depth h, of indefinite length and communicating at $x=0$ with a sea Neglecting the earth's rotation and friction, the equations of free motion are—

$$\frac{\partial}{\partial x}\{(h+\zeta)u\}+\frac{\partial\zeta}{\partial t}=0. \qquad \frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}=-g\frac{\partial\zeta}{\partial x}.$$

When the product terms are neglected a solution of the equations is—

$$\zeta=H\cos n\left(t-\frac{x}{c}\right), \qquad u=\frac{g}{c}H\cos n\left(t-\frac{x}{c}\right)$$

where $c^2=gh$. If now these expressions be substituted into the product terms and the equations again integrated, with no change of elevation at $x=0$, we obtain—

$$\zeta=H\cos n\left(t-\frac{x}{c}\right)-\frac{3}{4}\frac{gnH^2}{c^3}x\sin 2n\left(t-\frac{x}{c}\right),$$

$$u=\frac{g}{c}H\cos n\left(t-\frac{x}{c}\right)-\frac{1}{8}\frac{g^2H^2}{c^3}\cos 2n\left(t-\frac{x}{c}\right)-\frac{3}{4}\frac{g^2nH^2}{c^4}x\sin 2n\left(t-\frac{x}{c}\right).$$

Further approximations would give *second* and *third overtides*, etc All the overtides travel up the canal at the same rate as the fundamental, but they have double, treble, quadruple "speeds," and the ratio of the amplitude of the first overtide to the fundamental is $\frac{3}{4}gnH/c^2$. If the canal shallows very gradually the formula will still hold and we see that the height of the overtide varies as (depth)$^{\frac{1}{2}}$. Fig. 5, read from left to right, exhibits the progressive change of shape. The steepness of the advancing crest shows that a shorter time elapses from low water to high water than inversely. The investigation also shows that the law of the ebb and flow of currents in estuaries mentioned in §2 must hold good.

Instead of an indefinitely long canal, suppose we take a gulf so that

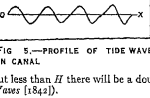


FIG 5.—PROFILE OF TIDE WAVE IN CANAL

with product terms neglected, we have the solution in which at the head of the gulf $\zeta=H\cos nt$ Then, when we retain the product terms and apply the same process as above, we find at the head of the gulf an additional term of the form $-\frac{H^2}{4h}\cos 2nt$ If H' is greater than $\frac{1}{4}H$ but less than H there will be a double high water (G. B Airy, *Tides and Waves* [1842]).

ATMOSPHERIC TIDES

(19) As air, like all other matter, is subject to gravitational influence, there will be tides in the atmosphere possessing many features of similarity with those in the ocean. One of the characteristics of these tides will be a very small oscillatory variation in the atmospheric pressure at any place, and this may be regarded as the superposition of harmonic constituents with the ordinary tidal periods. By the systematic analysis of long series of regular barometric records, the principal lunar semi-diurnal constituent M_2 of the barometric variation has been determined for a number of places, and found to have an amplitude of the order 002 inch The dynamical theory of these tides has been the subject of considerable study. The derivation of the equations is not so simple as for ocean-tides, one difficulty being that of taking account of the physical conditions in the upper regions. The equations which have been proposed are of the same general form as those for ocean-tides, but the theory is still imperfect

The results of analysis for the M_2 constituent show variations of phase from place to place and certain seasonal changes which are as yet unexplained The results of analysis for the S_2 constituent show a much larger oscillation with an amplitude of barometric variation of the order 03 inch For this constituent, however, it is certain that thermal factors play a large part, though the theory is far from complete (S. Chapman, *Quart. Journ. R. Met. Soc.* [1918, 1919, 1924]).

EARTH-TIDES

(20) The main body of the earth yields to tidal forces, either with perfect or imperfect elasticity, and these minute tides of the solid earth have been measured The *measurement* of earth-tides consists in determining the tilt of the earth's surface about its mean position in the earth's figure, and this has been carried out with apparatus of two kinds. One instrument, viz., the horizontal pendulum, is of a type also used in Seismology (O. Hecker, *Veröff. K Preuss. Geod. Inst.* [1907]) Its action is analogous to that of a door whose hinges are not exactly one above the other, so that it lies in a definite vertical plane depending on the position of its line of hinges The other instrument consists of a horizontal tube, of length from 100 to 500 ft., acting as a water-level and read by optical interferometer devices (A A. Michelson, *Astrophys Journ* [1914]). But it should also be possible to detect earth-tides by means of observations of ordinary water-tides. The general form of the dynamical equations, when allowance is made for the yielding of the earth, is—

$$\frac{\partial u}{\partial t}-2\Omega\cos\theta\,v=-\frac{g}{a}\frac{\partial}{\partial\theta}(\zeta+\bar{\gamma}_r-\bar{\gamma}-\bar{\tau}_\theta),$$

$$\frac{\partial v}{\partial t}+2\Omega\cos\theta\,u=-\frac{g}{a\sin\theta}\frac{\partial}{\partial\phi}(\zeta+\bar{\gamma}_r-\bar{\gamma}-\bar{\tau}_\lambda)$$

Now $\bar{\gamma}$ is known, so that if we also know $\bar{\tau}$, u, v, these equations would enable us to calculate—

$$\frac{1}{a}\cdot\frac{\partial}{\partial\theta}(\zeta+\bar{\gamma}_r), \qquad \frac{1}{a\sin\theta}\frac{\partial}{\partial\phi}(\zeta+\bar{\gamma}_r).$$

But in the absence of full observational knowledge of water-tides over a region we must have recourse to a certain amount of theory. Up to the present the method which has been adopted has utilized the ocean tides of long period and in particular the lunar fortnightly constituent Mf It has been assumed that this constituent followed the equilibrium-law, and this is not certain, while in addition there is the fact that the complete equilibrium-form has not yet been numerically calculated. There is a further serious difficulty in isolating the purely astronomical long period constituents in analysis, and it may well be doubted whether reliable constants for the Mf constituent have ever yet been obtained from the records of observation.

When we come to consider the *dynamical theory* of earth-tides we see that there are various factors involved There is the direct response of the solid earth to the tide-generating forces of the moon and sun; there is the yielding produced by the varying pressure of the tidal load on the ocean-floor; there is also the yielding of the earth's varying gravitational field itself, as produced by the moving water and solid earth. The contributions from these factors have not yet been completely disentangled from the results of observation. The period of the slowest free tidal oscillation of a homogeneous sphere of the same radius and mass as the earth, and as rigid as steel, is about one hour (H. Lamb, *Proc Lond. Math. Soc.* [1882]) The corresponding period for a homogeneous fluid sphere, of the same size and mass, is about one and a half hours (W. Thomson, *Phil. Trans.* [1863]). It is therefore probably correct to as-

sume that the period of the free oscillations of the actual earth are all small compared with those of the chief constituents of the tides This means that the earth-tides will approximate closely to their equilibrium forms, or in other words, that they may be calculated on the principles of statics

For an earth of uniform density and elasticity and with an ocean of uniform depth over the whole of it, a complete solution of the tidal problem, both ocean and earth, has been obtained, allowing for all the factors enumerated above (R O Street, *Mon Not R A. S. Geophys. Supp.* [1925]). For the simpler case in which there is no ocean, if the assumed rigidity be that of steel, the earth-tide would be approximately equal to 1/3 of the equilibrium ocean-tide, while if the rigidity be that of glass the fraction would be 3/5 Such determinations as have yet been made indicate that the effective rigidity of the earth as a whole is somewhat greater than that of steel (W. D Lambert, *Bull. U. S. Nat. Research Council* [1922])

ANALYSIS OF OBSERVATIONS

(21). The tide-gauge furnishes us with a continuous graphical record of the level of the water above some known datum mark for every instant of time The first operation performed on this record is the measurement of the height of water above the datum for every mean solar hour. In analysis it is necessary that these hourly heights be combined in such a way as to magnify one constituent relatively to all others, and in practice only linear combinations are used The complete process of finding all the important constituents may be carried out in two stages, in the first of which simple linear combinations are made and in the second, essentially a correction process, the results of all the linear combinations for all the constituents are used. We will restrict our consideration to the problem of determining the principal solar series of constituents S_1, S_2, S_4, whose speeds are exactly 24, 12, 6 mean solar hours At instants of time separated by 24 hours each constituent of this series will have the same value. If then we calculate the average of the heights at the same hour of each solar day, the corresponding value of each of these constituents will be unchanged Any other constituent will occur in a different phase each day, so that the algebraic additions will partially counterbalance, and if the number of days taken extend over a year, the average value for a particular hour of a solar day will be very small, If such an averaging process be carried out for each of the 24 hours of the day we have a method of isolating the principal solar series. When this series has been isolated with sufficient completeness the amplitudes and initial phases of its constituents may be determined in a number of ways (*see* HARMONIC ANALYSIS). The process just sketched has been followed in actual practice, especially in the early days of harmonic analysis of tidal observations. When applied to constituents other than those of the principal solar series it becomes less simple, as it is impossible to choose an interval of an exact number of mean solar hours which gives perfect repetition in the values of any other constituent. A common practice has been to treat the height at any mean solar hour as though it occurred at another time not differing by more than half an hour. In some cases an allowance has been made for this assignment of heights to different times, but in other cases no such allowance has been made. It is clear, however, that the effect on any constituent of any definite arithmetical process may be accurately determined, and this has led to important modifications in the processes of analysis In designing these modifications the criteria in mind have been: (1) the amount of labour involved, (2) the degree of elimination of all other constituents in the analysis for a particular constituent, (3) the completeness of the analysis (A T Doodson, *Phil Trans.* A [1927]). Similar methods will serve for the analysis of a continuous record of a particular component reduced to harmonic form, say in the west-to-east or south-to-north directions. Methods have also been devised for the harmonic analysis of observations of times and heights of high and low water only, and for the observations of times of slack water only (G. H. Darwin, *Proc. Roy. Soc.* [1890]; A. T. Doodson, *ibid.* [1928]).

Even when the most complete methods are utilized on the most carefully made observations, there remains quite an appreciable fraction of the variation of sea level which has not been reduced to law. For British waters this reaches the order of magnitude of 1 ft. and consists of something lying outside the harmonic constituents with the periods of the generating potential or of a small number of compound constituents (A. T. Doodson, *Brit Assoc. Report* [1921]).

The variations of *atmospheric pressure* and *wind* produce changes in the level of the sea. Under favourable conditions and as a consequence of storms the change of level in an estuary may exceed 10 ft. In so far as such changes are not periodic they are not represented by the results of harmonic analysis.

PREDICTION: TIDE-TABLES

(22). For many purposes it is of great importance to know in advance the times and heights of high water at a particular place on a particular day. Consequently governments and harbour authorities publish, a year or so in advance, tables giving such information for all the principal ports of the world In a few cases tables are similarly published giving the height of water above datum at every hour of the year, while for a certain number of navigable channels tables of the times of slack water are also issued The determination of the information contained in these tables is known as tide prediction, and obviously demands a knowledge of the laws of the tides at the place in question, including their correlation with astronomical variables. The standard method of tidal prediction is the harmonic method based on the idea of harmonic constituents (§9), and the necessary information for any particular place is provided by the process of harmonic analysis (§21) For a number of ports, however, some of which are in British waters, it is found practicable to use the older nonharmonic methods, based on the nonharmonic constants (§9). In any case, the only part of the dynamical theory which is utilized is that which relates to periodicity, at one place, so that the empirical element is still very large.

The process of *harmonic prediction* consists in the calculation of the value of each harmonic constituent for a given time, and then the addition of the values obtained for all the constituents. When this is done for every hour of a year, the computational task becomes enormous, and to obviate this a calculating machine has been specially designed. Fig 16 illustrates diagrammatically the nature of the instrument A cord passes over and under a succession of pulleys, every other pulley being balanced in a fixed position and the alternate ones being movable, the cord is fixed at one end and carries at the other a pen which traces a curve on a revolving drum In the diagram the instrument possesses one unit; there are two balanced pulleys and one movable one. If the latest or movable pulley were made to oscillate up and down with simple harmonic motion the pen would execute the same motion on twice the linear scale If the instrument possessed two units, *i.e.*, one more movable pulley and one more balanced one, and the second movable pulley also rocked up and down, the pen would add to its previous motion that of this second oscillation, again on twice the scale For any number of additional units the pen would add together all the separate simple oscillations The rocking motion is communicated to each movable pulley by means of a pin *P* attached to a fixed point of the wheel of centre *C*, sliding in a slot attached to the pulley frame All the wheels *C* and the drum are geared together so that, as the drum turns, all the movable pulleys rock up and down The gearing is of such a nature that if one revolution of the drum represents a single day, the rocking motion of each movable pulley corresponds to one harmonic constituent. The nature of the gearing is determined by the relative speeds of the different constituents, but the length of each crank *CP* and the angle at which it has to be set are derived from the results of harmonic analysis. When the machine has been set appropriately it will run off a complete tide-curve for any length of time.

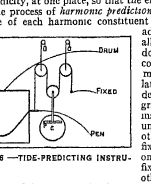


FIG 6.—TIDE-PREDICTING INSTRUMENT

Of course the irregular *meteorological effects* on sea level cannot be incorporated in a tide-table, and hence any individual prediction is liable to differ considerably from the actual occurrence

HISTORY OF THE STUDY OF TIDES

(23). The writings of various Chinese, Arabic and Icelandic authors show that they paid some attention to the tides, but the theories advanced are fantastic. The writings of the classical authors of antiquity contain but a few references to the tides, for the Greeks and Romans lived on the shores of an almost tideless sea.

Johann Kepler (q.v.) recognized the tendency of the water of the ocean to move towards the sun and moon, but Galileo's explanation referred the phenomenon to the rotation and orbital motions of the earth. It was Isaac Newton (q.v.) who, in his *Principia* of 1687, laid the foundations of the modern theory of the tides when he first gave the correct explanation of the tide-generating forces. He considered a canal of uniform depth encircling the globe, the plane of which was parallel to the plane of the moon's orbit, and showed that the tide-generating force would cause a wave to travel round the canal with a velocity equal to that of a long wave in the canal. He proved that the time of high water at any place would be the same on each day, and that the height would be greatest when the moon was on the meridian of the place. He considered the case of the canal lying in the plane of the moon's orbit, and investigated the effect of the obliquity of the moon's orbit to the equator. He also considered the case when the canal was inclined to the equator, and showed that the tide-generating force would be reduced in the ratio of the cosine of the inclination. Newton's theory was developed by Bernoulli, Euler and Maclaurin, who added to the theory the consideration of the effect of the sun. Laplace introduced the idea of the dynamical resonance of the ocean basins, and J. Redfield pointed out the importance of the shape of the coast-line and the configuration of the bottom of the sea. Finally, Lord Kelvin and Sir William Thomson (afterwards Lord Kelvin) made the important contributions.

In the early years of the 19th century the work was mainly concerned with the practical problem of tide prediction. In the Mediterranean Sea the tides are of small amplitude, so that the consequent feature of coast-tides is the dependence of an ocean constituent upon the speed. Henry Aldrich (q.v.) was the first to take advantage of this fact in the construction of his tide-tables.

The connexion between the tides and the motions of the moon and sun was also one that lent itself to empirical methods, and rules and published tables of tide-predictions had covered their appearance before the first complete mathematical theory of the tides was advanced by Bernoulli. The first complete tide-table was afforded by Bernoulli's rules for Liverpool, based on

twenty years of personal observation by a harbour-master named Hutchinson. The use of automatic tide-gauges appears to have begun about 1830.

The work of J. Lubbock (Senior) and W Whewell is chiefly remarkable for the co-ordination and analysis of data at various ports, and for the construction of tide-tables Airy in his *Tides and Waves* of 1842 studied profoundly the theory of tidal motions in canals, while in 1847 and 1857 F W Beechy published the results of a survey of tidal currents over the Irish sea, the English channel and the North sea (*Phil. Trans*).

About 1863 W. Thomson (afterwards Lord Kelvin) became interested in the problems presented by earth-tides. In 1866 he took up the analysis of ordinary tidal observations and established the harmonic methods, which quickly developed He introduced the rotation of the earth into the tidal dynamics of small seas, and in 1872 he designed the tide-predicting machine.

In 1874 W. Ferrel, of the U.S coast and geodetic survey, published his *Tidal Researches* which included a harmonic development of the generating potential, and from the same year A. W Baird, of the survey of India, organized a service of observation and harmonic analysis for Indian tides. In 1883 G. H. Darwin took up harmonic analysis and [illegible]

[illegible]

[illegible] in each ocean there exist regions capable of free oscillation with a period near one of the principal tidal periods, and that the nature of these free oscillations may be calculated approximately, without allow- [illegible]

[illegible]

[illegible] (3rd ed. 1911); E. Fichot, *Les marees et leur utilisation industrielle* (1923); H. A. Marmer, *The Tide* (1926); A. Defant, *Gezeitenprobleme des Meeres in Landnahe* (1925). *See* also Kelvin's collected *Mathematical and Physical Papers*, G. H. Darwin's collected *Scientific Papers* and the various treatises and papers referred to in the article.

For information on actual tides *see* the *Admiralty Tide Tables*, Part II, and tables published by the U.S. Coast and Geodetic Survey.

For full bibliographies *see* J. C. Houzeau and A. Lancaster, *Bibliographie de l'astronomie* (1882), and a bibliography of publications from 1910–1927 published by the International Union for Geodesy and Geophysics. (J. Pr.)

TIDORE or **TIDOR,** a mountainous island of the Moluccas, D E. Indies, lying south of Ternate, nearly circular in shape, with an area of about 30 square miles. The southern part is occupied almost entirely by an inactive volcanic peak (5,900 ft.). Below the 1,000 ft. level coffee, fruit and tobacco are cultivated, the soil being very fertile. The northern half consists mostly of hills, though there are a few level strips along the coast. Pop., about 25,000. Tidore is part of the residency of Ternate, and, with neighbouring islands, comes under the resident of Ternate. The inhabitants are akin to the Ternatans. They dislike work, but sell fish and cultivate garden produce. Some Tidorese do smiths' work, in which they are proficient.

The other islands of the Ternate-Tidore group are Hiri, Mayu, Taifore, Maitara, Pilonga, Maré, Pasuraja, Moti, Makian, Waidoba, Taneti and the Kayua and Goraityi groups. All stretch along by the coast of Halmaheira towards Bachian, with the exception of Taifore and Mayu, which lie out in the Molucca passage. Kayua (of coralline and crystalline rock formation), is nearly 10 mi. long and has a mountain range traversing most of its length The people are Mohammedans, and grow rice and maize, and fish. Makian has a mountain of more than 4,000 ft., is well-wooded, volcanic, and has suffered from eruptions. It has a population of more than 8,000 Mohammedans, resembling the people of Ternate and Tidore, who weave, fish and grow tobacco, fruit, rice and sugar cane. Sago, the staple food, is imported from Halmaheira. Moti is surrounded with coral reefs. Maitara has mountains which attain an elevation of nearly 3,000 ft., and is well forested and fertile.

Like Ternate, Tidore is the seat of an ancient and once powerful sultanate. The Portuguese established themselves there in 1521 and fought the sultan, whose capital they destroyed. Later, the Spaniards, when Portugal had become incorporated with Spain, obtained a hold which they retained until well into the 17th century, aiding the Tidorese in maintaining their independence in Ceram, Halmaheira and other islands, against the sultan of Ternate and the Dutch. The latter, in 1654, conquered the island, but recognized the nominal power of the sultan. Japan occupied Tidore in 1942. (E. E. L.; X)

TIDY TIPS (*Layia platyglossa*), a small North American herb of the family Compositae, native to California. It is an attractive spring-blooming annual, about a foot high, bearing showy flowering heads, 1½ in broad, with sulphur-yellow rays tipped with white. This plant and other related Californian species, as *L. elegans*, are grown as garden annuals. The white-flowered *L glandulosa*, found from British Columbia to Mexico, is also cultivated

TIECK, JOHANN LUDWIG (1773–1853), German poet, novelist and critic, was born in Berlin on May 31, 1773, his father being a rope maker. He was educated at the Friedrich-Werdersche gymnasium, and at the universities of Halle, Gottingen and Erlangen. At Göttingen Shakespeare and the Elizabethan drama were the chief subjects of his study. In 1794 he returned to Berlin, resolved to make a living by his pen. He contributed a number of short stories (1795–1798) to the series of *Straussfedern*, published by the bookseller C. F. Nicolai and originally edited by J K. A. Musäus, and wrote *Abdallah* (1796) and a novel in letters, *William Lovell* (3 vols. 1795–1796). Tieck's transition to romanticism is to be seen in the series of plays and stories published under the title *Volksmärchen von Peter Lebrecht* (3 vols., 1797), a collection which contains the admirable fairy-tale *Der blonde Eckbert*, and the witty dramatic satire on Berlin literary taste, *Der gestiefelte Kater.* With his school and college friend W. H. Wackenroder (1773–1798), he planned the novel *Franz Sternbalds Wanderungen* (vols i–ii 1798), which was the first expression of the romantic enthusiasm for old German art

In 1801 Tieck went to Dresden, then lived for a time near Frankfort-on-the-Oder, and spent many months in Italy. In 1803 he published a translation of *Minnelieder aus der schwäbischen Vorzeit,* between 1799 and 1804 an excellent version of *Don Quixote*, and in 1811 two volumes of Elizabethan dramas, *Altenglisches Theater.* The stories *Der Runenberg, Die Elfen, Der Pokal,* and the dramatic fairy tale, *Fortunat,* with earlier works, appeared in the collection *Phantasus* (3 vols., 1812–17). In 1817 Tieck visited England in order to collect materials for a work on Shakespeare (unfortunately never finished) and in 1819 he settled permanently in Dresden; from 1825 on he was literary adviser to the Court theatre, and his semipublic readings from the dramatic poets gave him a reputation which extended far beyond the Saxon capital. The new series of short stories which he began to publish in 1822 also won him a wide popularity. Notable among these are *Die Gemälde, Die Reisenden, Die Verlobung, Des Lebens Überfluss.* More ambitious and on a wider canvas are the historical or semihistorical novels, *Dichterleben* (1826), *Der Aufruhr in den Cevennen* (1826, unfinished). *Der Tod des Dichters* (1834), *Der junge Tischlermeister* (1836; but begun in 1811), an excellent story written under the influence of Goethe's *Wilhelm Meister. Vittoria Accorombona* (1840), in the style of the French Romanticists, shows a falling-off. In later years Tieck carried on a varied literary activity as critic (*Dramaturgische Blätter,* 2 vols., 1825–26; *Kritische Schriften,* 2 vols, 1848); he also edited the translation of Shake-

speare by A. W. Schlegel, who was assisted by Tieck's daughter Dorothea (1799–1841) and by Graf Wolf Heinrich Baudissin (1789–1878); *Shakespeares Vorschule* (2 vols, 1823–29), the works of H. von Kleist (1826) and of J. M. R. Lenz (1828). In 1841 Friedrich Wilhelm IV of Prussia invited him to Berlin where he enjoyed a pension for his remaining years. He died on April 28, 1853

Tieck's *Schriften* appeared in 20 vols. (1828–46); and his *Gesammelte Novellen* in 12 (1852–54). *Nachgelassene Schriften* were published in 2 vols in 1855. Of modern editions of *Ausgewaehlte Werke see* those by G. Klee (with an excellent biography, 3 vols, 1892), and G. Witkowski (4 vols, 1903). *The Elves* and *The Goblet* were translated by Carlyle in *German Romance* (1827), *The Pictures* and *The Betrothal* by Bishop Thirlwall (1825) *See* for Tieck's earlier life R. Kopke, *Ludwig Tieck* (2 vols, 1855), for the Dresden period, H. von Friesen, *Ludwig Tieck. Erinnerungen* (2 vols, 1871), Also A. Stern, *Ludwig Tieck in Dresden (Zur Literatur der Gegenwart*, 1879), B. Steiner, *L. Tieck und die Volksbucher* (1893); H. Bischof, *Tieck als Dramaturg* (1897); H. Luedeke, *L. Tieck und das alte englische Theater* (Frankfurt, 1922), A. E. Lussky, *Tieck's approach to Romanticusm* (Borna-Leipzig, 1925).

TIEL, a town in the province of Gelderland, the Netherlands, on the right bank of the Waal (here crossed by a pontoon bridge), 25 mi by rail west of Nijmwegen. Pop. (1940), 12,705 It possesses fine streets and open places, but of its fortifications the Kleiberg gate (1647) alone remains. The principal buildings are St. Martin's church (15th century), the town hall, courthouse and the historical castle of the family of van Arkel

TIELE, CORNELIS PETRUS (1830–1902), Dutch theologian and scholar, was born at Leiden on Dec. 16, 1830 He was educated at Amsterdam high school and afterward at the seminary of the Remonstrant Brotherhood. He was destined for the pastorate in his own brotherhood. Tiele certainly had liberal religious views himself, which he early enunciated from the pulpit, as Remonstrant pastor of Moordrecht (1853) and at Rotterdam (1856). Upon the removal of the seminary of the brotherhood from Amsterdam to Leiden in 1873, Tiele was appointed one of its leading professors. In 1877 followed his appointment at the university of Leiden as professor of the history of religions, a chair specially created for him. Of his many learned works, the *Vergelijkende geschiedenis van de egyptische en mesopotamusche Godsdiensten* (1872), and the *Geschiedenis van den Godsdienst* (1876; new ed. 1892), have been translated into English, the former by James Ballingall (1878–82), the latter by J. Estlin Carpenter (1877) under the title "Outlines of the History of Religion" (French translation, 1885; German translation, 1895). A French translation of the *Comparative History* was published in 1882. Other works by Tiele are: *De Godsdienst van Zarathustra, van het Ontstaan in Baktrie, tot den Val van het Oud-Perzische Rijk* (1864) a work now embodied, but much enlarged and improved by the latest researches of the author, in the *History of Religions* (vol. ii, part ii, Amsterdam, 1901), a part which appeared only a short time before the author's death; *De Vrucht der Assyriologie voor de vergelijkende geschiedenis der Godsdienten* (1877; German ed., 1878); *Babylonisch-assyrische Geschichte* (two parts, Leipzig, 1886–88); *Western Asia, according to the most Recent Discoveries* (London, 1894). He was also the writer of the article "Religions" in the 9th edition of the *Encyclopædia Britannica.* He died on Jan. 11, 1902

TIEN-SHAN or Celestial Mountains, one of the most extensive mountain systems of Central Asia In the widest acceptation, the system extends from the Aral-Caspian depression (about 67° E.) to the great bend of the Hwang-ho (about 103° E.). Chinese geographers confine the term to that part between Khan-tengri (80° 11′ E. and 42° 13′ N.) and the Barkul depression (92°–93° E.), where the northern ranges abut upon the Ektagh Altai;' and this conception is accepted by some European geographers. P. P. Semenov applies the name to the ranges which lie immediately west of Khān-tengri, including Khan-tengri The Tarbagatai and their northwestern continuation, the Chinghis mountains, are sometimes considered to belong to the Altai system; but there are good reasons for regarding them as an independent range. Excluding these, the northernmost member of the Tien-shan system is the Dzungarian Ala-tau (45° N.), the southernmost, the Trans-Alai, or rather its west prolongation, Peter the Great mountains in Karateghin (Bukhara), though some geographers assign both the Alai and the Trans-Alai mountains to the Pamirs.

Khan-tengri and the Central Tien-shan.—The peak of Khan-tengri (22,440 ft.) stands but on a spur which projects from the main watershed of the central Tien-shan, towards the southwest The loftiest summit on the actual watershed is named Nicholas Mikailovich (22,670 ft.). The general altitude of the crest of the watershed is about 16,500 ft., and it is overtopped by peaks rising 3,000–3,500 ft. higher. East of Khan-tengri is Khalyk-tau, and west three diverging lines of elevation, viz , the Terskei Alatau; the Kokshal-tau, continued in the Terez Mountains, and, between these two, the successive ranges of the Sary-jas, Kulu-tau, and Ak-shiryak. The snowy chain of Khalyk-tau is highest in the west and sinks gradually towards the east. The highest parts of the range have generally an east-west strike and the range itself is continued east in the Kokteke (12,300 ft.), with the Kui-kuleh pass at 11,500 ft.

From Issyk-kul there is a sharp rise of 6,000–9,000 ft. to the snow-capped ridge of the Terskei Ala-tau, the peaks of which ascend to 15,000–16,500 ft and even 18,000 ft. At this part the system has a breadth of 150 mi. The Terskei Ala-tau forms a sharp, continuous, snow-clad range. It is continued westwards in the Son-kul (alt. 9,500 ft.), the Kara-kol, and the Suzamir-tau, until it abuts upon the Talas-tau. There are broad shallow basins south of the Terskei Ala-tau and between them from five to seven ridges as broad as the basins. The ridges rise to 13,000–16,000 ft. by long gentle slopes, are flat topped and snow covered with a few individual peaks and passes Beeng an uplifted peneplain and little or no erosion having taken place since late Tertiary times, the result is that although highly mountainous, in external appearance the district is that of a plateau The passes over the Terskei Ala-tau and the country to the south lie at great altitudes—Kulu-tau (13,560 ft), Bedel (13,800 ft), Kubergenty (12,400 ft.), Terekty (12,600 ft.) and Jan-art (14,440 ft)—all in the Kokshal-tau; Terek (12,800 ft) and Turugurt (12,730 ft), both in the Terek range; Barskaun (12,000 ft), Suka (11,650 ft.), and Jauku (14,000 ft) in the Terskei Ala-tau; and Tez (11,800 ft.) and Akbel (12,000 ft), both in the Sary-jas, and Muz-art (12,000 ft) on the east shoulder of Khan-tengri. The snow-line on Terskei Ala-tau runs at 11,500 ft. The summits of the Kulu-tau reach 13,700 to 14,750 ft.; those of the Ak-shiryak 15,000–16,000 ft. The Kokshal-tau consists of several parallel ranges, is truly alpine in character and bears large glaciers, which send out arms into U-shaped valleys, behind which the pyramidal mountain peaks tower up. The loftiest range is that to the north, which exceeds 16,000 ft., and the altitude increases generally from west to east as far as the Bedel pass in 78° 30′ E., where the road crosses from Ak-su and Uch-Turfan to the valley of the Naryn and Ferghana

Eastern and Northern Tien-shan.—The system is known here locally as the Barkul Mountains and the Karlyk-tagh. Its middle parts are snow-clad, the snow lying down to 12,000 ft. on the north side, while the peaks reach altitudes of 13,000–14,700 ft., but the range is only crossed by passes in the east, at altitudes from 7,805–10,984 ft. Toward the east, the Karlyk-tagh radiates outward, and decreases in altitude, though it rises again in the rocky Emir-tagh. From the Karlyk-tagh a stony desert slopes south to the Chol-tagh. The Chol-tagh marks the northern escarpment, as the Kuruk-tagh, farther south, the southern escarpment, of the great Pe-shan swelling of the desert of Gobi. These two ranges are eastern prolongations, the former of the Khaidyk-tagh and the latter of the Kok-teke Mountains; which enclose on north and south respectively the Yulduz valley and the Lake of Baghrash-kul Thus the Kuruk-tagh are linked, by the Kok-teke, on to the Khalyk-tau of the Khan-tengri group. The Khaidyk-tau, which are crossed by the passes of Tash-again,m (7,610 ft.) and Kotyl (9,900 ft.), are probably connected with the Trans-Ili Ala-tau, or its twin parallel range, the Kunghei Ala-tau, in the west The Narat-tau appear to form a diagonal link between the Khaidyk-tau and the Khalyk-tau and are crossed by passes Sarytvur (10,800 ft.), Mukhurdui (11,800 ft.), Jambi (11,415 ft.)

and the Dundeh-keldeh (11,710 ft.).

West of the Barkul range is the gap of Otunkoza by which the Hami and Barkul caravan roads cross into the valley of Dzungaria, and at Urumchi (87° 30′ E.), over 200 mi. farther west, is a similar gap which facilitates communication between Turfan and Dzungaria. Between these gaps stretches the snow-clad range of the Bogdo-ola, average altitude 13,000 ft., and rising to 17,000–18,000 ft. in the double peak of Turpanat-tagh. On the north side of this range the snow-line runs at an altitude of 9,500 ft. At the foot lies the broad, deep valley of Dzungaria (2,500–1,000 ft.). On the south the Bogdo-ola is flanked by the nearly parallel range of the Jargoz, a range which carries no perpetual snow. But its altitude does not exceed 10,000 ft., and its steep rocky slopes meet in a sharp, denticulated crest. West of the Urumchi gap, the Bogdo-ola is continued in the snow capped double range of the Iren-khabirga (11,500 ft.), which curve northwest and finally, as the Talki mountains, merge into the Boro-khoro range. They culminate in the peak of Dos-megen-ora (20,000 ft.). The Boro-khoro mountains (average elevation 11,500 ft.) have all the characteristics of a border-ridge. The slopes are clothed with Coniferae between 6,000 and 9,000 ft., and the range separates the valley of Kulja (Ili) on the south from the depressions of Zaisan-nor (6,820 ft.) and Ebi-nor (670 ft.). It passes in the Boro-khoro ile at lower altitudes than is usual in the Tien-shan ranges, namely at 7,000–7,415 ft.

On the north side of the valley of Borotala is the Dzungarian Ala-tau, the northernmost member of the Tien-shan. The two principal series of parallel ranges are the northern series (going from east to west) of the Baskan-tau, Sarkan-tau, Karazryk-tau, Bionyn-tau, and Koranyn-tau, at an average elevation of 11,000–13,000 ft., and the southern series of the Urtak-saryk, Bejin-tau and Kok-su, at altitudes of 12,000–14,000 ft.

Western and Southern Tien-shan.—On the north side of the Issyk-kul are the parallel twin ranges of the Trans-Ili Ala-tau and Kunghei Ala-tau. The two chains are connected by the lofty transverse ridge of Almaty. The Trans-Ili Ala-tau swings away to the north-west, and is continued in the echeloned ranges of Kandyk-tau, Kulja-bashi, Khan-tau and the Chu-Ili mountains of general altitudes between 4,000 ft. and 9,000 ft. These latter ranges separate the Muyunkum desert on the west from the Balkash deserts. The Trans-Ili itself culminates in Mt. Talgar at an altitude of 15,725 ft. The Kunghei Ala-tau rises 8,000 ft. above the Issyk-kul and lifts its summits higher than 13,000 ft. The passes across the twin ranges lie at 8,000–11,000 ft. (Almaty pass) in the Trans-Ili Ala-tau and at 9,000–10,885 ft. (Kurmenty pass) in the Kunghei Ala-tau. On neither of these ranges are there any true glaciers.

The Alexander mountains terminate over against the town of Aulie-ata (71° 20′ E.) at the relatively low altitude of 2,460 ft., though farther east they rise to 13,000–14,000 ft., and even reach 15,350 ft. in Mt. Semenov. On the north their declivities are steep and rugged. They are crossed by passes at 6,550–11,825 ft.

From the middle of the Alexander range (74° E.) the Talas-tau breaks away in a west-south-west direction, and from near the western extremity of this latter two parallel ranges, the Chotkal (14,000 ft.) and the Ala-tau, break away in a south-westerly direction, and running parallel to one another and to the river Naryn, terminate at right angles to the middle Syr Darya, after it has made its sweeping turn to the northwest. The Talas-tau has an average elevation of 14,000–15,000 ft., its snow-capped summits at 15,750 ft.; it is crossed by passes at 8,000–10,650 ft.

Near the west end of the Alexander range, (71° E.) the Karatau stretches northwest, between the Syr Darya and the Chu. It consists almost entirely of sedimentary rocks. Its average elevation is 5,000 ft., in places it reaches 7,000–8,000 ft. In the same north-westerly to south-easterly direction are the Ferghana mountains. The Ferghana mountains, which are cleft by the Naryn river, have a mean altitude of 10,000 ft., but attain elevations of 12,740 ft. (Suyuk) and are crossed by the Terek pass at 9,140 ft.

On the south of the Ferghana valley is the lofty range of the Alai, backed by the parallel range of the Trans-Alai. Both ranges abut at their eastern extremity upon the Pamir plateau, and both extend a long way out into the desert. The Alai is a well-defined ridge with steep slopes, and both it and Terek-tau, which prolongs it towards the Kokshal-tau, are flanked next the Ferghana valley Palaeozoic metamorphic limestones and newer Tertiary series of softer conglomerates and sandstones. The general altitude of both ranges is 16,000–19,000 ft., but the Trans-Alai culminates in peak Kaufmann (23,386 ft.). The Trans-Alai is a true border range, the ascent to it from the Pamir plateau (13,000 ft.) on the southeast being gentle and relatively short, while both it and the Alai tower above the valley of the Alai to an altitude of 11,000 to 14,000 ft. This valley is 75 miles in length and is continued toward the southwest by the valley of Karateghin. Its breadth varies from three to 12 miles, and it falls from 10,500 ft. (north-east) to 8,200 ft. (south-west). It is drained by the Kyzyl-su, which, under the name of Vakhish, finally enters the Amu Darya. Despite frequent avalanches of snow it is an important highway of communication between Bukhara and the Pamirs on the one hand and Kashgar and Ferghana on the other. The principal passes over it into the valley of Ferghana are Taldyk, 11,605 ft. with a military road; Iuptyk, 13,605 ft.; Saryk-mogal, 14,110 ft.; Tenghiz-bai, 12,630 ft.; and Kara-kazyk, 14,305 ft. The Pamir plateau is reached by the Kyzyl-art pass at 14,015 ft.

The Alai Mountains are continued westward in the radiating ranges of the Karateghin, Zarafshan and Hissar Mountains and the Turkistan range, which reach altitudes of 18,500 ft. The Trans-Alai are continued in the Peter the Great range, which culminates in the Sandal group (24,935 ft.). The passes across these ranges are difficult and at 10,000–13,000 ft. The last outlying range of the Tien-shan system in this direction is the Nura-tau. It rises abruptly from the desert and lifts its snowy peaks to altitudes of 15,000–16,000 ft., separating the river Syr Darya from the river Zarafshan. The passes over it lie at 10,000–13,000 ft.

Routes.—The traditional routes between China, and West Turkistan and Persia have crossed the Tien-shan system at some half a dozen points. After traversing the desert of Gobi from Sa-chou to Hami, the northern route crossed over into the Dzungarian valley either by the Otun-koza depression or by the gap at Urumchi, or else it proceeded over the Muz-art pass on the east side of Khan-tengri or over the Bedel pass in the Kokshal-tau and so down into the valley of Kulja. The shortest route, though not the easiest, between Kashgar and East Turkistan, and Ferghana and West Turkistan is over the Terek pass or the pass at the head of the Alai valley, a dangerous route in winter by reason of snow

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TIENTSIN, a large commercial city in the province of Hopei, China. Estimated pop. (1935) 1,217,616. It is situated at the junction of the Peiho and the Hun-ho, which is connected by the Grand canal with the Yangtze kiang. The town is built on a vast alluvial plain, which extends from the mountains beyond Peiping to the sea, and through which the Peiho runs a circuitous course, making the distance by water from Tientsin to the coast about 70 mi, as against 30 mi. by rail. The area is 21 sq mi.

In 1853 Tientsin was besieged by an army of T'aip'ing rebels, who were ultimately forced to retreat. The city and suburbs were occupied by allied forces, English and French, in 1860–62. The city was constituted an open port. There were further riots in 1870. During the period 1874–94 the city prospered under Li Hung-Chang, viceroy of Chihli. The entire city, native and foreign, suffered severely during the Boxer hostilities, June-July 1900. After this the city walls were razed and the municipal services considerably improved. In 1937 the Japanese attacked and bombarded the Chinese city and destroyed the Nankai university. In 1939 they blockaded the British concession to force

recognition of their supremacy in north China.

TIEPOLO, GIOVANNI BATTISTA (1692–1769), Italian painter, was born at Venice, and acquired the rudiments of his art from Gregorio Lazzarini, and probably from Piazzetta, though the decisive influence on the formation of his style was the study of Paolo Veronese's sumptuous paintings. He developed an extraordinary facility of brushwork, and proved himself, as a fresco-painter, a colourist of the first order, though this early mastery of technique made him frequently neglect form and composition. He decorated many Venetian churches and palaces with ceilings and frescoes full of turbulent movement and rich colour, extending his operations to the near cities of the mainland and to Bergamo (Colleoni chapel) and Milan (ceiling at Palazzo Clerici). In 1750 he went to Würzburg to paint the magnificent ceilings and frescoes at the archbishop's palace. From 1753 to 1761 he worked again at Venice and in the cities of northeast Italy, until he was summoned to Madrid by Charles III to paint some frescoes for the royal palace. He died at Madrid in 1769.

Tiepolo's altarpieces and easel pictures show more clearly even than his frescoes how deeply he was imbued with the spirit of Paolo Veronese, for in these smaller works he paid more attention to the balance of composition, while retaining the luminosity of his color harmonies. The majority of his works, both in fresco and in oils, are to be found in Venice in the churches of S. Aloise, SS. Apostoli, Gesuati, the Academy, the Palazzi Labia and Quirini-Stampalia, and the Doge's palace.

See Henry de Chennevières, *Les Tiepolo* (1898); and Pompeo Molmenti, *G. B. Tiepolo* (Milan 1909).

TIERCERON, in mediaeval architecture, an intermediate vaulting rib running from the spring of the vault to the ridge, at an angle between the cross rib and the diagonal or groin rib; or, in cross vaults, between the diagonal rib and the wall rib. Tiercerons came into use in the early Decorated period of English Gothic and Exeter cathedral (1308–67) shows the delicate beauty and lightness that the use of tiercerons gives. *See* GOTHIC ARCHITECTURE; VAULT.

TIERRA DEL FUEGO, an archipelago lying between 52° 27′ and 55° 59′ S. lat. and 63° 43′ and 74° 44′ W. long. at the southern extremity of South America, from which it is separated by Magellan strait. At the First Narrows and at other points the strait is scarcely a mile wide. In shape the main island is a triangle with its base in the Beagle channel. The total area is about 28,000 sq mi. of which 19,500 sq.mi. belong to Chile and 8,500 to Argentina.

Argentina holds that part of the main island which lies east of the meridian of Cape Espíritu Santo (68° 36′ 38″ W.) and Chile holds all the western part of the main island and other numerous islands to the west and to the south of Beagle channel. The Argentine side is known as the Gobernacion of Tierra del Fuego (including Isla de los Estados) and the Chilean forms part of the province of Magallanes.

The population on the Argentine side (1947) was 5,001 and on the Chilean side (1950) 4,128.

The sheep industry is particularly widespread and profitable in the archipelago.

Physical Features.—The greater part of the main island is formed by the continuation of the Tertiary beds of the Patagonian tableland cut by the transversal depression of Magellan strait and by the lowland extending from Useless bay in the west to San Sebastian bay on the east and analogous to the transverse valleys of the Patagonian tableland.

North of the lowland is an undulating tableland with an average height of 400 ft., intersected by numerous *arroyos* with little water and with good sheep pasture.

In the west and southwest the general character of the main island changes, the ends of the Tertiary beds are raised—small hills and Mesozoic rocks appear, forming broken ridges east of the main range of the Andes. In this region appears the Antarctic forest. Lake Solier and Lake Fagnans receive the water from these mountains and hills. To the south of the lake rises the southeastern prolongation of the Andes with ridges at a uniform height of 3,500 ft. in which predominate crystalline schists. Some peaks of Tertiary granite break the uniformity, such as Mt. Sarmiento (7,546 ft.), Mt. Darwin (about 7,000 ft.) and Mt. Ulewaia (4,495 ft.), called Olivaia on some maps.

The section of the archipelago south of Beagle channel includes the islands of Hoste, Navarin, Gordon, Londonderry, Stewart Wollaston and numerous islets, disposed in triangular form with the base on Beagle channel and the apex at Cape Horn. Important explorations in this region were conducted by the French Mission de Cap Horn (1882–83). The most recent explorations on the western part of the main island of Tierra del Fuego immediately south of Beagle channel (in the Fiords de Agostini, Admiral Martinez and others) were carried out by Alberto M. de Agostini in 1913–14. The western group of islands includes Clarence island formerly believed to be a single island but now known to be divided by a channel into two sections known as Santa Ives and Desolation islands) and numerous small islands and rocks.

Climate.—At Ushuaia ten years' meteorological observations have shown a mean annual temperature of 42.8° F, with a winter mean of 34.7°, a summer mean of 50.2°, and an average yearly precipitation of 24.8 inches. Of all winds, 80% are westerly and a great difference in precipitation between the windward and leeward sides of the islands has been noted not only in the western part but also on Staten and Observatory islands. Precipitation on all windward slopes is almost continuous, producing dense forests on the lower slopes, where it falls as rain, and snow and ice-fields on the upper slopes.

Inhabitants.—To the three geographical divisions correspond three well-marked ethnical groups—the Onas on the main island south of the Grande river, the Yagans (Yahgans) on the southern islands and the Alakalups on the western. The origin of the Onas, like that of the other groups, is obscure. Undoubtedly among them are many that resemble some Patagonian type; but they seem to be not the same as the Tehuelche type and may pertain to one of the earlier Patagonian races. Their language is closely allied to that called Old Tehuelche; it is a hard guttural, slow-spoken speech, not at all resembling the soft, rapidly-spoken language of the Yahgans, which has many points of similarity with that of the Alakalups. The isolation of the Onas is peculiarly marked as they are inland people who do not use boats. The Yahgans live under conditions of extraordinary rigour. In order to obtain food, they venture naked with small canoes into the tremendous seas. Their life is a constant battle with starvation and a severe climate and their number is being rapidly depleted. They have no higher social unit than the family. The missionaries, who have reduced their language to writing, assert that it contains no less than 30,000 words, although the numerals stop at five, but it appears that a large number of words included in this total are compounds. Comparatively little is known of the Alakalups.

Discovery and Exploration.—Tierra del Fuego was discovered by Fernando de Magellan in 1520 when he sailed through the strait named after him and called this region "Land of Fire." In 1578 Sir Francis Drake first sighted the point which in 1616 was named Cape Hoorn (Anglicized Horn) by the Dutch navigators Jacob Lemaire and William Cornelis Schoote (1615–17). In 1619 the brothers Garcia and Gonzalo de Nodal first circumnavigated the archipelago. No systematic exploration was attempted until the British Admiralty undertook a thorough survey of the whole group by Philip Parker King (1762–1828) and Robert Fitzroy (1831–36). The latter expedition (Voyage of the "Beagle") was accompanied by Charles Darwin, then a young man. To these admirable surveys is due most of the present geographical terminology of the archipelago, and although supplemented by later surveys in many parts by the Chilean navy they still form the basis and, to a large extent furnish the detail, for most hydrographic charts of the region.

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TIFFANY, CHARLES LEWIS (1812–1902), U S. jeweller, was born in Killingly, Conn., on Feb. 15, 1812. He removed to New York city in 1837, and with John B. Young opened a fancy goods store. In 1847 the firm began to manufacture gold jewellery. It became Tiffany, Young and Ellis in 1841 and was reorganized as Tiffany & Co. in 1853.

At the beginning of the Civil War, Tiffany turned most of his capital to the manufacture of swords, medals and similar war material In 1868 the company was incorporated and branches were established at London and at Geneva. Tiffany made a specialty of importing historic gems, jewellery and art works, and in 1887 bought some of the crown jewels of France. He was made a chevalier of the Legion of Honour in 1878. He died in New York on Feb. 18, 1902

TIFFANY, LOUIS COMFORT (1848–1933), U.S. artist, son of Charles L. Tiffany, was born in New York city on Feb. 18, 1848. He was a pupil of George Inness and of Samuel Coleman, New York, and of Léon Bailly, Paris. He travelled extensively in Europe, and painted in oil and water colour, but eventually devoted himself to decorative glass work. In 1918 he founded the Louis Comfort Tiffany foundation for art students at Oyster Bay (N Y.).

TIFFIN, a city of northern Ohio, U.S A., the county seat of Seneca county; on the Sandusky river, 40 mi. S S E. of Toledo. It is served by the Baltimore and Ohio, the Big Four and the Pennsylvania railways. Population 18,943 in 1950

Tiffin was settled in 1817 and was named after the first governor of the state It was incorporated as a town in 1835 and as a city in 1850, when the village of Fort Ball, across the Sandusky, was united with it.

TIFLIS (now renamed, as in Georgian, TBILISI, also *Tpilisi*), the capital of the Georgian S.S.R., and the chief town of Transcaucasia, situated on both banks of the Kura river, and on the railway linking the Black sea and the Caspian, in 41° 41′ N., 44° 48′ E. Pop (1939) 519,175. Shut in by hills (1,500 to 2,400 ft.), it is sheltered in winter, but hot and stifling in summer, its average temperature ranging between 34 7° F in winter and 73.4° F. in summer. It manufactures bricks, tobacco, vegetable oils, soap, cognac, leather goods, furniture, and has a sawmilling industry. In 1926–27, the Zemo-Avchal hydroelectric station, with a capacity of 13,000 kw., was opened. There are municipal electricity, water, canal and tramway services, and the town is well built. On the left bank of the Kur stands the Metekhi castle, formerly a palace of the Georgian kings, the foundation of which is ascribed to King Vakhtang Gorgasali (Gurgaslan) of Iberia (5th–6th century). The Sion cathedral traces its origin to the 5th century; other churches date from the 14th and 15th centuries, and the Armenian cathedral of Van, rebuilt in the 18th century, from 1480. There are numerous museums and educational institutions. The town is at the southern extremity of the Georgian military road, which links it through the Darial gorge with Orjonikidze. The oriental markets and bazaars, where Iranians, Kirghiz, Tatars and peoples from the east congregate, display the work of Georgian silversmiths, gunsmiths and swordmakers; carpets, dried fruits and silken goods are important items, and there is much exchange of Iranian and Russian wares

The foundation of Tiflis dates from the 4th century A.D., but it succeeded Mtskhet as the capital of Iberia (eastern Georgia) in the 5th-6th century. After the temporary abolition of the Iberian monarchy, after 532, Tiflis was made the residence of the Iranian viceroys (*marsbans*). It then suffered successive plunderings at the hands of the Byzantines, in 626, during the wars of the emperor Heraclius; the Arabs took it in the same century, and from the 8th century it was the seat of an Arab emirate until its incorporation into the kingdom of Georgia in 1122, by David II the Builder, and its installation as the national capital. In 1225–31 it was taken by the Khwarizm-Shah Jalaladdin and in 1234 by the Mongols. In the autumn of 1386 Tiflis fell to the Mongol conquerer Tamerlane, who led into captivity King Bagrat V of Georgia and his queen, Anne of Trebizond. Afterward the Turks seized it several times, and toward the end of the 17th century the Lesghians attacked it. In 1795 the shah of Persia, Agha Mohammed Khan, sacked and plundered Tiflis in the war intended as a reprisal for King Heraclius II's treaty of alliance with Russia of 1783. The Russian troops sent later to the aid of Georgia were instrumental, upon the death of the last king, George XIII, in 1800, in effecting the Russian annexation of that kingdom.

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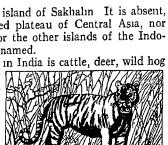
TIGELLINUS, TOFONIUS, minister and favourite of the emperor Nero, was a native of Agrigentum, possibly of Greek descent. During the reign of Caligula he was banished (A D 39) for adultery with the emperor's sisters, but recalled by Claudius (41) Having inherited a fortune, he bought land in Apulia and Calabria and devoted himself to breeding race-horses. In this manner he gained the favour of Nero. In 62 he was promoted to the prefecture of the praetorian guards. The great fire of 64 broke out afresh in his gardens, and he was suspected of being concerned with it. In 65, during the investigation into the abortive conspiracy of Piso, he and Poppaea formed a kind of imperial privy council In 67 he accompanied Nero on his tour in Greece. He deserted Nero at the last, and took the praetorians with him. Under Galba he was obliged to give up his command, but managed to save his life. Otho on his accession (69) determined to remove him. While in the baths at Sinuessa, Tigellinus received the news that he must die, and, having failed to gain a respite, cut his throat.

See Tacitus, *Annals*, XIV, XV, XVI; *Hist.* I 72; Dio Cassius lix, 23, lxii, 13, 25, 27, lxiii, 12, 21, lxiv, 3; Suetonius, *Galba*, 15; Plutarch, *Galba*, *Otho*; ancient authorities quoted by Mayor on Juvenal, 1, 155; B. W. Henderson, *Life and Principate of the Emperor Nero* (1903).

TIGER (*Panthera tigris*), an animal rivalled only by the lion in size, strength and ferocity among the catlike beasts of prey (*see* CARNIVORA), the difference between the two lying mainly in the skin and its coverings. A tiger's skull may almost always be distinguished from that of a lion by the circumstance that the nasal bones extend higher on the forehead than the maxillae, instead of stopping on nearly the same line. Although examples of both species present considerable variations in size, the length of the largest Bengal tiger may exceed that of any lion. Ten feet from the tip of the nose to the end of the tail is no unusual length for a large male tiger. The female is somewhat smaller, and has a lighter and narrower head. The tiger has no mane, but in old males the hair on the cheeks is rather long and spreading. The ground-colour of the upper and outer parts of the head, body, limbs and tail, is bright rufous fawn; and these parts are beautifully marked with transverse stripes of a dark, almost black colour. The markings vary much in different individuals, and even on the two sides of the same individual. The under-parts of the body, the inside of the limbs, the cheeks and a large spot over each eye are nearly white The tigers which inhabit hotter regions, as Bengal and the south Asiatic islands, have shorter and smoother hair, and are more richly coloured and distinctly striped than those of northern China and Siberia, in which the fur is longer, softer and lighter-coloured. Black and white phases have been recorded, but they are rare The tiger is exclusively Asiatic, but has a wide range in that continent, having been found in almost all suitable localities south of a line drawn from the River Euphrates, passing along the southern shores of the Caspian and Sea of Aral by Lake Baikal to the Sea of Okhotsk. Its most northern range is the territory of the Amur, its most southern the islands of Sumatra, Java and Bali. Westward it reaches to Turk-

ish Georgia and eastward to the island of Sakhalin It is absent, however, from the great elevated plateau of Central Asia, nor does it inhabit Ceylon, Borneo or the other islands of the Indo-Malay archipelago, except those named.

The principal food of the tiger in India is cattle, deer, wild hog and peafowl, and occasionally human beings. The regular "man-eater" is generally an old tiger whose vigour is past, and whose teeth are worn and defective, it takes up its abode in the neighbourhood of a village, the population of which it finds an easier prey than wild animals. Though chiefly affecting grassy plains or swamps, tigers are also found in forests, and seem to be fond of haunting the neighbourhood of old ruins As a rule, they do not climb trees; but when pressed by fear, as during an inundation, they have been known to do so They take to the water readily and are good swimmers.



BY COURTESY OF THE N Y ZOOLOGICAL SOCIETY

THE TIGER (PANTHERA TIGRIS), THE MOST POWERFUL OF THE CAT FAMILY

The tigress gives birth to from two to six cubs, but three is the common number. She is an affectionate mother, and generally guards and trains her young with watchful solicitude. They remain with her until nearly full-grown, or about the second year, when they are able to kill for themselves. While they remain with her she defends them with courage and energy, but she has been known to desert them when pressed, and even to eat them when starved As soon as they begin to require other food than her milk, she kills for them, teaching them to do so by practising on small animals The tiger and lion occasionally hybridize in zoos.

See Sir J Fayrer, *Royal Tiger of Bengal* (1875); F W. Champion, *With a Camera in Tiger Land* (1927); R. I Pocock, *Fauna of British India. Mammalia*, vol. i (1939).

TIGER CAT or margay, *Felis tigrina*, an American cat found from Honduras to Paraguay, east of the Andes. It is 2 ft. long, with tail 18 in , resembling the larger ocelot, coloured like it but with more elongate spots and longer tail The head is more rounded The name is also applied to several other American wildcats. (J. E. HL.)

TIGER-FLOWER, botanically *Tigridia*, a genus of bulbous plants (family Iridaceae), natives of Mexico, Central America, Peru and Chile. They have long narrow plicately-veined leaves springing from the bulb and a stem bearing two or three scattered smaller leaves and above a few flowers emerging from a spathe. The flowers are spotted (whence the name tiger-flower or tiger-iris) and have free segments springing from a tube; the three large broad outer segments are concavely spreading, the three inner are much smaller and more erect. *T. Pavonia* (flower of Tigris or tiger-flower) has large flowers with a golden orange, white or yellow ground colour.

TIGHINA (Turkish, *Bender*, the Gate, from the fortress erected by Suleiman the Magnificent in 1558, but demolished in 1897; Russian, *Bendery*), a town of Bessarabia, on the Dniester. Pop. (1930) 31,698, including many Jews and Ukrainians It is connected by rail with Kishinev (37 mi.) and southward via Basarabiasia with Cetatea Alba and Galatz, and a railway also runs over the river into Russia to Tiraspol and Odessa. Tighina possesses a tobacco factory, candleworks and brick-kilns and a sawmill. Timber is floated down the Dniester. In the 12th century it was a Genoese trading centre, and has been held in turn by Tatars, Moldavians, Turks, Russians and Rumanians. The forces of Charles XII camped here 1709–13. Rumania ceded the town, with northern Bessarabia, to the U.S.S.R. in 1940, but regained the area in the following year, when the axis attacked the soviet union.

TIGLATH-PILESER (Ass. *Tukulti-pal-E-sarra*, "my confidence is the son of E-sarra," *i.e.*, the god In-Aristi), the name of several Assyrian kings. Their numbering is not certain.

TIGLATH-PILESER I, the son of Assur-ris-isi, ascended the throne *c.* 1120 B.C., and was one of the greatest of Assyrian conquerors His first campaign was against the Moschi who had occupied certain Assyrian districts on the Upper Euphrates; then he overran Commagene and eastern Cappadocia, and drove the Hittites from the Assyrian province of Subarti northeast of Malatia. In a subsequent campaign the Assyrian forces penetrated into the Kurdish mountains south of Lake Van and then turned westward, Malatia submitting to the invader In his fifth year Tiglath-Pileser attacked Comana in Cappadocia, and placed a record of his victories engraved on copper plates in a fortress he built to secure his Cilician conquests. The Aramaeans of north Syria were the next to be attacked, and he thrice made his way as far as the sources of the Tigris. The command of the high road to the Mediterranean was secured by the possession of the Hittite town of Pethor at the junction of the Euphrates and Sajur, and at Arvad he received presents, including a crocodile, from the Egyptian king, and, embarking in a ship, killed a dolphin in the sea. He was passionately fond of the chase and was also a great builder, the restoration of the temple of Assur and Hadad at Assur (*q.v.*) being one of his works

TIGLATH-PILESER II or III, son of Hadad-nirari II, appears to have reigned from about 950 to 930 B.C., but nothing is known about him.

TIGLATH-PILESER III or IV, was a successful general who usurped the Assyrian throne on the 13th of Iyyar 745 B.C., after the fall of the older dynasty, and changed his name of Pulu (Pul) to that of the famous conqueror of earlier times. In Babylonia, however, he continued to be known as Pulu. He was a man of great ability, both military and administrative, and initiated a new system of policy in Assyria which he aimed at making the head of a centralized empire, bound together by a bureaucracy who derived their power from the king. The empire was supported by a standing army and an elaborate system of finance The first task of Tiglath-Pileser was to reduce the Aramaean tribes to order, and so win the gratitude of the Babylonian priests. Then he struck terror into the wild tribes on the eastern frontiers of the kingdom by a campaign which extended into the remotest parts of Media. Next came the defeat of a northern coalition headed by Sar-duris of Ararat, no fewer than 72,950 of the enemy being captured along with the city of Arpad, where the Assyrian king received the homage of various Syrian princes Arpad revolted soon afterward, but after a siege was taken in 740 B.C. The following year Azariah of Judah appears among the enemies of Tiglath-Pileser who had overthrown the Hittite power and [illegible] 738 B.C. [illegible] Menahem of Samaria [illegible] Arpad [illegible] Rezon of Damascus [illegible] Ararat [illegible] Rezon was put to death, and an Assyrian satrap appointed in his stead. Tyre also was made tributary. The next year Tiglath-Pileser entered Babylonia, but it was not until 729 B.C that the Chaldaean prince Ukin-zer (Chinzirus) was driven from Babylon and Tiglath-Pileser acknowledged as its legitimate ruler. In the early part of Tebet 727 B.C. he died, after having built two palaces, one at Nineveh, the other at Calah.

See P. Rost, *Die Keilschrifttexte Tiglat-Pilesers III* (1893); also BABYLONIA AND ASSYRIA: *History: Rise of Assyria; Second Assyrian Empire;* and authorities quoted under *Ancient Sites.*

TIGRANES or **DIKRAN,** king of Armenia (*c.* 140–55 B.C.). He was the son or nephew of Artavasdes of Armenia, and a member of the dynasty founded by Artaxias, a general of Antiochus III. (*See* SELEUCID DYNASTY) He was given to Mithradates II of Parthia as a hostage, and purchased his freedom by ceding 70 valleys bordering on Media.

Tigranes ascended the throne in 95 or 94 B.C. (Plut. *Luc.* 21), and immediately began to enlarge his kingdom. He deposed Artanes, king of Sophene, and entered into alliance with Mithra-

dates VI Eupator of Pontus, whose daughter Cleopatra he married. In 93 he invaded Cappadocia in the interest of Mithradates, but was driven back by Sulla in 92. During his first war with Rome, Mithradates was supported by Tigranes, although he abstained from interfering openly But he meanwhile began war with the Parthians, whose empire was weakened after the death of Mithradates II (about 88) by internal dissensions and invasions of the Scythians. Tigranes reconquered the valleys which he had ceded, and laid waste a great part of Media; the kings of Atropatene, Gordyene (now Bohtan), Adiabene (Assyria) and Osroene (Edessa) became his vassals, who attended him like slaves wherever he went; he also annexed northern Mesopotamia. In 83 he invaded Syria, defeated the last successors of Seleucus and occupied Cilicia. In the war between Mithradates and Sulla he did not interfere, but after the death of Sulla (78) he occupied Cappadocia again and expelled King Ariobarzanes I, the vassal of the Romans During the next years he had a war in Syria, against Cleopatra Selene, and in Cilicia, where he destroyed the Greek town of Soli Tigranes now had become "king of kings" and the mightiest monarch of Asia So he built a new royal city, Tigranocerta, on the borders of Armenia and Mesopotamia, between Mt. Masius and the Tigris, where he accumulated all his wealth and to which he transplanted the inhabitants of 12 Greek towns of Cappadocia, Cilicia and Syria (for the situation, which is much disputed, *cf.* Tac. *Ann.* xiv, 24, xv, 5, ed. Furneaux). He also transplanted many Arabic tribes into Mesopotamia. But the Romans could not tolerate encroachment upon their sphere of power, and in 69 Lucullus invaded Armenia. Tigranes was beaten at Tigranocerta on Oct. 6, 69, and again near Artaxata in Sept. 68. The recall of Lucullus gave some respite to the two kings, who even invaded Asia Minor again. But meanwhile a son of Tigranes and Cleopatra, called Tigranes, like his father, rebelled against him (as the old man had already killed two of his sons, he had reason enough to be afraid for his life) and found refuge with the Parthian king Phraates III, who sent him back with an army. The old king now gave up all hope of resistance; he put a price on the head of Mithradates, and when Pompey advanced into Armenia and united with the younger Tigranes, he surrendered (66 B.C.). Pompey now changed his policy, he received the old Tigranes graciously and gave him back his diadem, while he treated the son very coolly and soon made him prisoner. The younger Tigranes was led in triumph into Rome, where he found his death when he tried to escape from his confinement by the intrigues of P. Clodius in 58. The father after his defeat ruled about ten years longer over Armenia, as vassal of the Romans. He died about 56, and was succeeded by his son Artavasdes. (*See also* MITHRADATES.)

See Lucian, *Macrob.* 15; Appian, *Syr.* 48; *Mithr.* 67, 104; Strabo, xi, 531 *seq.*; xii, 539; xvi, 745, *seq.*; Plut., *Luc.*, *Pomp*, *Sulla*; Justin, xxxvii, 3, xl, 1.

TIGRÉ, a northern province of Abyssinia; one of the four former principal divisions of the country. Pop. (1939 est.) 1,850,000; area 25,283 sq mi. Tigré contains the towns of Axum (Aksum, *q.v.*), capital of the ancient Ethiopic Empire, and Adua (Aduwa, *q v*). (*See* ABYSSINIA.) Tigriña, the dialect spoken in Tigré and Lasta, is nearer the ancient Gîz than is Amharic, the official and more widely diffused language of Abyssinia.

See J Schreiber, *Manuel de la langue tigrai* (Vienna, 1887–93); and L. de Vito, *Grammatica della lingua tigrigna* (Rome, 1895).

TIGRIS, the more eastern of the two rivers of Mesopotamia. It rises from two principal sources. The eastern branch rises from several streams to the south and west of Lake Van. The western branch rises about 10 miles south of Lake Geuljik. The upper waters of the Tigris therefore lie on the southern slopes of the Taurus the northern slopes of which are part of the basin of the Euphrates. The Tigris in its lower course seems to be particularly unstable Although there is no evidence of any great change in the upper waters, from Kut al Amara onward the bed of the river has shown considerable variations At the beginning of the second millennium B.C. the river appears to have been flowing along the Shatt al Hai; indeed the position of Lagash makes it almost certain that this was its normal course in Sumerian times. In Sassanid times it followed its present easterly course, during Arab times, however, it was apparently flowing along the Shatt al Hai There are no ancient remains on the Tigris therefore below Kut al Amara, and owing to the changeable nature of the stream even few modern villages. In the alluvial area the Tigris lies lower than the Euphrates as far as the Shatt al Hai, and therefore in ancient times received the tailings of the canals, but did not supply water except locally for irrigation. It appears not to have deposited its silt as much as the Euphrates, probably due to the lack of suitable terrain for the formation of fresh water lakes, which are usually a silting ground for river deposits. Since its abandonment of the old channel the Tigris has probably contributed very considerably to the formation of new land at the head of the gulf. The upper drainage area also seems to have altered to a slight extent. The Arab geographers suggest that at one time at least part of the waters of the Khabur, a tributary of the Euphrates, flowed into the Tigris by a channel which was navigable when in flood. As late as 1832 Ormsby reported a stream from Jabal Sinjar which joined the Euphrates near Shargat. This stream still appears to exist, but it no longer empties itself into the Tigris and in view of the waywardness of the rivers of Mesopotamia it is possible that Ormsby's observation was made at an unusual period

Topography.—The Western Tigris, on whose banks lies the important town of Diarbekr flows east along the southern slopes of the Taurus and receives a number of tributaries of small size The two main branches join at Til, from which point it runs in a southeasterly direction. It continues to receive a number of small tributary streams, mostly on the left bank. From the neighbourhood of Mosul to the confluence of the Greater Zab there lies a fertile triangle of land between the hills and the river. Nineveh lay on the left bank opposite Mosul. A little lower down the stream was the city of Kalakh. At this point two great barrages were erected in ancient times, which still effectively block the river for navigation. From a little above the confluence of the Greater Zab down to Tekrit the river flows through an uninhabited desert, the only important town being Kalaat Shargat, the ancient Assur, which at present forms the railhead of the southern part of the Baghdad railway. About 30 miles below Shargat the Lesser Zab joins the Tigris. From Tekrit, a city founded during the Persian domination, downwards, signs of ancient irrigation begin, although the alluvial plain is not entered until Samarra is reached. Below Samarra as far as Kut al Amara, a distance of about 200 miles, there was in ancient times a canal which served to straighten the course of the stream. The two principal tributaries in this region, the Adhem and the Diala, were also canalized, the Adhem reaching the main stream just below Samarra, the Diala below Baghdad. Close to the mouth of the Adhem are the ruins of an ancient city probably to be identified with Xenophon's Opis. Near this point the river makes a great bend and flows south to Baghdad (*g.v.*) at which point the Tigris and the Euphrates are only about 35 miles apart. In ancient times the two rivers ran close to one another and there are traces of numerous old irrigation canals connecting them. Below Baghdad lie the ruins of ancient Ctesiphon, on the left bank; opposite Seleucia on the other bank Kut al Amara marks the point where the Shatt al Hai leaves the present main stream. Below this point owing to the change in the course of the stream there are no ancient remains along the Tigris. The modern towns are Ali al Gharbi, Ali esh Sharki Amara, Qalaat Saleh and Kurna, below which point the two rivers unite to form the Shatt al Arab

Navigation.—Although before World War I a launch navigated the river between Baghdad and Samarra (about 90 miles), and in 1838 a steamer went to within 28 miles of Mosul the upper Tigris is only navigable for native rafts These rafts which may be as much as 35 tons burden are made of timber supported by inflated skins. During flood they cover the 275 miles between Baghdad and Mosul in three or four days. At their destination the wood finds a ready market in this treeless country, and the skins are carried back again on the backs of asses. No upstream traffic is carried on The river flows over a bed of clay, sand or conglomerate, and is full of obstructions. Opinion has however

been expressed that if these obstructions and the ancient barrages at Shargat were cleared away, navigation to Mosul would be possible. In the lower part of the river there are bridges of boats at Baghdad, Gerara, Kut, Kut al Amara and Kale Sale. Between Baghdad and Kale Sale the Tigris is navigable all through the year by vessels drawing up to 5 feet of water. Below this point the river is in a bad condition, largely owing to the barrages built by native cultivators, but great efforts have been made to restore the channel. At low water it is generally estimated that only three feet of water is available. The low water period is reckoned from July to November, and high water from December to June, but the river is extremely liable to sudden floods.

The statistical details so far as at present recorded are as follows. From Baghdad to Kut the distance by river is 216 miles, the distance by land being 103 miles. At Baghdad the river is 114 feet above sea level, at Kut it is 57 feet, the fall in the river surface being 1 in 20,000. The width of the river is about a quarter of a mile, its depth at high water 26 feet, and at low 4½ The discharge in flood is 5,500 cubic metres a second, dropping to as low as 300 cubic metres at low water. The velocity in flood is a little under 4 miles an hour, dropping at low water 1½. At Kut the Shatt al Hai discharges about 1,000 cubic metres at high flood, but is dry at low water. Between Kut and Kut al Amara the river distance is 153 miles, and by land 119. The mean level at Amara is 28 feet, the drop between the two points being therefore about 29 feet, the gradient of the river level is 1 in 35,000. The average width of the river in this reach, which is singularly free from any obstacles for navigation, is about 365 yards, while the depth is 25 feet in flood and about 6 ft. 6 in. at low water, with a respective velocity of about the same as in the upper reach. The discharge at low water is similar but at high water about 1,000 cubic metres less at the head of the reach; owing however to branches at the lower end of the reach the discharge at high water only reaches about 2,500 cubic metres per second.

Between Amara and Kurna the river is affected by various channels which drain off much of the water. At Amara on the left bank the Chala, with a bed about 6 feet lower than the main stream, discharges about 1,000 cubic metres a second at high water falling to rather more than a tenth of that amount at low. Below this point first the Major Kebir and then the Machera draw off about the same amount. Considerable changes take place therefore in the size of the stream between Amara and Kurna, at which point the level is 10 feet above sea level. The average width of the Tigris at this reach is a little under 200 yards, with a depth of 13 feet in flood and 6 ft. 6 in. at low water with a discharge of only 1,250 cubic metres per second and 150 at high water and low water respectively. Below Kale Sale although the depth is the same the average width is only 65 yards. Below Ezra's Tomb some of the lost waters return to the river from swamps and the stream becomes once more nearly 200 yards broad. The two rivers meet at Karmat Ali at which point the Tigris, full of dark marshy water, is more than 30 feet deep and more than 400 yards broad.

It will be seen from these details that the river presents great difficulties for navigation. In flood time it is liable to overrun its banks and convert the whole region into a vast lake. In addition to river steamers two types of native boats are used, a large coracle or *Quffeh* and river boats, *Safineh*, capable of carrying a cargo of as much as 100 tons. The coracles can only go downstream but the river boats are poled or towed upstream and are sailed or rowed with the current.

See Sir W. Willcocks, *The Irrigation of Mesopotamia* (1911), *Memorandum respecting the Navigation of the Tigris and Euphrates* (1913); *Colonial Office Reports* (annually). For ancient sites *see* S. Langdon, *Cambridge Ancient History* (1923) (Bibliography)

(L. H. D. B.)

TILAK, BALGANGADHAR (1856–1920), Indian nationalist leader, a Chitpavan Brahmin, was born at Ratnagiri July 23, 1856. At an early age he took the lead in providing education in Poona under Indian direction. In 1890 he was proprietor and editor of two weekly papers, *Mahratta*, in English, and *Kesari* (*Lion*), in Mahratti, which he used for antigovernment propaganda. His violent condemnation in 1897 of the plague prevention regulations resulted in his being convicted for sedition and sentenced to 18 months' imprisonment. For a similar offence he was sentenced in 1908 to six years' transportation, later commuted to simple imprisonment. After his release he took part in the home-rule campaign, and secured for his party control of the national congress. He died in Bombay Aug. 1, 1920. His formative part in the cult of Indian unrest is shown in the report of the Rowlatt sedition committee (1918). His speeches are collected in *Lokamanya B. G. Tilak* (2nd ed. Madras, 1920).

TILBURG, a town, province of North Brabant, the Netherlands, and a junction station 13½ mi SE. of Breda by rail Pop. (1940) 95,141. Tilburg rose to importance after the separation of Belgium from Holland as one of the chief industrial (mainly textile) centres of the south. In 1927 a Roman Catholic graduate school for business administration was established there Tilburg was the favourite residence of King William II.

TILBURY DOCKS, on the north shore of the Thames, in Essex, England. They lie opposite Gravesend 25 mi. below London bridge, and about the same distance from the Nore, being thus within the Port of London. They were constructed in 1886, but the rapid development of the Port of London necessitated many changes and extensions. There is extensive warehousing and accommodation for passengers, as the largest passenger steamers trading with the Port of London he here. Railway communication is provided by the L.M.S. There is direct connection for goods traffic with all northern lines The system has a total land area of 725 ac. and a water area of 104½ ac. It consists of a main dock with three branch docks, connected with a tidal basin. The entrance dock, about 400 yd. above Tilburyness, is 1,000 ft long, 110 ft. wide, with a depth on the sills of 45½ ft. There are two dry docks more than 800 ft. long, including basin ends, a third is 750 ft. long and 110 ft. wide, though capable of being lengthened to 1,000 ft. A jetty 1,000 ft. by 50 ft, mainly for the discharge of part-cargoes, was completed in 1921, while a passenger landing stage 1,142 ft. long, with 35 ft. depth alongside at low water, was opened in 1930. Total length of quayage is 4 mi.

TILDEN, SAMUEL JONES (1814–1886), U S. statesman, was born at New Lebanon, N.Y., Feb. 9, 1814. In 1834 he entered Yale university, but soon withdrew on account of ill health, and later studied in the College of the City of New York. He was admitted to the bar in 1841. In the financial troubles between 1850 and 1860 it is said that more than half the railways north of the Ohio river and between the Hudson and the Missouri rivers were at some time his clients. Tilden served in the state assembly in 1846 and in the state constitutional conventions of 1846 and 1867. In 1848 he participated in the revolt of the "Barn-burner" or free-soil faction of the New York Democrats, and in 1855 was the candidate of the "softshell" or antislavery faction for attorney general of the state. During the Civil War, although he opposed several of Lincoln's war measures, he gave the union cause his heartiest support.

In 1866 Tilden became chairman of the Democratic state committee, and soon came into conflict with the notorious "Tweed ring." As the "ring" could be destroyed only by removing the corrupt judges who were its tools, Tilden, after entering the assembly in 1872, took a leading part in their impeachment. By analysing the bank accounts of certain members of the "ring," he obtained legal proof of the principle on which the spoils had been divided. His fame as a reformer brought him to the governor's chair in 1874, and he gave his attention to breaking up the "canal ring," made up of members of both parties who had been robbing the state through maladministration of its canals.

In 1876 the Democrats nominated him for the presidency, the Republicans nominating Rutherford B. Hayes of Ohio. The result was the disputed election of 1876, when two sets of returns were sent to Washington from the states of Florida, Louisiana, South Carolina and Oregon. As the federal constitution contained no provision for settling a dispute of this kind the two houses of congress agreed to the appointment of an extra-constitutional body, the "Electoral Commission" (*q.v.*), which de-

cided all the contests in favour of the Republican candidates. Tilden counselled his followers to abide quietly by the result. The remainder of his life was spent in retirement at his country home, Greystone, near Yonkers, N.Y., where he died Aug. 4, 1886 Of his fortune (estimated at $5,000,000) approximately $4,000,000 was bequeathed for the establishment and maintenance of "a free public library and reading-room in the City of New York"; but, as the will was successfully contested by relatives, only about $2,000,000 of the bequest was applied to its original purpose; in 1895 the Tilden Trust was combined with the Astor and Lenox libraries to form the New York public library.

See *Writings and Speeches of Samuel J. Tilden* (1885) and *Letters and Literary Memorials of Samuel J. Tilden* (1908), both edited by John Bigelow; also Bigelow's *Life of Samuel J. Tilden* (1895); and P. L. Haworth, *The Hayes-Tilden Election* (1927).

TILE, a thin, flat slab, usually of burned clay, glazed or unglazed, used either structurally or decoratively in building. The usage of the word varies widely; in connection with roofing, flat slabs of any material are sometimes termed tiles, as for instance, the marble tiles occasionally used in Greek temples or the bronze tiles used extensively in ancient Rome, and occasionally in China. Similarly, stone slabs, used for roofing, as in certain parts of England, are termed stone tiles; slate, however, is never so called, and wood shingles are so called only rarely. Many forms of rough terra cotta used structurally in building are called tiles; thus an arch of hollow terra cotta blocks between steel beams is known as a "tile arch"; partitions built of hollow terra cotta blocks are known as hollow tile partitions, and the steel forms used for casting certain types of reinforced concrete floors are frequently referred to as steel tiles. The differentiation between tile, terra cotta and brick is thus exceedingly vague.

Tiles divide themselves naturally into several classes, structural tile, such as the hollow terra cotta blocks referred to above, for which *see* TERRA COTTA; and *below*.

Roofing Tiles.—There is no evidence of the use of roofing tiles in the Mediterranean basin prior to the development of Hellenic civilization, but the most ancient examples of roof tiles we possess show such highly developed forms that earlier usage must be assumed. The Greek form of temple roof which remained constant throughout the history of Greek architecture consisted of two types of tile, used together. First the roof surface was covered with tiles generally flat, but with adjoining edges raised These were laid in overlapping courses, and were all of equal size so that the joints of each course occurred directly in a line with those of the courses above and below. Convex covering tiles, also overlapping, were then laid over the joints of the flat tiles below, and were so profiled as to cover, not only the joint, but the raised edges of the lower tiles; in this manner an absolutely watertight roof could be produced. In order to make the architectural effect more delicate the ends of both lower tile and covering tile were rebated, so that the thickness of the overlapping portion was only half the thickness of the tile. At the bottom of each row of covering tiles was either a marble or tile upright, curved, decorative member known as an antefix (*see* ANTEFIXAE).

In some cases the covering tiles were of pointed, straight line section—the most common Greek type—in others a tile of semicircular section was used, easy to manufacture, but lacking in the extreme refinement of the other type; in the simpler domestic work, the lower courses were also of curved section, a segmental concave shape replacing the flat tile with raised edges. The marble tile used in some Greek temples, as in that of Bassae (*c.* 430 B.C., by Iktinos) is universally of the type with flat under tile and pointed covering tile, although at times, in order to reduce the number of joints, the covering tile and the under tile are cut from the same piece of marble

Two other types of roof tile were common in Roman times and probably represent common Mediterranean types of much earlier origin These are the so-called "Spanish tiles," with a contour resembling a letter S, in which the convex part of each tile fits over the edge of the concave portion of the next, and the shingle or flat tile found frequently in the Roman ruins of the northern provinces. These flat tiles are often of stone.

The usual material of all of these types of tile is burned clay, varying in colour from orange-yellow to purple-red. It is known, however, that bronze tiles were relatively common on the most monumental buildings of the Roman empire. Due to the rarity and value of bronze during the middle ages and the Renaissance, no examples of ancient bronze roof tiles are now known.

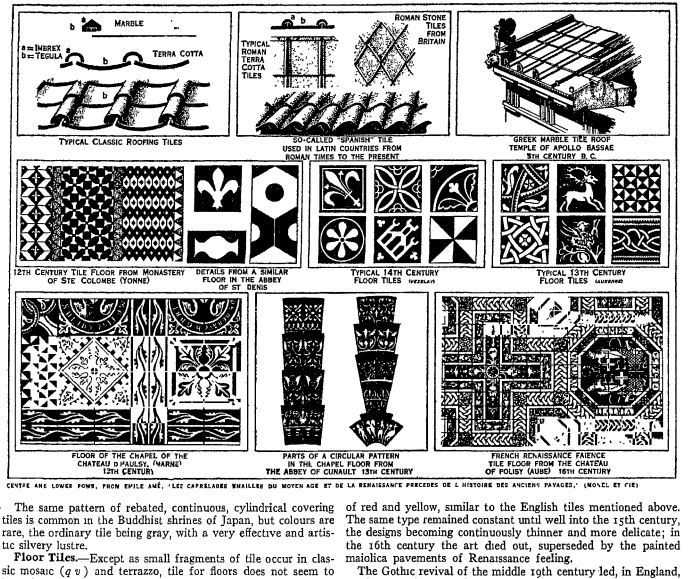
All of the classic forms of clay tile continued in use in various parts of the world during the mediaeval period, but their supremacy as a roofing material gradually yielded to lead and zinc for churches, public buildings, palaces, etc, and to slate, stone and thatch for the smaller private houses

Clay roof tiles used at the present day remain of substantially the same form; improvements have been only in methods of manufacture and not in design. The flat tile designed to hook over roof battens or boards, is perhaps the most common type of small house roof covering in England and parts of France, and the combination of concave under tile and convex over tile is almost universal on pitched roofs in Italy, Spain, Greece and Turkey. The S-shaped tile is also common around the Mediterranean. The curved tiles are almost always laid in a heavy bed of waterproofed mortar, with ridges and hips covered by courses of overlapping tiles, similarly bedded; with flat tiles, the use of mortar is restricted to the convex or pointed tiles covering the hips and ridges. The best modern usage in laying tiles of this type demands the complete covering of the roof surface with a watertight material such as slaters' felt or heavy waterproofed paper, before the tile is applied. The tiles themselves are held in place sometimes by copper nails which secure the under tiles direct to the roofing and the covering tiles to wood battens which run up the slope of the roof under each row of covering tiles, and sometimes by copper wire brought up through two holes in each tile and twisted together. In America the popularity of houses of Spanish and Italian types has led to widespread manufacture of tiles both of the S-shape and alternately concave and convex.

Although various attempts have been made to imitate clay tiles in stamped metal and concrete, these imitations are so lacking in the individual variation typical of ceramic ware that their use has been restricted to the cheapest type of jerry-built construction; their use, even there, is seriously questionable. Quite different are the roofing tiles of reinforced and waterproof concrete, which are common in industrial buildings, especially in Europe, although their use in America is increasing. These modern, industrial tiles are usually of large size—sometimes running to 4 ft. in length, and arranged to interlock, with the exposed surfaces grooved or channelled in such a way as to lead the water away from any joints. In these concrete tiles colouring matter is usually added in the material itself.

Roofing Tiles in the Far East.—Although the principle of the roofing tiles of China and Japan is the same as that in the west, there are many differences in detail. Thus, in temples and palaces in China, the under tiles are slightly concave and overlap, much like those of classic roofs; the covering tiles, however, are made absolutely cylindrical in general contour, with rebated ends, so that they form long, unbroken lines of shadow down the roof. Moreover, instead of the upright antefix of the classic roof, the Chinese tiles have ornaments that project downward, in generally scalloped shapes, over the face of the cornice. There is also, particularly in north China, a tremendous elaboration of ridge and hip tiles, which are frequently of great height, with an elaborately moulded section, and carry at their ends rows of animals, a great dragon or the like. At the ends of the ridge are large, grotesque beasts with their heads pointing inward; all these ornaments are modelled and baked in the tile itself. One of the chief glories of the Chinese roof tiles is their colour. This is produced by a shiny glaze that reveals the expected Chinese ceramic skill.

The usual colour of temple and palace roofs is bright yellow but other colours frequently occur. In central and south China, even temple roofs are frequently black. The cheap roof tile of the ordinary house is also almost black, but without lustre and with overlapping covering tiles like those of the west.



The same pattern of rebated, continuous, cylindrical covering tiles is common in the Buddhist shrines of Japan, but colours are rare, the ordinary tile being gray, with a very effective and artistic silvery lustre.

Floor Tiles.—Except as small fragments of tile occur in classic mosaic (*q v*) and terrazzo, tile for floors does not seem to have been common in Europe prior to the 12th century. In the late 12th and 13th centuries, however, tile floors became usual in churches and other important buildings. The most common type consisted of square tile in two colours, usually a dark brown-red and a pale orange or brownish yellow. They were made by casting clay in such a manner that the parts to be in a lighter colour were sunk, when dry, these parts were filled with a clay of different composition which would burn to a lighter colour; the tile thus prepared was then burned. Patterns were formed of many tiles and consisted usually of circles or stars containing heraldic beasts, ecclesiastical symbols, etc.; in many cases the pattern was made with reversed colours, so that what was background colour in one tile was ornament colour in the one next it. In the earliest examples designs were formed by a mosaic treatment in which the pattern was made by the shape and size of the individual tiles, as in the 13th century example found at Fountains abbey and at Prior Crauden's chapel at Ely (1321–41), both in England. Other common types of mediæval pavement have the pattern merely incised, producing the artistic effect of a sketch.

The development of floor tiles in Gothic France was similar. The 12th century examples are usually mosaic in type with black, dark green, light green and yellow as the predominating colours. The richest examples of these are in the abbey church of St. Denis, near Paris, where certain elaborate, chapel floor pavements still exist from the original building by Abbott Suger (1140–44). By the end of the century, mosaic had yielded to two-coloured tiles of red and yellow, similar to the English tiles mentioned above. The same type remained constant until well into the 15th century, the designs becoming continuously thinner and more delicate; in the 16th century the art died out, superseded by the painted maiolica pavements of Renaissance feeling.

The Gothic revival of the middle 19th century led, in England, to the revival of the designing and making of tiles of the mediæval type and many modern pavements were placed in old churches as a result. Most of this tile has a simple lead glaze and is made not by casting damp, plastic clay, as in the mediæval examples, but by compressing powdered clay in steel dies so that shapes are more perfect and the rapidity of manufacture is vastly increased. This type of tile, usually known as "encaustic," is especially associated with the English ceramic works at Stoke-upon-Trent, particularly those of Minturn. Recently, however, the manufacture of such tiles has become widespread in the United States and in Germany.

Meanwhile the Moorish skill in tile making had gradually come to be applied to floors. This type of maiolica tile was adopted in early Renaissance churches, both in Italy and Spain, although not many examples remain, as the glaze was too soft. The decoration of the Italian maiolica pavements consists of the same type of free and graceful classic arabesque, trophies, acanthus ornament and coats of arms that is found on contemporary maiolica.

In France not only were Italian tiles imported and used, but there soon grew up a local manufacture of similar painted floor tiles, especially at Rouen (established by Masseot Abaquesne, 1542–57), Nevers and Marseilles. With the increasing use of oak parquetry flooring for houses and marble for churches, toward the end of the 17th century, the use of tile diminished. There was similar importation of Italian and Spanish tiles into England during the early Renaissance and possible spasmodic attempts toward the making of certain types of this tile in England itself.

In the 18th century the use of plain, undecorated, square, red
:s, now commonly known as quarry tiles, became common all
er northern and western Europe, and to a less extent in the
nerican Colonies.
Although modern potteries all over the western world were pro-
cing in 1929 many varieties of elaborate, decorative floor tile,
iging from those in varied and brilliant colours with all sorts of
nding glazes to the most complicated so-called Spanish tiles
relief, the greatest advances in modern floor tiles have been
de in simple, vitrified, mosaic tiles for use in bath rooms,
chens, swimming pools, etc. These are always machine pressed
d are made of fine clays, thoroughly vitrified, and very hard.
ese are made in small squares, rectangles, hexagons and circles,
a few simple colours and are usually pasted, face down, on
per, in order to increase the speed of their application. (*See*
SAIC.) Some, by the addition of gritty substances, such as
ndum or carborundum, are given a surface which prevents
ping, even when the tile is wet.
Wall Tiles.—Earthenware was used spasmodically for wall
oration by the Egyptians, as in the doorway of the Abusir
amid of Neterkhet (3rd dynasty) More usually, however,
y were in the form of mosaic (*q.v.*) Perhaps based upon
lier Egyptian examples, the people of Crete developed to an
n higher degree the use of faience for walls Thus our knowl-
e of early Cretan houses is largely furnished by many frag-
nts of small faience plaques from the 18th century, B.C., which
med portions of a large, mosaic, faience wall decoration.
oreover, there are in existence many modelled reliefs of faience
m the middle and late Minoan period which were apparently
erted in the plaster of walls
Farther east, in the Tigro-Euphrates valley, a tradition of
amic wall decoration was early established. (*See* WESTERN
TATIC ARCHITECTURE.) This took the form of glazed and enam-
d bricks rather than tiles proper. It is nevertheless, important,
being one of the first attempts to cover large and continuous
ll surfaces with a decorative, ceramic material, and the friezes
marching beasts from Chaldean and Babylonian palaces, from
later Assyrian palaces and from their Persian successors, the
nous friezes of the archers and the lions from the early 4th
ntury palace of Artaxerxes II at Susa, have remained models
this type of decorative work ever since. (*See* illustration of
Gate of Ishtar at Babylon, under BRICKWORK.) Moreover,
tradition of fine ceramic work continued vital throughout the
rmy period of the fall of the Roman empire and the Moham-
dan conquest. It is in Syria, the Tigro-Euphrates valley and
rsia that wall tiles were, undoubtedly, first made. Thus tradi-
n relates that the lustre tiles of the mosque of Sidi Okba at
iouan were brought from Baghdad in 894, and it is certain
t by the 13th century the manufacture of wall tiles for both
erior and interior use was well established in various centres in
rsia, notably Rhages and Veramne. The exterior use of wall
s was most highly developed, and in Persia, also, the transition
m enamelled and modelled brick to true, thin tile can easily be
n. By the 15th century tile decoration was supreme in Persia
l the character had changed. Mosaics and mouldings in relief
lded to a flat treatment with the richness entirely in the
oured, foliated ornament and the inscriptions painted on the
s themselves. In later Persian art there is no distinguishable
erence between the tiles of the exterior and the interior.
t was these Persian tiles which governed the taste of the eastern
t of the Mohammedan world, the same running patterns of
ves, palmettes, the carnation and other flowers that appear on
rsian carpets, decorate alike the interiors of mosques in Persia,
sopotamia and Turkey, from potteries as far apart as Rhodes,
mascus and Kutayieh. In colour these have, universally, a
e-white ground with patterns predominantly blue and green
l lesser touches of vermilion and rose and occasional yellows.
veral potteries in Asia Minor still operate and produce exquisite
ll tiles in the traditional patterns and colours. Because of the
icious delicacy of the interlacing stems and the careful spacing
the leaves and flowers, together with a spring-like clarity of
: colours, these Turkish, Syrian and Persian wall tiles are
among the most perfect wall decorations of their type.

Moorish Wall Tiles.—Farther west, in Spain and North Africa, the Mohammedan potters were developing a new type of design which gave rise to the famous Spanish *Azulejos*, whose decorative richness was such an important feature in the Alhambra at Granada (14th century), the so-called house of Pilate at Seville and similar buildings. Although transitional types occur, like the great plaque from Malaga at the beginning of the 15th century in the collection of M. de Osma, in which the patterns are of an almost Persian freedom, with twining foliage, in the greater number the design was almost purely geometric, being formed of interlacing lines than generate 8- and 10-pointed stars, octagons, irregular pentagons and similar figures. There are, in addition, a great many early tiles from the 13th and 14th centuries in which the influence of Christian heraldry is dominant. Even in the transitional plaque mentioned above, coats of arms appear and it is evident that the Mohammedan potters produced much purely heraldic tile work for Christian consumption. Many of these tiles are rich with metallic lustre decoration; the chief colours are blue, green and brown, with white lines, and in the later work a growing use of black and yellow. The earliest examples of Moorish wall tiles produced their geometric patterns by a mosaic method in which each bit of separate colour is formed by a separate tile In order to develop a more facile method of producing the same effect, the technique known as *cuenda seca* (dry cord), in which the tiles are rectangular, and the pattern on each tile is formed by raised fillets between the different colours, which prevented the adjoining enamels from running together. After the Christian conquest a third method was introduced, called *cuenca* (bowl), somewhat similar to the northern Gothic process in which the portions to be coloured were depressed and then filled with their enamels. These tiles, even in their old traditional Mohammedan patterns, were popular throughout the 16th century and even later for wainscots in Renaissance houses. The potters were evidently Moors; the great centres of manufacture remained as before in Malaga, Valencia, Granada and Seville. In the 16th century the Italian maiolica type of tile was introduced by Francesco Niculoso of Pisa, and these Spanish maiolica tiles were much used, as in the door of the convent of St. Paula at Seville (early 16th century) or the exquisite altar-piece in the Alcazar at Seville made by the same artist in 1503, where the design is purely Italian. Both the *cuenca* and the *pisano* or maiolica types of tile have been made in Spain almost continuously ever since, and the recent years have seen a great increase in the Spanish tile output both in Spain and for export.

Meanwhile in Germany there had been developing a type of tile used principally for stoves, with ornament in relief and a glaze of green, yellow or brown. This tile was in widespread use as early as the 14th century and many examples exist throughout Germany, upper Austria and Switzerland, in which the ornament is of great richness, with Gothic architectural forms in the earlier types and Renaissance forms later.

The most important of the north European tiles are undoubtedly those made in Delft from 1600 on. These are plain, square tiles, each containing a figure, a bit of landscape or a genre group, freely painted in a gray-blue upon a background of bluish-white. The little freehand sketches were so instinct with life, and the colour so subtly beautiful that by the middle of the 17th century these tiles enjoyed a great vogue, not only throughout the Germanic countries, but in England and the American Colonies as well. Although outside of Holland they were chiefly used for fireplace and stove facings, in Holland itself they were often employed for wall wainscotings. Some of the later examples have the decorations in manganese purple instead of blue. During the 18th century many attempts were made to imitate the Delft ware and during the latter half of the 18th century, particularly in England, scenes, printed from copper plates were used instead of the painted scenes.

Although many of the ancient pottery centres are still produc-
ing tiles in the traditional manner and although modern imitations
of old wares are of ex[illegible]nt quality, the greatest modern contri-
bution to wall tile d[illegible] has been the great development of
square or rectangular [illegible] with relatively uneven surfaces and

shapes on which colours and glazes of the greatest variety are unevenly flowed, so that each tile has marked individuality of colour and texture. All sorts of crackled and crystalline effects are common as well as the blending of two or more colours. The scientific development of glazings and colourings gives the decorator an almost unlimited palette for either exterior or interior use, even gold tiles being simple and comparatively inexpensive There has been a corresponding development in the use of tile in relief, usually with the background sunk and glazed in a different colour.

Important centres of tile production are: Asia Minor, for so-called Persian tiles; north Africa and Spain, for Moorish and Spanish tiles; north Italy for faience; the Netherlands for "Delft" tiles; Belgium for many types of handmade wall tiles; Germany for polychrome, machine-pressed floor tiles, England for reproductions of Gothic floor tiles and richly figured tile work generally; and the United States, particularly New Jersey, Pennsylvania, Ohio and southern California for vitrified floor and handmade wall tiles.

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TILEFISH (*Lopholatilus chamaeleonticeps*), a beautifully coloured fish of the family Latilidae, living in rather deep water in the western Atlantic. It was first discovered on a bank about 80 mi S.E. of Boston, and proved to be a valuable food fish

The tilefish is said to reach a weight of 50 lb., but about 10 lb. is more nearly the average size.

TILIACEAE, a family of dicotyledonous plants with 55 genera and about 450 species, found in most parts of the world, but largely tropical. Most of the genera are small, but *Grewia* in the old world tropics, contains about 90 species. *Tilia*, various species known as linden and as basswood (originally bast wood), is typical of the north temperate zone of both hemispheres with in excess of 100 described species. The bast of many representatives of the family is tough and strong; *Corchorus capsularis* and *C. olitorius* being jute (*q.v.*) of commerce, largely produced in India

TILING OF ROOFS: *see* ROOFS; TILE.

TILLAGE. The word "tillage" is of Saxon derivation and ancient usage. In England it is often employed in the form "tillages" in tenant right valuations and denotes the operations by which land has been prepared for crops by the outgoing tenant.

The first tilling of the soil was carried on with sharpened sticks and simple instruments of stone or flint. These were followed by the spade and the hoe, forerunners of all the modern cultivating machinery.

Tillage differs for different crops, and different soils or climates Methods are improved as investigations reveal better systems (*See* AGRICULTURAL POWER AND MACHINERY; CULTIVATION; TILLAGE MACHINERY)

TILLAGE MACHINERY. The term tillage includes such soil management practises as manuring, plowing, harrowing, rolling and cultivating, and its primary purposes are: (1) to prepare a seedbed; (2) to retard weed growth; and (3) to improve the physical condition of the soil. The manner of handling the soil depends upon the conditions to be met and involves the use of a wide variety of types and sizes of equipment ranging from the simple walking plow to the more complicated equipment used for building terraces to control soil erosion.

Plow.—The basic or primary tillage operation is plowing, and its main objective is to invert the soil so as to cover the surface trash, weed seeds and expose a large area of fresh soil to weathering which helps mellow the furrow slice so it can be more readily harrowed into a good seedbed. The plow in its simplest form is a single-furrow, horse-drawn implement held by the plowman who walks behind it. It consists of a beam to which is attached a pair of handles for controlling it; a bottom made up of a share (lay or sock) for cutting the furrow slice loose; a landside for taking the side thrust; a mouldboard or breast for turning the furrow; braces; a coulter for cutting the vertical side or wall of the furrow (this may be a vertical knife, a circular knife, or rolling coulter) and an adjustable hitch. Most European and some U.S. plows have one or two gauge wheels at the front end of the beam which control the levelness of the plow, and the width and depth of cut. To a large extent in the United States and Canada, however, a wing bearing (flat on underside of outer point of share) is provided to aid in keeping the plow level. The depth is controlled by the adjustment of the clevis hitch. Fig. 1 is typical of an English plow and fig. 2 of a U.S. plow, with the essential parts named.

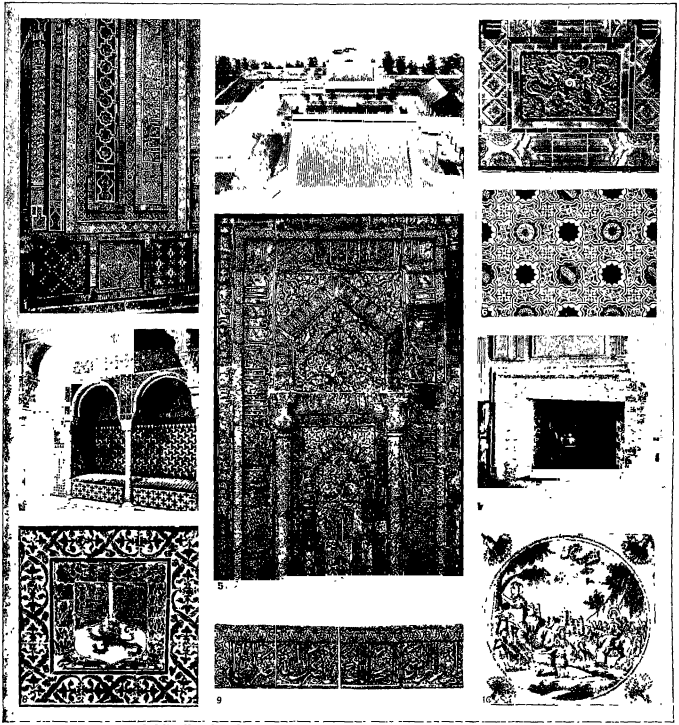
The use of plows—mouldboard and disk—is wide and varied, and their designs as to shape, size and materials have been developed to meet practically every need. Mouldboard plows, the type most commonly used, vary in size from 6 or 8 in. in width of furrow cut to as much as 6 ft., the latter being a special ditching plow developed in the western U.S. Probably most mouldboard plows range in size from 7 to 18 in. and are single- or two-furrow, horse-drawn walking plows, one- or two-furrow sulky (wheeled) plows, horse- or tractor-drawn, and up to probably six-furrow tractor-drawn plows.

The tractor-drawn plow is attached to the tractor by means of an adjustable hitch. This permits horizontal adjustment to minimize side draught and ensure correct width of cutting of the front furrow, and vertical adjustment to prevent nosing (downward tilting of plow points), which results in heavy wearing of underside of share point and poorly turned furrow slices. Incorporated in the hitch is usually a spring release or similar device which disconnects the plow when it strikes a heavy or firmly anchored obstacle such as a rock or stump. The tractor-drawn plow is generally provided with a self-lift mechanism actuated through a cord pulled by the tractor driver. A short pull causes the plows to be raised, a second pull causes them to drop and again enter the ground. In this way only one man is required to operate both tractor and plow as compared with two or more men needed in the earlier days of tractor plowing.

Plows are also made for mounting on the rear of the tractor. They are usually without transport wheel but may have a land wheel for steadying them while at work. This type permits backing into tight corners and the use of short headlands. Plows so attached are raised and lowered with the power lift of the tractor.

Where so-called one-mule farming is done, as in many localities of the southeastern cotton belt of the U.S., a single-furrow, 7- or 8-in. walking plow is commonly used. This does not permit of plowing more than about 4 in. deep, or of covering much trash or much growth of cover crop. This plow, as a rule, is fitted with chilled mouldboards and shares to resist abrasive soils. In sticky soils, slatted mouldboards are sometimes used to avoid excessive friction. This type of mouldboard is also used under similar conditions on larger horse and tractor plows. Hillside plows are so made that the plow bottom can be turned on a longitudinal axis, thus enabling the plowman to go back and forth across slopes, always throwing the furrow slice in the same direction. These plows do not usually cut a furrow wider than 8 in.

In the larger plows, both horse- and tractor-drawn, there are several different shapes of bottom adapted to a variety of soil and field conditions. At one extreme, according to classification in the U.S., is the breaker (lea) type with a long, easy-turning mouldboard, adapted to virgin or other tough sod, for laying the furrow slice over smoothly in a long ribbon. At the other extreme is the stubble bottom with its short, abrupt mouldboard for pulverizing old ground, as in fields of small grain or corn

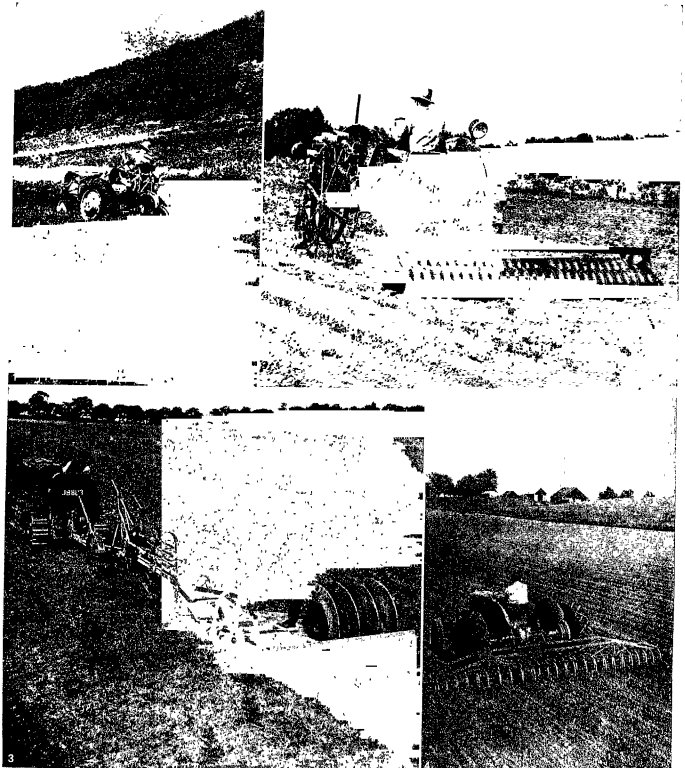


BY COURTESY OF (1, 2) RENÉ A. STUDY FROM "ART DÉCORATIF EN SURSIÈCLE D'ISLAM," (3) THE METROPOLITAN MUSEUM OF ART, NEW YORK PHOTOGRAPHS, (4, 5) EWING GALLOWAY, (8) HERBERT W. FONTINE, P H P.H.

ARTISTIC EXAMPLES OF THE USE OF TILE

1. Elaborately designed tile wall decoration of Shah-Zinda, Samarkand
2. Roofs of the summer Palace of the royal family in Peking, China
3. Tile in the Hall of Classics, Peking, China
4. Court of Divans (cooling room of bath) in the Alhambra, Spain
5. Lustre tile Mihrab (niche in a mosque indicating the direction of Mecca, toward which Muslims turn when praying), from the Maidan Mosque, Kashan Now in the Berlin Staatliche Museen, Islamische Abteilung
6. Painted tile in the floor of one of the alcoves of the Hall of Justice in the Alhambra
7. Tiles formerly around the fireplace of a Long Island home, built about 1745
8. Panel of wall tiles in Seville, Spain, of the 16th century
9. Persian frieze "Veramin," 13th century
10. Glazed blue and white Delft tiling

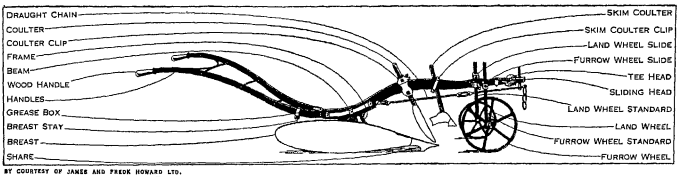
TILLAGE MACHINERY



BY COURTESY OF (1) ALLIS CHALMERS MFG CO., (2) THE OLIVER CORPORATION, (4) HARRY FERGUSON, INC., PHOTOGRAPH, (3) ERIC GUY

MODERN TILLAGE MACHINERY IN OPERATION

1. Plowing a hillside with a tractor and a direct-connected two-way plow which causes the furrows to be turned uphill to maintain soil in place for contour plowing
2. Breaking up clods in a plowed field with a corrugated roller attached to a tractor fitted with "flip-toe" steel wheels
3. Firming the soil with an English land presser attached behind a plow
4. Spring-tooth weeder in operation. These machines are useful for destroying small weeds which have shallow roots



BY COURTESY OF JAMES AND FREDK HOWARD LTD.

FIG. 1.—PARTS OF A SINGLE FURROW WALKING HORSE PLOW WITH LEA BREAST

stubble, and mixing it with the stubble and trash. Intermediate are such plows as the general-purpose bottom, which works well in stubble land, tame sod, or old ground, and is effective in covering trash and weeds; and the blackland bottom, with the mould and the suction of the share so constructed that the plow will penetrate and stay in the ground whether or not the parts scour (clean themselves). The latter is used in blackland buckshot and other heavy soils. Slatted mouldboards of the stubble type also are used frequently in these difficult soils. With the advent of rubber-tired tractors and the tendency to increase plowing speeds, have come plow bottoms with less abrupt shapes, sometimes called speed bottoms.

The type of soil and its physical condition materially influence the draught and, accordingly, the power required for plowing, as does also the speed of the plow. It is customary to express the draught, or pull, required to operate plows, in pounds per square inch of furrow section Table I gives average draught figures in various soils and is based on a large number of actual field tests conducted in various parts of the U S. and Canada.

TABLE I.—*Draught in Pounds per Square Inch of Furrow Section*

Sandy soil	3
Sandy loam, moist	3–4
Sandy loam, dry	4–6
Silt loam, moist	5–6
Clay loam, moist	6–7
Clay loam, dry	7–8
Heavy clay, dry	9–10
Heavy clay soil	10–11
Virgin prairie land—clay, moist	12–13
Virgin prairie land—clay, dry	14–15
Gumbo, moist	16–18
Dry adobe	18–20

In England, plows are divided into two general classes: the lea plow and the digger plow, the latter resembling the U.S. stubble plow, which is also called digger plow in England. The lea plow has a long, sloping mouldboard (considerably longer than the U S. sod bottom), and is used mainly in sod and especially for fall plowing as it places the furrow on edge at an angle of 45° or 50° and permits underdrainage—the English winters generally having a considerable rainfall. The digger plow is used mainly in the spring, although where deeper plowing is necessary in the fall than is possible with other equipment the digger plow is used. The lea plow usually has a chilled cast-iron share. This is about two-thirds of the width of the furrow to be turned, compared with full width of cut of the digger plowshare, and is provided with a socket to slip on to the nose of the plow frame or frog This frog contains a hole which registers with a corresponding hole in the share into which a wooden plug is driven to keep the share in place. In operation the narrow lea share acts as an entering wedge to pry a portion of the furrow slice loose from the soil below. As the plow proceeds, the furrow slice is gradually turned by the mouldboard or breast and the uncut portion is broken loose by the crowding action of the rear portion of the mouldboard, which scrapes on the bottom of the furrow at the same level as the share, breaks the balance of the furrow slice loose and lays it at the angle above mentioned.

Table II shows the effect of speed on the draught of two types of plows in two soils, from observations made at the U.S department of agriculture, Tillage Machinery laboratory, Auburn, Ala. (At the same laboratory studies of the comparative draught

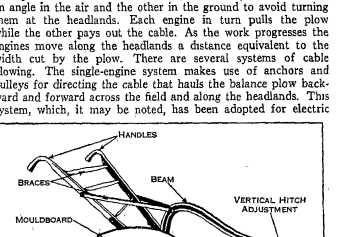
TABLE II.—*Effect of Speed on the Draught*

Soil	Loamy Sand		Decatur Clay	
Kind of Bottom	General Purpose	Sod	General Purpose	Sod
Speed (m p h.)	Draught in lb. per sq in. of furrow section			
2 50	3 94	5.40	7 09	7 63
3 20	4.10	5.40	7.19	8 24
3.75	4 89	...	8 28	8.84
5 00	6 05	6.17	9 01	9 17
6 50	6.32	6.81	10 25	10.69

of the mouldboard and disk plows showed that the average draught of the mouldboard plow per square inch of furrow turned was about 10% lighter than that of the disk plow This finding is contrary to the common belief.)

Adapted for use in hilly regions, in irrigated fields where dead furrows are a hindrance in controlling the flow of water, and in irregularly shaped fields is the special tool known as the two-way plow (called one-way plow in Europe). As its name indicates, it may be used to plow in either direction and throw all of the furrows one way. It is fitted with both right- and left-hand bottoms, one of each on horse-drawn plows and generally two of each on tractor-drawn plows. This plow accomplishes the same results as the hillside plow previously mentioned.

In European countries, particularly in England, some use is still made of plows pulled across fields by cable. Theoretically the cable system is a very efficient method of plowing, since it avoids all unnecessary haulage and minimizes soil packing, but in practice this is discounted by the high capital cost of the equipment; hence, the cable system can be employed economically only where large areas, usually heavy land, can be plowed with one set. Such plows are usually made on the balance principle with two sets of bodies, right and left, with one set at an angle in the air and the other in the ground to avoid turning them at the headlands. Each engine in turn pulls the plow while the other pays out the cable. As the work progresses the engines move along the headlands a distance equivalent to the width cut by the plow. There are several systems of cable plowing. The single-engine system makes use of anchors and pulleys for directing the cable that hauls the balance plow backward and forward across the field and along the headlands. This system, which, it may be noted, has been adopted for electric



COURTESY OF JOHN DEERE

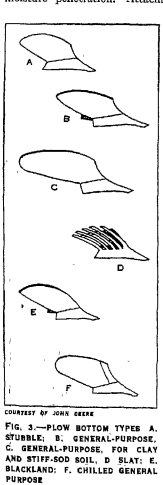
FIG 2.—HORSE-DRAWN WALKING PLOW

plowing, is lower in first cost but slower and less satisfactory than the more popular double-engine system, where an engine is employed at each side of the field. Cable plowing, however, is passing out of use.

As mentioned before, conditions determine not only the shape but the size of the bottom. It is generally considered that a plow does its best work when plowing at a depth equivalent to one-half to six-tenths of the width of the furrow at normal speed under good plowing conditions For root crops, such as sugar beets, potatoes and mangels, at least a 14-in. plow is necessary and a 16- or 18-in. plow may be better, because a depth of 8 to 10 in. is usually necessary for these crops. The 14-in. is the predominating size of tractor plow bottom made in the U.S. Those made in England are usually somewhat narrower. If much trash is to be plowed under, as a rank growth of cornstalks, plows with 16- and 18-in. bottoms and large clearance are the most effective

Complete coverage of trash and weeds is facilitated by the use of attachments. The rolling coulter and jointer used together cut the edge of the furrow slice cleanly, pare off a corner of the slice with its projecting grass or weed growth, and deposit it in the furrow where it is covered by the furrow slice. These attachments may be used as separate units, or in combination mounted on the same shank. Heavy soft-iron wires, as long as 10 ft., are sometimes attached to each plow bottom to facilitate good coverage as they drag down cornstalks and tall weeds into the furrow. For the coverage of broomcorn stalks, sweet clover and stubble, broomcorn spring attachments are used. These attachments press the stalks down; if a notched coulter is used in conjunction with them, the notches catch the trash so it is crowded down and cut, and not pushed ahead as it often is with the smaller, plain-disk coulters.

In semiarid farming regions where soil is underlaid with hardpan, subsoil plows are used to open up the ground for deeper moisture penetration. Attachments for mouldboard plows as well as so-called chisels are also used for the purpose. Some chisels penetrate 18 in. or more and are used in the deeper soils to open them and break hardpan to let in more surface water The chisel blade is sometimes replaced by a bullet-shaped ball called a mole for making drainage openings. The mole plow is equipped with a beam carrying a stout knife coulter, to the foot of which this cartridge-shaped piece of steel, the mole, is attached. In England, mole plows are commonly used for draining land with a clay subsoil. The mole may be set to work at different depths and, by being drawn through the ground, compresses the subsoil in its passage, leaving a drainage channel of its own diameter at the required depth The narrow slit cut by the coulter closes up and the water then passes into the drain by percolation. Mole drains must have outlets into a main underground drain or an open ditch and a natural gradient is essential as they follow the contour of the land. There are a number of mole plows suitable for tractor haulage which will cut drains from 15 to 18 in. deep; but for deeper work than this it is preferable to use cable haulage as the draught is too great for the average agricultural tractor.



COURTESY OF JOHN DEERE

FIG. 3.—PLOW BOTTOM TYPES A, STUBBLE; B, GENERAL-PURPOSE; C, GENERAL-PURPOSE, FOR CLAY AND STIFF-SOD SOIL; D SLAT; E, BLACKLAND; F, CHILLED GENERAL PURPOSE

Disk plows work best in dry, hard soils which mouldboard plows penetrate with difficulty, and in sticky soils, such as gumbo, where mouldboards do not scour They may also be used effectively in loose soil and where there are many roots, shrubs and bushes Disk plows are of both tractor- and horse-drawn types, with from one to seven or eight disks. The most common sizes of the tractor- and horse-drawn plows are 24 and 20 in., respectively, but some disks are as large as 30 in in diameter. The depth of plowing with these plows may be varied from 4 to 16 in. and the width cut per disk from about 7 to 12 in.

On some disk plows the angle of the disk with the vertical plane may be varied for better penetration, pulverization and turning Some of them are made to permit of widening the space between adjacent disks for better handling of heavy trash For use in ordinary plowing there are individual stationary paddle-type scrapers for cleaning the disks and a revolving-type disk scraper for use in sticky soils.

The one-way disk plow (variously known as the one-way, Wheatland, harrow, disk tiller, cylinder and vertical disk plow), which might be called a combination of a disk plow and disk harrow, is used in many sections for summer-fallow work In fallow land it should be used as early as possible in the spring to start weed growth by loosening the soil and causing earlier warming, and throughout the summer to destroy weeds When used in the stubble fields of the wheat belt of the U S. it leaves the stubble well-mixed with the soil but with enough exposed to retard blowing (While this tool has become popular it should be used with discretion, since excessive use of it in certain localities fines the soil to the extent of increasing losses from blowing and washing) Because the disks of this plow all face one way, it works with its axis at an angle—between 35° and 45°—and the thrust is taken by specially angled front and rear wheels.

The cutting width of these tools ranges between 4 and 10 ft, the disk sizes from 20 to 26 in., and disk spacings from 6 to 10 in.

Middlebusters and listers are similar in appearance to a double plow with a right- and a left-hand bottom mounted back to back. They are used in preparation of ridges in which to plant cotton, potatoes, sweet potatoes and other crops bedded in rows. Frequently the land is first plowed (flat broken) then later ridged with the middlebuster. This tool is also used to clean out the middles, break out the rows and sometimes "rebust" (throw back the soil broken out of the rows). In the semiarid regions it is used for placing the soil in ridges to hold moisture and prevent blowing. In these regions, too, this type of tool is mounted on a planter called a lister, and wheat or corn is planted in the resulting furrow.

Listers and middlebusters (middlebreakers) are available in walking, riding and tractor types of from one to five rows, and, according to the type, in furrow sizes from 8 to 14 in. There is also a 20-in. size for opening up furrows in which to plant sugar cane.

Harrows.—As plowing may be considered the primary tillage operation, harrowing may be termed the secondary operation, its purposes being to level the plowed soil, fine and compact it and destroy weed seedlings.

The disk harrow is probably the most useful of all harrows, ranking next in importance to the plow. After spring plowing as a rule the ground should be disked immediately. Fall-plowed land should preferably be disked the following spring as soon as the land is dry enough to work. Disking pulverizes the soil, reduces large air spaces and helps firm the seedbed Sometimes the disk is drawn along behind the plow, making a once-over operation. Frequently fields can be put in good condition for planting small grain by double disking alone. Some makes of disks are provided with depth gauges which prevent too deep penetration in light and sandy soils, such as are found in fruit-growing areas in Florida and other regions. The penetration of a disk harrow may be regulated by angling the gangs, the greater the angle the greater depth the disks will penetrate. Disk harrows may be horse-drawn or tractor-drawn. The horse-drawn, as a rule, are single-cut, and in order to leave the soil level the land

must be disked in the opposite direction. Double-cut or tandem disk harrows—two gangs in front and two in the rear—keep the soil level Both 16- and 18-in disk sizes are available and widths of cut range from 4 ft. if horse-drawn to 20 ft if tractor-drawn. Special disk harrows with distance between gangs adjustable for cultivating under trees in orchards are available in several sizes, as are also cutaway disks—with sections of the periphery in the disk cut out—for conditions where extra penetration is necessary and thorough pulverization is not essential.

The spike-tooth (peg-tooth, smoothing) harrow aids materially in breaking clods and levelling the ground. It is also effective in covering seeds. The desired depth of penetration may be obtained by adjusting the angle of the teeth—the nearer to vertical, the deeper the penetration. Under extreme conditions deeper penetration may be obtained by the addition of suitable weights. The width of cut ranges from the size of a single section, which is about 5 ft., to about 25 ft. when several sections are pulled abreast. In some types the teeth are rigid within the section while in others the individual bars are free to conform to the surface of the ground, and in still others, through links, the individual teeth are free to follow the ground contour.

Where the ground is trashy a self-cleaning implement is desirable. In England zigzag harrows with special hitch poles are sometimes used, but special implements for the purpose have also been developed under various trade names. One of these has two sets of teeth mounted diametrically opposite one another on parallel spindles set in a rectangular frame so that when one set of teeth is at work in the soil the other is in the air. A pull on the trip cord by the operator in the tractor seat causes the spindles to make half a revolution, which releases the accumulated trash and brings the other set of teeth into operation. Another harrowlike implement has two pairs of spiked rollers so mounted that they rotate when in contact with the ground and produce diagonal cuts in the soil as the machine is pulled along. The two rollers of each pair are geared to form a right angle, with the open sides opposite one another, and are free to rotate in a three-wheeled frame supporting them. The rollers revolve at a 45° angle with the line of forward travel. This tool is self-cleaning and is effective in tearing out dead or decaying grass in rough pasture land.

In countries where intensive farming is practised, various implements are used for grassland cultivation. Chain harrows (consisting of studded metal links fastened together like a net), brush harrows (made by drawing brushwood through a frame in such a way as to form a rough soil-smoothing surface) or ordinary peg-tooth harrows are used in the spring for dragging out moss or matted undergrowth and dispersing lumps of manure, molehills, etc. For aerating old pasture-land, particularly where much coarse or matted undergrowth is present, cultivators with twisted knifelike tines are used, while so-called pasture rejuvenators utilize tines of various shapes to cut or tear the turf to admit air.

The spring-tooth harrow does not have so wide an application as the peg-tooth harrow, but it penetrates sufficiently to tear up deep clods. With the flexible teeth little damage is incurred from striking stones or other obstructions. When equipped with special teeth, this tool may be used to advantage in digging out roots of quack grass and other noxious weeds or in cultivating alfalfa. One type of spring-tooth harrow is carried on a frame supported on wheels; another type slides along the ground Levers are provided for changing pressure on the teeth which determines depth of digging. Generally the sections of this harrow have three rows of teeth staggered, and the harrow is available in working widths of from about 5 to 17 ft. in one to six sections. Certain designs enable the operator, without leaving the seat of the tractor, to clear trash by pulling a string. This releases a catch which permits the teeth to roll one-half revolution forward to the transport position, at the same time dumping the trash. When the trip rope is pulled again the teeth roll forward another one-half revolution to their working position.

Pulverizers.—Clod crushers and mulchers are used to break up lumps left by harrows and to compact the soil, thereby eliminating large air spaces which destroy capillarity and interfere with seed germination Various rollers are used for this purpose. The plain roller is often used to compact grassland damaged by winter heaving which leaves pockets detrimental to the growth of the grass. It is used frequently on alfalfa fields also.

The corrugated roller—single or tandem—is used to firm the soil after plowing and to break up clods. Tandem rollers are especially effective in crushing clods as the ridges of the second roller split the ridges left by the first Usually the front roller is about 3 in larger in diameter than the rear one, and when clods are very hard the rear roller may be raised and fixed in position so that its weight is added to that of the front one. After wheat has been sown this type of roller compacts the soil around the seed to improve germination, and the corrugations left on the surface help prevent soil blowing. The working width of these tools—single and tandem—ranges from 3 ft. to as much as 10 ft

Another type of effective clod crusher and packer is one made up of a series of sprockets loosely fitted at the hub and mounted alternately on the axle with sharply ridged rollers. In moist soil the lagging of the sprocket members tends to prevent clogging of the rollers. These are available for use with both horses and tractors and range in size from 4 to 15 ft.

In England special land pressers or subsurface packers, consisting of a number of heavy wedge-shaped wheels about 3 ft. in diameter, are often used in dry seasons to firm the soil at the bottom of the furrow. Frequently these are hitched behind the plow.

For preparing a seedbed in one operation there is available a power-driven machine, with tines rapidly revolving in a vertical plane, which pulverizes the soil as the tool is moved over the field. This is mainly for spring work in market-gardening districts or for preparing soil for greenhouses, nurseries, etc., and is available in sizes ranging from a 14-in. width of cut to 48 in. The depth may be varied from very shallow to about 10 in. In England there is an implement with two sets of horizontally revolving blades which prepares a seedbed in one operation as it moves across the field, stirring the soil to a depth of 12 to 18 in., and breaking up any hardpan. It does not bring up subsoil or dormant weed seeds, and it is especially useful in preparing land for root crops, but a very large tractor is required to operate it

Cultivators.—In general, weed destruction is the primary purpose of cultivation (commonly called hoeing in Great Britain), but the method and degree of cultivation affect the quality and yield of the crop. Except for combatting the longer-rooted perennial weeds, shallow cultivation is preferable Deep cultivation, particularly after the plants have considerable root spread, tends to cut off the roots, a practice particularly bad in dry periods.

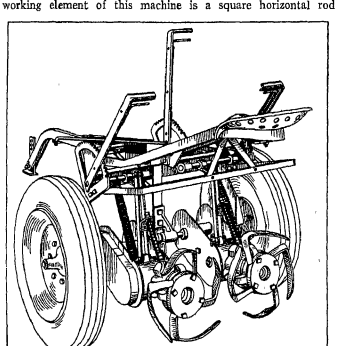
Probably the most common cultivating tool is the shovel cultivator. In their simplest form the shovels are short, narrow, slightly curved, pointed steel pieces with polished front surfaces which dig into the soil according to the pressure applied. For very shallow cultivation there are sweeps (sometimes called duckfoot) of various widths These cultivators are available in sizes ranging from the one-horse type up to two-row horse- or tractor-drawn, and three- and four-row tractor-mounted machines. One-horse and one-row equipment may be either for walking or riding. The number of shovels used per gang, as well as the type, depends on the crop and on soil characteristics. The shovels or sweeps are sometimes replaced by disks or disk hillers when it is desirable to move a considerable quantity of soil, or where trash and vines are to be cut to prevent clogging the cultivator. Sections similar to spring-tooth harrows, flexible-tooth weeders, or flat-surface cultivator blades may also be used in place of shovels

The rotary hoe, consisting of a series of 18-in. hoe wheels fitted with radially projecting fingers, is useful in the early growth stages of corn and other row crops. Its success, however, depends on getting into the field before the weeds have made as much growth as the crop; otherwise the crop plants also may be kicked out. It appears to be most effective at speeds somewhat higher than the average speed at which a horse walks. This tool

is effective also in breaking crusts resulting from hot sunshine after a beating rain. It is available for use with horses or tractor and is frequently used in combination with other cultivating tools. The sizes range from 7 to 21 ft. in width and hoes of some sizes are built in tandem.

For cultivating crops with narrow row-spacing—beets and beans, for example—there is a special cultivator which covers at one time the same number of rows as planted at one time with the drill For the cross-blocking (gapping) of sugar beets—reducing the number of seedlings previous to final thinning—the sweeps or knives attached to the beam of the cultivator frame may be shifted to leave any size block desired. In some European countries the same type of tool is used for cultivating wheat Originally built for chopping cotton, but later adapted to blocking sugar beets, is the cotton chopper for row blocking. These usually utilize knives on a revolving cutter head. As the machine goes down the row, the knives, set at an angle diagonal to the direction of rotation and revolving in a vertical plane, chop the plants and weeds out—the frequency of blocks being related to the number of knives and their relation to the rate of forward travel, and the width of gap to the angle of the knives.

The so-called field cultivator, with long slender teeth spaced about 3 in. apart, is another implement which may be used for cultivating practically any crop when weeds are small and not firmly rooted. This tool, however, is not especially effective in wet or firm soil. The rod weeder is still another tool for weed control used in cultivating fields where weed growth is to be kept down and a good seedbed maintained for the next crop. The working element of this machine is a square horizontal rod

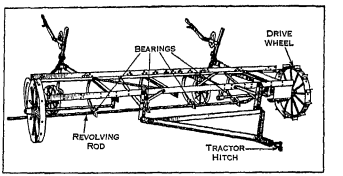


COURTESY OF THE DIXIE COTTON CHOPPER COMPANY

FIG. 4.—SUGAR BEET AND VEGETABLE THINNING MACHINE

mounted crosswise, driven by one of the supporting wheels and revolving at a depth of 1 to 5 in. below the soil surface The roots and weeds are caught on the rod and pulled out but do not collect on it. This weeder is frequently used in fallow land and ranges in working width from 8 to 12 ft. in single units to greater widths up to 36 ft. in combinations of two or more units.

For the use of market gardeners, horticulturists, amateur gardeners and growers with small acreages a wide variety of tillage tools is available to fit practically every requirement. These include garden tractors—both walking and riding, ranging in size from 1 h.p. to a maximum of 10 h.p.—capable of pulling single-furrow plows of 6-in. size to a maximum of 12 in. Such



COURTESY OF JOHN DEERE

FIG 5.—TRACTOR-DRAWN ROD WEEDER

tractors are provided with various types of attachments for cultivating and other tillage operations

For the garden there are many hand-operated tools, such as the push-type cultivator and seeder, as well as a wide assortment of small tools for specific tillage purposes.

Farm machinery dealers and hardware merchants can furnish information on practically any kind of tillage tool or advise customers where it can be obtained

Manure Spreaders, Lime and Fertilizer Distributors.—As manures and fertilizers are applied to the soil, previous to or during some tillage operation, machines for their distribution are discussed in this section. Manure here referred to means the excrements of farm animals mixed with litter or bedding; fertilizers mean artificial manure or commercial fertilizers.

The purpose of the manure spreader is to carry the manure to the field, tear it up and spread it in a uniform layer on the ground. The basic design is based on that of the four-wheeled wagon While most spreaders are of the four-wheel design, increasing use is being made of a two-wheel type with rubber tires. The distributing mechanism usually consists of a drag chain conveyor at the bottom of the wagon box to carry the manure to the rear end where it is shredded and scattered on the land This is accomplished by an upper beater which levels and shreds the manure as it is driven into the lower spike-tooth beater where it is torn to bits. Wide rotating spiral fins complete the operation by spreading the manure in a uniform layer, the thickness of which is determined by the speed at which the conveyor is set to run. These implements work best when the manure is well rotted. A practice still common in Europe, and to some extent in the U.S. and elsewhere, is to cart the manure, pile it in heaps on the field and distribute it by hand. However, this method in certain sections is being replaced by spreaders Sometimes the manure is spread by hand directly from the wagon.

The loading of manure spreaders or carts by hand is a laborious and unpleasant task. To remove this drudgery manure loaders of various types have been developed and appeared on the market about 1940. These devices are in the nature of an attachment to a tractor and are powered by the tractor engine under the control of the operator from the tractor seat. Usually they consist essentially of a single mast or a vertical framework braced firmly to the tractor frame, a jib or boom and a forked bucket with connecting steel cables, control levers and other accessories according to the particular make. On some types the loader is mounted so that the bucket will operate at the front, and on others at the rear, of the tractor. In either case, the bucket is lowered to the material to be loaded, is caused to scoop up a charge and then is raised. By tripping a catch the bucket unloads into the cart or spreader, after which it is lowered preparatory to repeating the operation.

With the recognition of the value of liquid manure and the extended use of artificial fertilizers, devices have been increasingly employed for economizing labour and for placing the fertilizer uniformly where best for the crop.

Carts for applying liquid manure are usually made of steel or iron plate (wood is unsuitable) with an axle which passes

across the vehicle. A pump is provided for filling the tank and a valve for regulating the outflow of the liquid. The simplest form of distributor is a trough extending the full width of the cart with a continuous slit running along the rear side.

Distributors for artificial manure or commercial fertilizer should be able to distribute fertilizers uniformly, whether the dressings are heavy or light, and should be easy to clean, while the working parts must be of material resistant to the corrosive action of certain fertilizers. The various kinds of distributors differ mainly in the method adopted for distributing the materials. In Europe most of them have a hopper for carrying fertilizers and are usually mounted on two wheels. Distribution is effected by a roller at the bottom of the hopper which revolves so as to work the fertilizer out backward as the machine advances; by agitators placed over holes in the hopper bottom; by an endless chain with projecting fingers which travels across the hopper bottom; or by rotating fingers of various kinds placed at the bottom of the hopper so as to work out the fertilizer as the machine advances. In many of these types the fertilizer falls more or less straight to the ground and is distributed from the full width of the machine although some machines are fitted with several series of tubes for row distribution. Another type with a narrow wheel base has a tub-shaped hopper and utilizes a centrifugal device for broadcasting the fertilizer which, in this case, is spread over a strip much wider than the machine track. Even distribution with this machine can be effected only in calm weather. Artificial or commercial fertilizer must be in a uniform and dry condition to be distributed satisfactorily by mechanical means, and care must be taken to see that these requirements are fulfilled before the material is put in the machine.

As a result of much experimentation in the U.S. fertilizer distributors are available for placing the fertilizer, at time of planting, at the best position for optimum plant growth and yield for the various crops (which may be under the seed or at a certain distance to one side and below the soil surface—in general around 2 in. below and 2 in. to the side of seed or transplant), as a side dressing at time of cultivation by an attachment mounted on the cultivator, or in a band in the bottom of the furrow at time of plowing. This latter has not yet come into general use, but, because of the time saved during rush seasons, the lessened danger of burning and the improved crop yields generally resulting therefrom, much enthusiasm has been manifested for this method of fertilizer placement.

In the U.S. too, as in Europe, there is also another variety of distributing machine—the trailer lime spreader. As its name indicates, this machine is pulled behind a wagon or truck, and consists of a tub-shaped hopper with revolving disks which broadcasts lime, marl and other fertilizers up to a width of 21 ft. For the same purpose occasional use is made of the endgate seeder, the hopper of which attaches to the rear end of a wagon box. This also makes use of revolving disks but has the capacity of the wagon box to draw on. Lime is sometimes applied with a sower which consists of a hopper about 8 ft. long carried on wheels. The bottom has a combination agitator-feeder made up of reciprocating slotted plates which cause the material to be discharged underneath at a rate corresponding to the length of stroke, which is adjustable.

Stalk Cutters.—After hand- or machine-picking heavy cotton or corn (maize) growth, it is frequently desirable to cut the stalks so they may be easier turned under when plowing, and in order to add organic matter to the soil. For this purpose the stalk cutter is used. This stalk cutter is a one- or two-row horse-drawn or a 6 ft. tractor-drawn implement which consists essentially of a cutting cylinder—eight or ten sharp-edged knives mounted equidistant from their axis of rotation—weighted down to give a thorough cutting action to the stalks as the machine rolls along the field. The one- and two-row horse-drawn cutters are mounted on two wheels and depend for their pressure upon a compression spring; the tractor machine for its pressure depends upon its heavy frame, and usually has no wheels. It is transported by turning it upside down to make use of the runners mounted on its upper side for that purpose.

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(R. B. G.)

TILLEMONT, SÉBASTIEN LE NAIN DE (1637–1698), French ecclesiastical historian, was born in Paris on Nov. 30, 1637. The boy was brought up in the little schools of Port Royal, and in 1660 he was made a tutor in the seminary of Buzenval, Jansenist bishop of Beauvais. Ten years later he came back to Paris, and presently became a chaplain at Port Royal. In 1679 the storm of persecution drove him to settle on his family estate of Tillemont, where he spent the remainder of his life, dying on Jan. 10, 1698.

From the age of twenty he was at work on his two great books—the *Mémoires pour servir à l'histoire ecclésiastique des six premiers siècles*, and the *Histoire des empereurs* during the same period. Both works began to appear during his lifetime—the *Histoire* in 1690, the *Mémoires* in 1693—but in neither case was the publication finished till long after his death.

There is a full account of his life in the 4th volume of Sainte-Beuve's *Port Royal*.

TILLETT, BENJAMIN (1860–1943), British Labour politician, was born at Bristol, on Sept. 11, 1860. He started work in a brickyard at eight years, and was a "Risley" boy for two years. He served six months on a fishing smack, was apprenticed to a bootmaker, and then joined the royal navy. He was invalided out of the navy and made several voyages in merchant ships. He then settled at the London docks and organized the Dockers' union of which he became general secretary, taking a prominent part in the dock strike of 1889. He was one of the pioneer organizers of the General Federation of Trades, National Transport Workers' federation, National Federation of General Workers, International Transport federation, and of the Labour party.

For many years he was an alderman on the London County council, and was twice elected member of parliament by the Labour party. He died in London, Jan. 27, 1943.

His publications include *A Brief History of the Dockers' Union* (1910), and *A History of the Transport Workers' Strike* (1911).

TILLEY, SIR SAMUEL LEONARD (1818–1896), Canadian statesman, was born at Gagetown, New Brunswick, on May 18, 1818, the son of Samuel Tilley, an American Loyalist, who had settled in St. John in 1783. From 1860 to March 1865 he was premier of the province, and was prominent in organizing the conference on the union of the maritime provinces, which met at Charlottetown in 1864, and which soon widened into a discussion of Canadian federation.

In 1865 he was defeated in a general election on the federation question, but returned to power in 1866, partly through an intrigue of the colonial office. From 1868 till November 1873 he held various portfolios in the Dominion cabinet; from 1873 to 1878 he was lieutenant-governor of New Brunswick, but in 1878 was again elected as member for St. John, and entered the Conservative cabinet as minister of finance.

Later in 1878 he introduced and carried through parliament the "national policy" of protection, on which issue the election of 1878 had been won. The tariff so introduced became the basis of Canadian financial policy.

In Oct. 1885 ill health forced him to retire from the cabinet. He was again lieutenant-governor of New Brunswick from 1885 to 1893. He died on June 25, 1896.

His *Life*, by James Hannay (1907), forms one of the "Makers of Canada" series.

TILLODONTIA, a group of extinct mammals from the Eocene of North America and Europe. The average size was about that of a living brown bear. The canine teeth are very

small, one pair of incisors in each jaw much enlarged and chisel-like The general structure is very primitive, the brain small and elongate, the cheek teeth of generalized (tuberculo-sectorial) type, the feet plantigrade, with five toes The skull is more carnivore- than rodent-like in general aspect The best known genera are *Tillotherium*, *Esthonyx* and *Trogosus* Despite the relative large size of its members, the group is probably more suggestive of the Insectivora than of any other established order and it is apparently an early, extinct, rather aberrant offshoot of the earliest stock of the placental mammals. (G. G St.)



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE SKULL OF TILLOTHERIUM FODIENS, AN EXTINCT MAMMAL

TILLOTSON, JOHN (1630–1694), English archbishop, was the son of a Puritan clothier in Sowerby, Yorkshire, where he was born in October 1630. He was a fellow of Clare Hall, Cambridge, and about 1661 he was ordained without subscription by T Sydserf, a Scottish bishop. Tillotson was present at the Savoy Conference in 1661, and remained identified with the Presbyterians till the passing of the Act of Uniformity in 1662. Shortly afterwards he became curate of Cheshunt, Herts., and in June 1663, rector of Kedington, Suffolk. He now devoted himself to an exact study of biblical and patristic writers, especially Basil and Chrysostom The result of this reading, and of the influence of John Wilkins, master of Trinity College, Cambridge, was seen in the general tone of his preaching, which was practical rather than theological. In 1664 he became preacher at Lincoln's Inn. The same year he married Elizabeth French, a niece of Oliver Cromwell; and he also became Tuesday lecturer at St. Lawrence, Jewry. In 1670 he became prebendary and in 1672 dean of Canterbury. In 1675 he edited John Wilkins's *Principles of Natural Religion*, completing what was left unfinished of it, and in 1682 his *Sermons* With Burnet, Tillotson attended Lord Russell on the scaffold in 1683. It was partly through Lady Russell that he obtained influence with Princess Anne, who followed his advice in regard to the settlement of the crown on William of Orange. He possessed the special confidence of William and Mary, and was made clerk of the closet to the king and dean of St. Paul's. On his advice the king appointed an ecclesiastical commission for the reconciliation of the Dissenters. He was elected to succeed the Nonjuror Sancroft as archbishop of Canterbury, but accepted the promotion with extreme reluctance, and it was deferred from time to time, at his request, till April 1691. In 1693 he published four lectures on the Socinian controversy. He died on Nov. 22, 1694

Ralph Barker edited his *Sermons* together with the "Rule of Faith" (14 vols. 1695–1704). In 1752 an edition of his *Complete Works* appeared in 3 vols., with *Life* by Thomas Birch.

TILLY, JOHANN TZERCLAES, COUNT OF (1559–1632), general of the Catholic League in the Thirty Years' War, was born in 1559 at the château of Tilly in Brabant. He was destined for the priesthood and received a strict Jesuit education. But, preferring the career of a soldier, he entered a Spanish foot regiment about 1574 as a volunteer, and in the course of several campaigns rose to the command of a company. This being reduced, he again became a simple pikeman, and as such he took part in the famous siege of Antwerp by Parma. He distinguished himself by his bravery, and the duke of Lorraine gave him the governorship of Dun and Villefranche, which he held from 1590 to 1594. Henry IV. attempted unsuccessfully to induce him to enter the service of France. Somewhat later he left the Spanish service for that of Austria to fight against the Turks In 1602 he became colonel in the imperial army, and raised a regiment of Walloon infantry which he commanded in the assault on Budapest, receiving a severe wound. In 1604 he was made general of artillery; having shown great capacity and devotion to the emperor and the Catholic religion, he was made a field-marshal in 1605. In 1610 he left the service of the emperor to enter that of Maximilian, duke of Bavaria, the head of the Catholic League. In 1620 he became lieutenant-general to Maximilian and commander-in-chef of the field forces.

With the victory of the White Mountain (1620) the new army and its leader became celebrated throughout Germany and the subsequent campaigns (*see* THIRTY YEARS' WAR) established their reputation. The battle of Höchst (1622) won for Tilly the title of count.

The defeat of King Christian was soon followed by the intervention of Gustavus Adolphus The opening stages of the campaign did not display any marked superiority of the Swedes. At this time Tilly was commander of the imperial forces as well as of his own army The first great contest was for the possession of Magdeburg (1631). Tilly has been blamed for the atrocities which accompanied the sack of this town after its fall (May 20) Yet his personal exertions saved the cathedral and other religious buildings from pillage and fire. Four months later Tilly and Gustavus, the representatives of the old and the new art of war, met at Breitenfeld (*q.v.*). The victory of Gustavus was complete, though the imperial general, although severely wounded, drew off his men in good order. On the Lech, a few months later, Gustavus was again victorious, and Tilly received a mortal wound. He died on April 30, 1632, in Ingolstadt.

See O Klopp, *Tilly im 30-jährigen Krieg* (Stuttgart, 1861), K. Wittich, *Magdeburg, Gustav Adolf und Tilly*; also memoir of Tilly in *Allg deutsche Biographie*; Keym-Marcour, *Johann Tzerclaes, Graf v. Tilly*; Villermont, *Tilly, ou La Guerre de trente ans* (Tournay, 1859).

TILSIT, a town in the Prussian province of East Prussia, Germany, on the left bank of the Memel or Niemen, 57 mi. S.E of Memel and 72 N.E. of Königsberg by rail. Pop. (1939) 57,745. Tilsit, which received civic rights in 1552, grew up around a castle of the Teutonic order, known as the "Schalauner Haus," founded in 1288 It owes most of its interest to the peace signed here in July 1807, the preliminaries of which were settled by the emperors Alexander and Napoleon on a raft moored in the Memel This treaty, which constituted the kingdom of Westphalia and the duchy of Warsaw, registers the nadir of Prussia's humiliation.

TIMAEUS (*c.* 345–*c.* 250 B.C.), Greek historian, was born at Tauromenium in Sicily. Driven out by Agathocles, he migrated to Athens, where he studied rhetoric under a pupil of Isocrates and lived for 50 years. During the reign of Hiero II he returned to Sicily (probably to Syracuse), where he died. While at Athens he completed his great historical work. The *Histories*, in at least 38 (Bury says 33) books, was divided into unequal sections, containing the history of Italy and Sicily in early times; of Sicily alone; of Sicily and Greece; of the cities and kings of Syria (unless the text of Suïdas is corrupt); the lives of Agathocles and Pyrrhus, king of Epirus. The chronological sketch (Ὀλυμπιονῖκαι, the victors at Olympia) perhaps formed an appendix to the larger work. Timaeus was bitterly attacked by other historians, especially by Polybius.

The most serious charge against Timaeus is that he wilfully distorted the truth, when influenced by personal considerations. thus, he was less than fair to Dionysius and Agathocles, while loud in praise of his favourite Timoleon. On the other hand, as even Polybius admits, Timaeus consulted all available authorities and records. His attitude towards the myths, which he claims to have preserved in their simple form, is preferable to the rationalistic interpretation under which it had become the fashion to displace them In chronology, he introduced the system of reckoning by Olympiads, with which he compared the years of the Attic archons, the Spartan ephors, and the priestesses of Argos. This system was afterwards generally used by the Greek historians. Timaeus' prose is of the Asiatic school; Cicero praises it.

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TIMARU, a seaport of Geraldine county, New Zealand, on the E. coast of South Island, 100 mi. S.W. of Christchurch by rail. Pop (1936) 17,397 (18,814 urban area). The slight inward sweep of the coast forms the Canterbury Bight. The harbour is

formed by breakwaters enclosing a space of 50 acres The chief shipments from the port are wool, flour and frozen and chilled meat, and the town's industries are in connection with these Timaru, the chief town in the South Canterbury district, is well served by rail and road; it is a popular seaside resort

TIMBER. The terms "wood" and "timber" are not synonyms, for wood occurs in the veins of leaves and as strings in thick palm-stems, also in thicker cylindrical form in twigs of shrubs and trees. The term timber, synonymous with the North American term *lumber*, applies solely to wood of considerable dimensions produced by trees. (*See* LUMBERING)

Two great classes of trees provide timber. (1) *Conifers*, including pines, spruces and larches, usually have more or less needle-like leaves, and their naked seeds are most frequently borne on cones they yield the so-called *softwoods* (2) *Dicotyledons*, including oak, ash, beech and teak, commonly have broader flat leaves and their seeds are always produced in closed seed-cases: they provide the *hardwoods*

Origin and Structure of Timber.—The part of the tree above ground typically consists of a main *trunk* and the branch-system whose ultimate finest branches are the leaf-bearing twigs.

The trunk and branches grow in *length* solely at their tips, so that the oldest part of a trunk or branch is its base and the youngest is its slender tip. But after a portion of a trunk or branch has ceased to grow in length it can grow in *thickness* year after year and especially by producing new wood. This takes its origin from a microscopically thin sheet, the *cambium*, lying between the bark and the wood: the cambium deposits new wood outside the pre-existing wood. In the cool-temperate climate the cambium produces new wood only during spring and part of the summer and is inactive during autumn and winter: the wood produced first in each year is frequently (*e.g.*, ash, Scots pine) different from that produced later in the year, so that a distinction is drawn between the early *spring-wood* and the later *summer-wood* (frequently termed *autumn-wood*). In such cases a cross-section of the tree-trunk will show a number of concentric *annual rings*, whose number is equal to the age of the region of trunk cut. In the case of the beech and a number of other trees, the annual rings show no marked differentiation into spring-wood and summer-wood, but are recognisable because a very thin layer produced latest in the growing season differs in appearance from the rest of the wood Finally many kinds of evergreen tropical trees (*e.g.*, mahogany) show no distinct annual rings.

In certain kinds of trees, for instance species of pines and leaf-shedding oaks, after the wood has attained a certain age it darkens in colour, so that when a cross-cut of a 100-year old part of the trunk is taken the darker older central wood contrasts as *heart-wood* with the surrounding pale *sap-wood*.

Structure of Wood.—With the aid of the microscope it can be seen that a softwood consists mainly of very narrow hollow spindle-shaped "fibres" (properly, tracheids), running parallel to the long axis of the trunk or branch. The solid wall of each fibre consists of wood-substance and on at least two of its sides shows a series of thin round patches, the pits, through which water or sap can pass from fibre to fibre.

In addition to the fibres, certain softwoods, including those of true pines, have very thin resin-containing tubes, the *resin-ducts*, which run parallel with the fibres. In structure each duct in microscopic minuature recalls a tall factory chimney, as its central tubular hollow is surrounded by microscopic, short, more or less brick-shaped cells, which are hollow and have thin walls. All commercial softwoods (excluding that of the yew) contain resin but some of them (*e.g.*, Californian redwood) have in place of resin-ducts merely resin-containing short cells.

Traversing the wood at right angles to the fibres are thin string-like or ribbon-like structures that run from the outside of the wood radially inwards towards or actually to the pith. These are the *medullary rays*, which are usually nearly or quite invisible to the naked eye in cross-sections of softwoods. They consist of more or less brick-shaped cells, which in the sap-wood contain albuminous substances and at times such other nutritive substances as sugar, starch or fatty oil: in the sap-wood they consequently invite attack by animals and fungi. Softwoods that, like true pines, have resin-ducts in the wood also possess these in the thicker medullary rays.

The fundamental difference between softwoods and hardwoods is best understood if we imagine a number of the wider "water-fibres" very greatly widened and strung end to end with their terminal walls absorbed, so that long continuous tubes, sometimes yards in length, are produced. These water-conducting tubes are termed *wood-vessels:* in cross-section they are often visible to the naked eye as *"pores."* All commercial hardwoods have wood-vessels, which in the sap-wood contain air with or without liquid sap. In addition to the vessels, the different hardwoods have "fibres" of various forms

Finally medullary rays are present, and in many hardwoods some of them are much thicker than in softwoods and visible to the naked eye in cross-section, producing the so-called "silver grain" on the radial side view of the wood of, for instance, oaks, beech, plane, etc. Their contents in the sapwood are identical with those of softwoods

Sap-wood and Heart-wood.—The change of sap-wood into heart-wood is a vital one, occurring only in the living tree, and thus is very different from the process of seasoning of timber which takes place *post mortem*. The sap-wood is living inasmuch as its brick-shaped cells contain living protoplasm· the heart-wood is dead, as the protoplasm dies and the cells lose their nutritive contents, which are replaced by air and more indigestible substances such as "tannin," gums and resin The heart-wood contains less water than the sap-wood, and its water-conducting elements ("fibres" and vessels) become more or less plugged by microscopic bladders or gums, or the pits are closed Consequently sap-wood is more easily impregnated with wood-preservative liquids than is heart-wood of the same tree. In different trees the age at which sap-wood first changes to heart-wood differs: for instance the change takes place earlier in larches than in true pines, so that the former have fewer annual rings of sap-wood outside the heart-wood and produce valuable durable heart-wood earlier in the life of the tree, and contain a smaller proportion of the perishable sap-wood (*see* DRY ROT).

Grain of Timber.—Most frequently the fibres and other structural elements of knotless timber run parallel with the long axis of the trunk or branch, and the wood is described as being *straight-grained*. If a plank or post be sawn in a direction not parallel to the axis of the trunk, the grain of the sawn article is not parallel to the sides of this and the plank or post is described as *cross-grained*. But not infrequently the grain of the trunk (or branches) runs in a spiral direction as if the trunk had been twisted round its long axis: the grain is then described as *spiral* or *torse*, and the timber when cut up is inevitably cross-grained. There are yet other, especially tropical, woods in which the grain more or less swings from a left-banded to a right-handed spiral direction, so that the wood when cut into plain boards shows a *double cross-grain* or *interlocked grain*, and when cut along the radii of the trunk ("on the quarter," rift-sawn) shows *roe-figure*, for instance in mahogany.

In addition to these deviations from the straight grain the structural elements of the wood may pursue a wavy or *sinuous* course, for instance in so-called rammy-ash. When the waviness is exaggerated the grain is said to be curly.

Knots, being the basal parts of branches that have become embedded in the thickening trunk, are naturally associated with a change of direction of the fibres. The wood of large excrescences on the trunk of certain trees known as *burrs* exhibits structure similar to that which would be produced by many crowded branches. and a somewhat similar structure is shown by bird's eye maple.

The fibres of most timbers overlap and dovetail with one another at their ends, which are at different levels, and the medullary rays as seen in circumferential or tangential view are arranged apparently irregularly or in spirals. But some woods when examined from the same view-points show lines running across the grain and producing what is known as *ripple-marking:* this is

caused by either contiguous fibres ending at the same levels with little or no overlapping or medullary rays placed at the same levels, so that the structure of the wood is *tiered*. Such structure is often shown by true American mahoganies

Chemical Composition.—The wood-substance composing the walls of the hollow structural elements that constitute the solid frame-work or skeleton of wood may, for the present purpose, be regarded as always being composed of two main constituents, *lignone* and *cellulose*, together with smaller quantities of additional more or less gum-like bodies The lignone can be removed from the wood by steam or warm weak acids (and is so removed in the manufacture of chemical wood-pulp), the cellulose remaining.

The various substances here described collectively as cellulose are carbohydrates, which may be popularly defined as sugars or substances capable of being converted into sugars. Thus cellulose of wood yields for instance a sugar, glucose, which by fermentation can produce ethyl alcohol (spirits of wine) Cellulose by appropriate treatment with nitric or acetic acid produces soluble compounds which when precipitated serve to make artificial silk, dopes, films (collodion, etc), and in the case of nitric acid, explosives.

The general agreement of all kinds of timbers as regards chemical composition is illustrated by the fact that all these under destructive distillation yield tar and tar-derivatives and methyl alcohol (wood spirit).

But the various kinds of wood also have additional chemical bodies which differ in the different species, and include tannin-like bodies, resins, scented ethereal oils and colouring substances.

Physical Constitution.—Physically wood-substance is a very stiff jelly or *gel*, and consequently is comparable with glue, gelatin or gums. Like these, it is hygroscopic and swells as it absorbs water and shrinks as it dries. Wood-substance can take up only a definite amount of water, which lies near 30% of its dry weight when the wood is in a saturated atmosphere A piece of wood containing this maximum amount in its walls but none in its cavities is described as having reached *fibre-saturation point*, and has attained its maximum volume: when liquid water is added to it the water remains in the cavities and no additional swelling ensues

It is a familiar fact that when water is added to dry glue or gelatin these show a decline in hardness, strength and stiffness, and a rise in flexibilty and extensibility: as wood-substance is a gel, the same changes in its properties take place when water is added to a piece of dry wood until fibre-saturation point is reached Moreover, just as when heat is applied together with water to glue this shows increased loss of stiffness (by "melting"), so when moist steam is applied to wood this can readily be bent for the manufacture of furniture and so forth.

The weight or heaviness of wood is recorded as the weight of a unit of volume of the wood, which is the density. The units employed in the British Empire and United States are cubic feet and pounds avoirdupois: elsewhere, and in scientific work, they are cubic centimetres and grammes.

Since the fundamental chemical composition of wood-substance approaches identity in all timbers, its specific gravity in these varies but slightly and lies near 1·55; that is, dry wood-substance weighs slightly more than one and a half times as much as water. Consequently when two perfectly dry pieces of wood of equal size differ in weight, the one is heavier than the other because it contains more wood-substance; in other words the density of perfectly dry wood is a measure of the amount of wood in a unit volume. The various kinds of timbers differ in their densities, some woods, including ebony and box, even when fully seasoned, sink in water, whereas some balsa-woods are lighter than cork. Consequently density facilitates identification of different woods.

Water Content.—The amount of water present in a piece of wood is of profound practical importance, since it determines the weight (consequently cost of transport), size, shape, heat-raising power, hardness, strength and stiffness of the piece. as well as the vulnerability of the wood to attacks by fungi and insects: it also determines the changes in these characters that will ensue when the wood is transferred to another place.

In commerce the water-content of the wood is recorded as the percentage weight of the wood and contained water, but in scientific work and in this article, as a percentage weight of the wood when it is absolutely dry. According to the latter method of recording, a log of wood is described as containing 200% of water when it contains 200 lb. of water to every 100 lb of dry wood. Such a high water-content does occasionally occur naturally, for instance in freshly felled swamp (Louisiana) cypress; more frequent in freshly felled timber is 100% in the sap-wood. Heart-wood contains much less Here a popular error must be corrected: in cold-temperate regions the wood of a tree does not contain less water in winter than in summer; often the reverse is the case.

When exposed to the open air, preferably under cover, a freshly felled piece of wood dries and shrinks until the water-content at its surface has a vapour pressure equal to that of the atmosphere. The water-content of pieces of timber thus seasoned in the open air, and not too massive, varies according to the season and site between 15 and 20% in Great Britain but is much less in drier climates, for instance, that of Egypt, in which it may be 6%

Brought indoors into heated work-shops or rooms further drying and shrinking takes place, so that furniture in Great Britain contains about 7 to 9%, and in drier parts of South Africa and the United States only 6% or less.

Placed in a drying oven at a temperature of 100°C, all the water, save that which is chemically combined, is regarded as having been dried out and the wood is described as absolutely dry. When dry wood is once more exposed to moister air it reabsorbs water and swells.

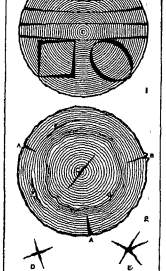
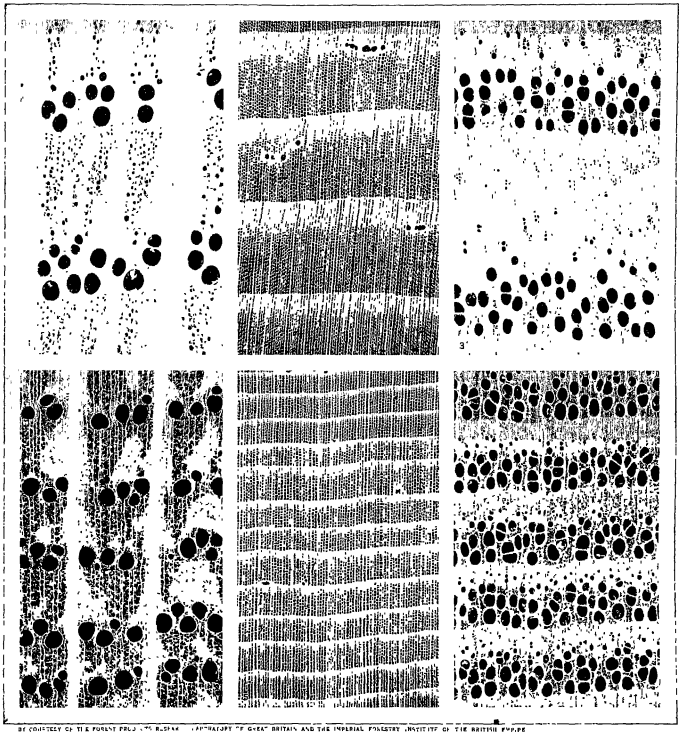


FIG. 1.—SHRINKAGE AND CHANGE OF SHAPE INCLUDING WARPING
FIG 2.—SHAKES AND SPLITS (A) SEASONING SPLIT (B) FROST-RIB AND SPLIT (C) SIMPLE HEART-SHAKE (D) DOUBLE HEART-SHAKE (E) STAR LIKE HEART-SHAKE (F) PARTIAL CUP-SHAKE (G) COMPLETE CUP-SHAKE

Different kinds of wood undergo different changes of volume with the same percentage gain or loss of water: heavy or non-resinous woods generally shrink or swell more than do light or resinous woods, with the consequence that softwoods usually show smaller changes of shape and volume than do hardwoods. But shrinkage and swelling are not proportional to density, for non-resinous woods of the same density show considerable differences in this respect; for instance, Central American mahogany with changed water-content undergoes comparatively slight change of size and shape.

A piece of wood tends to shrink and swell unequally in different directions Along the grain shrinkage and swelling are so slight that measuring rods made of well-seasoned wood are very reliable. Across the grain shrinkage and swelling are many times as great: in a radial direction 30 to 50 times and tangentially (or parallel to the annual rings) 60 to 100 or more times. Consequently when a piece of wood dries it undergoes greater or less change of shape. The accompanying diagrams show cross-sections of pieces of wood respectively cut into boards, joists and cylindrical rods, and the change of shape caused by drying; the warping of boards 2 to 4 contrasts with the preservation of flatness of board 1 which is cut nearly parallel to the radii (quarter-cut or rift-sawn).

A piece of wood whose fibres, like those of very knotty wood or burrs, run in various directions obviously is especially liable to split when dried. It is partly for this reason that the burr-wood used in the manufacture of beautifully figured furniture is cut



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MAGNIFIED TRANSVERSE SECTIONS OF TIMBER

Upper and lower photographs illustrate respectively broad and narrow annual rings of Oak, *Quercus robur* (1, 4), Douglas Fir, *Pseudotsuga taxifolia* (2, 5), and Ash, *Fraxinus excelsior* (3, 6). The spring-wood of their annual rings, produced at the beginning of the growing season, is more open or porous, and weaker than the summer-wood, produced later in the season. The proportion of weak spring-wood is greater in the wide than in the narrow rings of the Douglas Fir, but the reverse is the case in the Oak and Ash

into very thin sheets, termed *veneers*, which are glued on to straight-grained wood. *Plywoods* (including the commonest of these, three-plywood) consist of thin veneer-like sheets glued together so that the grains of the successive sheets cross one another at a given angle (usually at right angles), with the consequence that plywood warps less and shrinks more uniformly than does plain wood and is less unequal in strength in different directions.

Colour.—The different kinds of wood may be wholly white or in the heart may be black or have colours ranging from brown, yellow, red, green to violet, or mixtures of these. It is quite exceptional for one and the same wood when perfectly sound to show such a wide range of variation as does that of *Liriodendron* (whose English name is Canary white wood and North American name is yellow poplar). this wood varies in colour from light yellow to green and iridescent blue. The colour thus facilitates identification and helps to decide the decorative use to which a wood shall be put. It is not true that dark coloured woods are more durable than light coloured, though this is true of the heartwood when compared with the sap-wood of the same timber. Abnormal discolouration of wood is very frequently caused by fungi attacking the wood or its contents, such as the case with the *blue sap*(*wood*) of softwoods, rusty red of woods attacked by various fungi (including some causing dry rot), black lines and white patches of many rotting timbers, and sometimes false heartwood in trees which normally lack a coloured heart-wood.

Heating Power.—The heat-yielding power of a piece of wood sinks with increase of the water-content of this: consequently the succeeding remarks refer to wood absolutely dry. During the combustion of wood the heat liberated is mainly derived from the wood-substance: as the weight of this in a unit volume of wood is the density, it follows that the heavier a wood is the more heat can it supply: the presence of resin in wood, however, increases the heat-giving power. But when wood is used as fuel the most important character often is the form in which the heat is liberated. Very heavy woods produce short or no flames and burn slowly, light woods can produce long flames and burn fiercely: consequently for fire-lighting or steam-producing the latter are used, whereas for keeping rooms warm, woods of intermediate density (*e.g.*, oak, beech) are most efficient.

Mechanical Properties.—The trunk and woody branches of a tree owe their strength and stiffness mainly to their wood. Accordingly, wood must possess strength to resist breakage or permanent damage by slow crushing, stretching, bending and twisting; it must also resist shock in the form of sudden application of these stresses. it must possess sufficient stiffness to give the requisite pillar-strength to the trunk, and when a deforming stress is removed must return to its former shape.

In conformity with its difference of structure along and across the grain, wood differs in strength and stiffness in these two main directions As regards crushing (compression) and stretching (tension) wood is strongest and stiffest along the grain, and weakest at right angles to this: but as regards shear it is strongest at right angles to the grain: a beam in bending is strongest and stiffest when the load is applied perpendicular to the grain. Consequently, joists, beams, floor-boards, posts, axe-handles, wheel-spokes and so forth are strongest when their grain is straight and parallel to the sides of these objects, and they are weakened by cross-grain and considerable knots.

The remarkable mechanical property of wood is its combination of strength and lightness: for instance, if the crushing strength be divided by the density in the cases of constructional wood and iron, steel and other metals, the resultant value is highest in wood. Nevertheless, the tensile strength of steel or iron is so much higher than that of wood that one of the former is used in engineering construction for members required to resist rupture by tension, whereas wood is often used where resistance to bending or compression is needed. (*See* MATERIALS, STRENGTH OF.)

The peculiar *elastic* properties of wood render possible its employment as resonance-wood, used for instance in the bellies of violins, and the sounding boards of pianos Wood undergoing decay soon declines in strength and elasticity, and even when only partly decayed emits when struck a dull, in place of a sharp ringing sound.

Wood, thanks to its structure, elasticity, low tensile strength, and relative softness, can be riven or *cleft* along the grain and yields a more or less smooth surface.

Defects of Timber.—(*a*) *Standing Tree.* Wood may have structural peculiarities that represent defects from the mechanical point of view but may enhance the value because of the decorative effect. This is the case where *deviations of the grain* such as wavy or curly grain, or abundance of knots, weaken the wood.

Always decreasing the value of timber are long splits, termed *shakes*, directed along the grain of the standing tree. These in cross-section may run parallel with the annual rings (or contour of the trunk) and are termed *cup-shakes*, and may assume the form of short arcs or complete circles (*ring-shake*): in the latter case when the log is sawn the central part separates from the outer part. But in cross-section the shake may run in a radial direction, it is then a *heart-shake:* such a shake is widest towards the centre and tapers outward, and contrasts with the radial splits induced by drying of the felled timber which are wider at the outside and taper inwards. Heart-shake may assume the form, in cross-section, of a single split traversing the centre and is described as *simple*, or this split may be crossed at right angles by another thus producing *double* heart-shake, or, finally a number of splits may radiate from the centre and thus constitute *star-shake*, which is often associated with discolouration and decay. Radial *frost-shakes* are frequently associated with "frost-ribs" that are visible on the growing tree as ridges running down one or more sides of the trunk With these shakes contrast the internal radially directed splits that first arise in felled timber which has been so rapidly dried that *"case-hardening"* has resulted.

As coniferous wood resin-containing cavities, known as *resin-pockets* or *pitch-pockets*, occasionally occur: they are of varied dimensions but usually of width quite considerable in comparison with the length. Sometimes longer *resin-veins* easily visible to the naked eye traverse the wood or this may clearly show a general excess of resin in the absence of veins or pockets. In some cases excess of resin or abnormal development of the ducts is due to wood-attacking fungi. In hardwoods so-called *gum-veins* are occasionally present in Australian species of *Eucalyptus*, including jarrah, and in true mahoganies.

(*b*) *Felled Timber.*—Tunnels or other cavities are also produced by animals in felled timber. In sea-water they result from attacks by Molluscs (*e.g.*, shipworms) or small Crustacea (*cf.* shrimps), and on land are due to insects. Decay or rot of timber taking place in the standing tree or felled timber is always due to fungi (*see* DRY ROT), and is associated with discolouration and weakening of the wood but much less frequently with the production of internal cavities.

Opposed to the shakes already considered are *cross-shakes*, which are cracks or splits running at right angles to the grain. In the overwhelming majority of cases they are due to decay of the wood, caused by fungi, and consequent shrinkage (*see* DRY ROT). They render wood useless for mechanical usage. But the logs of certain species of trees, including spruce, sabicu and some African mahoganies, occasionally show cross-shakes, even when there is no trace of decay.

For a discussion of Felling, forms and sizes *see* LUMBERING. *See* also TIMBER PRESERVATION.

Special Softwoods.—The name cedar is given to various unrelated, usually fragrant, softwoods and hardwoods. The true cedars (*Cedrus*) are familiar as trees of three kinds: the Himalayan deodar, the cedar of Lebanon and the Atlas Mountains cedar. Junipers (*Juniperus*) supply the *pencil-wood cedar*, the most important being the North American *J. virginiana*, though pencil slats are also made from another species growing in Kenya Colony: the heartwood is durable, as the scented cedar-wood oil is antiseptic and distasteful to insects. Lawson's cypress (*Chamaecyparis Lawsoniana*), indigenous in western United States, yields the valuable *Port Orford cedar*. Other North American cedar woods are produced by arbor vitæ trees (*Thuja*), the durable red cedar wood (*T. plicata*) being used for shingles.

Bald, marsh or Louisiana cypress (*Taxodium distichum*) grows

in swamps of south-eastern United States and Central America: its durable wood is unsurpassed for conservatories

The European larch (*Larix decidua*) is rather heavy and the red heartwood is very durable. The rather similar North American timbers are those of the tamarack (*L. americana*) and the western larch (*L. occidentalis*). Larch timbers find many of the same uses as hard-pines (*see* later).

Pine, true—The name pine is given to a medley of softwoods, but should be restricted to timbers belonging to the genus *Pinus* Such genuine pine-timbers may be ranged into two classes, hard-pines and soft-pines, the former of which are generally heavier.

Hard-pines include one of the two most important softwoods of Europe, Baltic "red deal" (*Pinus sylvestris*, the Scots pine), which grows widely over Europe, and is represented in North America by a very similar timber, red or Norway pine (*P. resinosa*). The name pitch-pine as applied to North (and Central) American timbers in Great Britain and the United States, respectively, is liable to cause confusion: in the latter country it refers to relatively poor wood of *P. rigida*, whereas in Great Britain and Europe it refers to pine-timbers of the highest class produced by *P. palustris* and two or three other species all exported from south-eastern United States to England.

Soft-pines include the timber of the American Weymouth pine (*Pinus Strobus*), which is known in England as "Canadian yellow pine" and in the United States as "Eastern white pine". it is not used out of doors, but for making matches, patterns and for high-class cabinet work.

Pines, so called—A wide range of coniferous trees are known in Australasia as pines, and include the Kauri-pine (*Agathis australis*) of New Zealand, and Huon-pine (*Dacrydium Franklinii*) in Tasmania The Oregon or British Columbian pine is Douglas fir (*Pseudotsuga taxifolia*) which grows in the Pacific States of North America.

Californian redwood (*Sequoia sempervirens*) has a reddish heartwood light in weight, very durable, and used for the manufacture of shingles and patterns.

White deal is the wood of the Norway spruce (*Picea excelsa*) which is wide-spread over Europe The white wood ranges in quality from the common grades used in packing cases, woodwork of houses and pulp, to mountain-grown wood of the highest quality which provides the best sounding boards of pianos. To similar uses the black, white, red and Sitka spruces (*Picea* spp.) are put in North America (*See* SPRUCE.)

Special Hardwoods.—The ash-tree (*Fraxinus excelsior*) is widespread over Europe and supplies the timber of commerce, which is almost solely sap-wood, as any heart-wood is produced late in life. The wood is remarkably tough and, after steaming, can be permanently bent without losing its shock-resisting power. It is used in the manufacture of axe-handles, oars, bodies of carriages and motor-cars, hockey-sticks and so forth. In North America six species of *Fraxinus* supply commercial timbers.

The beech-timbers of commerce are the woods of *Fagus sylvatica* and *F americana* in Europe and North America respectively. The latter shows a distinction into white sap-wood and reddish heart-wood, but not so the former which is of uniform reddish white. Being perishable out of doors beech-wood is mainly made into articles used indoors, including furniture.

In addition to the softwoods enumerated a number of scented hardwoods from various countries are termed cedars: of these the most familiar is the tropical American cedar (*Cedrela odorata*) used in the manufacture of cigar-boxes and boards of boats.

Very similar to the timbers of ordinary oaks are those of the true chestnuts, *Castanea vesca* of Europe and *C. dentata* of North America, but these lack wide medullary rays and consequently display no striking "silver grain."

Species of *Diospyros* growing in tropical Asia and Africa supply the black ebonies of commerce. The black of the heart-wood may be interrupted by patches of white (in Andaman marble-wood) or brown (in calamander wood). The Japanese and North American *persimmon* woods belong to species of *Diospyros*, and pieces of the latter have little or no black wood.

The commercial timbers are produced by several species of European and North American species of elm (*Ulmus*). They generally have heart-woods lasting well in permanent contact with water; the water-pipes of London in olden times were often made of hollowed trunks of elms.

Australia is the world's centre for the growth of eucalyptus-trees, a number of which produce hard, heavy, strong timber of large dimensions, and include *jarrah*, *karri*, *tallow-wood*, and *tuart*.

Greenheart is a tropical South American wood, which is generally stated to be that of *Nectandra Rodiaei*, varies in colour from yellow-green to darker admixtures of colours. Resistant to shipworms it is used widely for piling in docks: for fishing rods it is pre-eminent

Commercial hickory woods of good quality are produced by a number of species of *Hicoria* in the United States. These find much the same uses as ash, since they are tough, but being stiffer than ash they can be used for the shafts of golf-clubs.

The name mahogany is improperly given to a medley of woods which range from white to bluish red in colour and grow in various countries The original mahogany was that of *Swietenia mahagoni* growing in the West Indies: this species together with the allied *S. macrophylla* growing on the mainland of Central America supply true American mahogany. These reddish-brown woods shrink and warp but little, are durable, light and polish readily to yield beautiful decorative effects. Any other woods named mahogany should share these characters. Such is the case with West African mahoganies produced by certain species of *Khaya* (belonging to the same family, Meliaceae, as *Swietenia*), which are indistinguishable by most people from the American mahogany. The West African "Gaboon mahogany" is a wood belonging to trees (or a tree) of an entirely different family, and is not a mahogany: neither are any of the so-called mahoganies of India, Australia, the United States and South America.

Maples, including the European sycamore, belong to the genus *Acer* and yield white firm woods that have a silvery sheen. North America supplies maples used in block-floorings and the beautiful bird's eye maple used in furniture.

True oak timbers are produced by species of *Quercus*, which is a genus not growing south of the equator, and the commercially important ones are European, North American and Japanese in origin. The European timber is mainly derived from the wide-spread *Q. pedunculata* and *Q. sessiliflora*, and stands apart from the other commercial kinds in being the sole one that can be safely used alone in the construction of casks and barrels for the storage of beer, wines and spirits without causing deterioration of flavour of these Great Britain produces a unique type, termed "brown oak," which is used in the manufacture of panelling and furniture in Europe and North America. The European oak imported into England is known as Russian and as Austrian oak, when exported from Baltic ports and Fiume respectively. North American commercial oak timbers are produced by a larger number of species of *Quercus* belonging to two groups, the "white" and "red oaks," which contrast in structure and uses

Genuine lustrous satinwoods in origin are respectively East Indian (*Chloroxylon Swietenia*) and West Indian (*Xanthoxylum*).

Teak timber is produced by *Tectona grandis* which yields commercial supplies only in the Indian Peninsula, Burma, Siam and Java. The valuable yellow to brown heart-wood is hard, strong, stiff and very durable; moreover, unlike oak, it does not attack iron. As the wood also "stands" well, it is excellently suited for use in window-sills, ships and flooring The wood shows annual rings, and thus contrasts with such spurious teak timbers as "West African teak" (*Chlorophora*) and Indo-Malayan "eng or yang teak" (*Dipterocarpus*).

The two most important walnut timbers are those of *Juglans regia*, whose distribution stretches from England to northern India, and *J nigra*, which is North American. The heart-wood of both species is brown, that of the former species is often traversed by brown lines, while that of the American is wholly of a blacker brown. Both woods are unrivalled for the manufacture of gun-stocks and are excellent furniture wood, as when it has been thoroughly seasoned and polished it shrinks and swells very

little. The wood has clearly marked annual rings and thus contrasts with two tropical spurious "walnuts," the East Indian (*Albizzia Lebbek*) and West African (*Lovoa Klaineana*). A third misnamed wood is known in Great Britain as "satin walnut" (also as "hazel-pine") and in the United States, its native country, as gum (sweet or red)

Confusion frequently arises in England as to the identities of several woods that are more or less white. From the United States there are exported to England several kinds of wood having that character. (1) One is named "canary whitewood" in Great Britain but "yellow poplar" in America. it is produced by the tulip-tree (*Liriodendron Tulipifera*), and ranges in colour from light yellow to iridescent blue. (2) In addition are woods produced by true poplar trees (*Populus*), which are named "cottonwoods" in the United States (3) Thirdly there are woods known in England as lime and in America as basswood, that are produced by lime-trees (*Tilia* spp.), which of course are very different from the limes (*Citrus*) producing the familiar juicy fruits.

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(P. Gm.)

TIMBER LINE, the altitudinal boundary of natural tree growth In any elevated area in low or middle latitudes the line is generally clearly marked, but its height is dependent not only on general but also on local climatic and soil conditions. (*See* SNOW LINE)

TIMBER PRESERVATION. The art of protecting timber from decay or the ravages of insects is of very ancient origin. It is probable that the Egyptians, who were experts in the preservation of organic bodies, also preserved wood by artificial means Pliny mentions that the ancients employed essential oils, such as oil of cedar, olive oil, oil of spikenard, or vinegar An even more universal method was to char wood to protect it from decay, a well-known instance of which is the charred piles under-pinning the temple of Diana at Ephesus The beginning of the 19th century saw the introduction of modern methods of injecting wood with either salt or oil solutions Later, a further impetus was given to wood preservation by the introduction of railways, requiring large quantities of wooden sleepers, and by the discovery of telegraphy, which necessitated large numbers of telegraph poles. There is at the present time an urgent need, other than that of direct monetary importance, for prolonging the life of timber, and that is to conserve the world's timber supply by every possible means, which includes, amongst others, the antiseptic treatment of timber. Antiseptic treatment was introduced into America about 1850, and gradually spread to most civilized countries of the world, though in India and Australia, where extremely durable timbers are available, such as teak and jarrah, the treatment of railway sleepers has only been undertaken in quite recent years.

Causes of Decay.—Timber may deteriorate from several causes; amongst the more common are decay due to fungi, the attack of insects and marine-borers, and mechanical defects such as abrasion, crushing, splitting or other types of fracture One of the commonest forms of decay is known as "dry rot," produced by several species of fungi, of which the most important is *Merulius lacrymans*. The number of insects which attack wood is very great, but probably those which do most damage are the death watch beetle (*Xestobium ru/o-villosum*), injurious to structural timber; the powder-post beetle (*Lyctus* sp.) and the common furniture beetle (*Anobium punctatum*), destructive to furniture. A number of marine molluscs (*Teredo*, the shipworm) and crustaceans (*Limnoria*, the gribble, and *Chelura*) are most destructive to wood construction in sea-water In the tropics the greatest enemy to timber are the termites known as white ants.

Antiseptics Used in Wood Preservation.—Antiseptics used in the preservation of wood may be divided into two broad classes, namely, oils and salts, of which the former are mostly derived from coal-tars, though wood-tar products and certain essential oils must be added to the list The oils are in certain processes mixed with salts, as for instance in the Card process, while, recently, considerable attention has been paid to mixtures of coal-tar creosotes and earth oils. Certain salts attracted attention as possible antiseptics for the treatment of timber, as early as 1705, when Homberg used mercuric chloride, although this salt is more commonly associated with Kyan, after whom the process is named. Of all salts which have been used in treating wood that which has best stood the test of time is chloride of zinc, discovered by Boucherie, but known as Burnettizing, after Sir William Burnett. Copper sulphate was used as long ago as 1840, but has since fallen out of favour; the most recent to be seriously considered are fluoride salts, which were first exhaustively tested by an Austrian engineer, named Malenkovic. Between 1904 and 1908 an entirely new process was brought out by Powell, which consisted in boiling timber in molasses, to which was added a small percentage of arsenic for use where white ants were prevalent.

It was Bethell who started on practical lines the treatment of wood with coal-tar products in 1838, though it is certain that the possibility of injecting these oils into timber was attempted before this date. Probably no name is better known in connection with timber preservation than that of Bethell, who used a product of coal-tar commercially known as creosote, which is at present by far the most popular antiseptic in use. It should here be noted that true creosote is a wood-tar product, though the word is now commonly and erroneously used for the coal-tar product Coal-tar creosotes differ greatly in composition, depending on the quality of the tar and the coal from which they are produced, and various commercial grades are prepared to meet different requirements. For standard products the *British Engineering Standards Association's Specification*, No. 144/, 1921, dated Aug. 1921, should be consulted.

Methods of Treatment.—Before treatment all bark should be removed and the ends of the timber cleansed It is important to note that the inner bark either stops or retards lateral penetration, which is one of the most difficult obstacles to be overcome. All processes, with the exception of the Boucherie and Powell processes, require that the timber should be seasoned. The degree of seasoning required will vary with the process, the class of timber to be treated and the use to which it is to be put. The moisture in wood occurs in the pores and cavities between the fibres and in the cell walls; the former being termed free-water and the latter sorbed water. As the timber seasons, the free-water is first given off until there remains from 25% to 30% by weight of the sorbed water. The moisture content should be reduced to below 20%, so that all the free, and part of the sorbed, moisture disappears, leaving the cavities free to take up the antiseptic.

The methods by which timber may be antiseptically treated fall under three heads, namely, the brush method, treatment in open tanks and treatment in closed cylinders under pressure.

By the open tank method the timber is immersed either in coal-tar creosote or a salt solution, in a tank which is heated by placing a fire beneath it, or preferably by means of steam coils. The antiseptic is gradually raised to a temperature of 90° C to 95° C, maintained at that temperature for a period dependent on the thickness of the material under treatment, and then allowed to cool down to atmospheric temperature. The heating period should, generally speaking, be maintained for an hour for every inch in thickness of the material. When the timber is heated in the solution it expands, and air is expelled from the cellular and intercellular spaces, as the timber cools that air is replaced by antiseptic. Fair penetration may be obtained by this process, which in pine-wood sleepers containing a moderate percentage of sapwood, amounts to approximately 5 lb. per cubic foot. This method of treating timber is applicable to cases where moderate

quantities of timber have to be dealt with A process by which wood is treated with saccharine solutions, known as the Powell process, is carried out in open tanks; the timber is boiled in a diluted solution of sugar, to which a small percentage of arsenic is added for protection, in tropical countries, against the attacks of white ants. The process consists in boiling green timber for several hours, the time varying according to the dimensions and species of wood under treatment. It is then allowed to cool down and is placed in a drying chamber This process has been successfully employed in Australia, while extensive tests carried out with Powellized sleepers on Indian railways give good results.

Pressure Processes.—These are carried out in cylindrical retorts varying in size from 6 to 9 feet in diameter, and 30 to 160 feet in length, capable of withstanding a pressure of 200 lb per square inch, and fitted with doors at either one or both ends. Inside the cylinder are placed rails to take the trolleys on which the timber is loaded, and below the rails is inserted a system of steam pipes for heating the antiseptic solution, and in certain plants a steam spray line To the cylinder are attached pressure and vacuum pumps and in some cases air pumps A second cylinder or storage tank is generally provided, which is generally placed above the pressure cylinder Surrounding the treating plant is the timber yard, which is conveniently laid out with feeder lines to and from the treating cylinder. The Full-cell or Bethell process, which employs coal-tar creosote, consists in subjecting the seasoned timber to a pressure of 100 to 180 lb. for one or more hours, after which the oil is run off and the timber allowed to drip. In some cases a vacuum is drawn for a short period, to hasten the removal of the coal-tar creosote left on the surface of the timber. Some operators when dealing with green timber, first subject it to a steaming period of several hours, and then draw a vacuum for one or two hours, in order partially to remove the free moisture in the wood, but this does not result in such satisfactory penetration as does the treatment of seasoned timber. Treatment by a full-cell process results in an absorption of from 7 to 15 lb. of coal-tar creosote per cubic foot.

The open-cell process may be carried out according to two different methods; one method was patented by C. B. Lowry, by which the coal-tar creosote is run into the cylinder at a temperature of 200° F, and a pressure of from 180 to 200 lb is applied, until no more oil can be forced into the timber, *i.e.*, until the timber has been treated "to refusal." The pressure is then released, the oil run off, and a vacuum drawn, until the oil in the intercellular spaces has been removed; this oil may amount to 40% of the original absorption, leaving some 6 to 7 lb per cubic foot behind in the timber. The other open-cell process, discovered by Rüping, aims at as deep a penetration as possible and at the same time economizes, recovering, as does the Lowry process, a portion of the oil originally introduced. To carry out this process a second cylinder, capable of withstanding 100 lb. air pressure, is placed at a higher level than the treating cylinder. The air-dried timber is placed in the treating cylinder and subjected to an air pressure of 60 to 80 lb. per square inch. The high level cylinder is filled with the preservative to within a few inches of the top, and an equal air-pressure is applied to its upper surface The antiseptic is then allowed to flow by gravity from the upper to the lower cylinder, the air displaced in the latter being led into the former by a by-pass. The two cylinders are then disconnected and the pressure in the treating cylinder is gradually raised to 150 lb. per square inch and held there until 10 to 12 lb. per cubic foot have been absorbed. The pressure is then released and the oil run off; this results in a partial vacuum being set up, and allows the compressed air in the wood to expand and to force out the surplus oil

A process invented by Card, for which a patent was granted in 1906, consists in treating timber with a mixture of 20% coal-tar creosote and an 80% solution of chloride of zinc, the strength of the latter being regulated so that ½ lb. of dry salt be taken up per cubic foot. It is a full-cell process, the operation being similar to that of the Bethell process, except that the mixture is kept in emulsion by a powerful centrifugal pump which circulates it through a spray pipe

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TIMBER WOLF, a name applied to the large wolf (*Canis lupus*) of the eastern and northern parts of North America The colour is usually gray but ranges from black to white. Timber wolves reach a length of 66 in., of which the tail is 12 in., and a weight of about 100 lbs. Over much of their former range, wolves have been exterminated (*See* WOLF, CARNIVORA)



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THE TIMBER OR GRAY WOLF

TIMBREL or **TABRET** (the *taf* of the ancient Hebrews, the *deff* of Islam, the *adufe* of the Moors of Spain), the principal musical instrument of percussion of the Israelites, identical with the modern tambourine. The tabret or timbrel was a favourite instrument of the women, and was used with dances, as by Miriam, to accompany songs of victory, or with the harp at banquets and processions; it was one of the instruments used by King David and his musicians when he danced before the Ark.

TIMBUKTU (Fr. Tombouctou), chief town of a district of the colony of French Sudan, French West Africa, 9 m. N. of the main stream of the Niger in 16° N. and 3° W.

Timbuktu lies on a terrace formed by the southern scarp of the Sahara, about 800 ft above sea-level, surrounded by sandy dunes covered with mimosas and other spiny trees. Timbuktu communicates with the Niger by a series of marigots or channels with alternating flow, which fill at flood time and empty themselves into the Niger when the dry season supervenes. In January, the maximum period, the waters reach the walls of the town through the marigot from Kabara, which is the port of Timbuktu.

Timbuktu has been described as "the meeting point of the camel and the canoe," "the port of the Sahara in the Sudan," and (more correctly) "the port of the Sudan in the Sahara." It was formerly a much larger place than it was found to be at the time of its occupation by the French in 1893–1894. Extensive ruins exist north and west of the present town. The great mosque which at one time stood in the centre of the town now lies near the western outskirts, where its high but unsightly earth tower forms a striking landmark. The mosque of Sidi Yahia (in the centre of the town) and that of Sankoré in the north-east also possess prominent towers. Whereas in 1895 the town was little more than a vast ruin, under French protection the inhabitants, relieved from the fear of Tuareg oppression, set about repairing and rebuilding their houses; new streets were built; European schools, churches and other establishments were opened. But Timbuktu has not yet recovered; pop. (1936 census) 5,610, including 110 Europeans. The majority are Songhoi. At the time of the commercial transactions from March to June, the population reaches 25,000. The industries of Timbuktu—cotton-weaving, earthenware, leatherwork and embroidery—are of subordinate importance, and the great bulk of the people are occupied exclusively with trade. The whole traffic of the surrounding lands converges on Timbuktu; two great caravans of 3,000 or 4,000 camels are yearly charged with salt from the Taudeni district.

Timbuktu, which possesses some valuable Arabic manuscripts —notably the *Tarik es-Sudan*, a 17th-century history of the Sudan written by Abderrahman Sadi of Timbuktu—and is a centre of Moslem teaching, is a converging point of the chief west Sudanese and Saharan races—Arabs or Arabized Berbers to the west; Sonrhaï in the immediate vicinity, and thence south-eastwards along the Niger; Ireghenaten or "mixed" Tuareg southwards across the Niger as far as the Hombori Hills and in the fertile Libbako plains beyond them; Fula, Mandingos, and Bambara in and about the city; and Imoshagh (Tuareg) belonging to the Awelliimiden confederation mainly to the north and east.

The local administration—preserved under French rule—is in the hands of an hereditary *kahia*, a kind of mayor, descended from one of the Ruma families. (A. Be.)

History.—The history of Timbuktu is intimately connected with that of the city of Jenné and the Songhoi empire. The Songhoi are a negro race who are said to have come to the Niger countries from the Nile valley. In the 8th century they made themselves masters of a considerable tract of country within the bend of the Niger, and built the city of Gao (*q v.*), 200m. in a direct line S S E of Timbuktu, making it their capital. In the 11th century they were converted to Islam. Besides Gao, the Songhoi founded Jenné (*q v*), which early attained considerable commercial importance. Meanwhile (11th century) a settlement had been made at Timbuktu by Tuareg Perceiving the advantages for trade with the north offered by this desert rendezvous, the merchants of Jenné sent agents thither (12th century), and Timbuktu shortly afterwards became known to the inhabitants of the Sahara and Barbary as an excellent market for their goods, and also for the purchase of the many commodities of the western Sudan In the 12th or 13th century Timbuktu fell under the power of the Mandingo kings of Melle or Mali, a country lying west and south of Jenné. Its fame as a mart for gold and salt spread to Europe, "Timboutch" being marked on a Catalan map dated 1373 In 1353 it had been visited by the famous traveller Ibn Batuta In 1434 the Tuareg made themselves masters of the city, which in 1469 was captured by the Songhoi king Sunni Ali It was at this time (1470) that Timbuktu was visited by an Italian, Benedetto Dei. In the days of Sunni's successor Askia (1494–1529) the Songhoi empire reached its highest development, and Timbuktu rose to great splendour. The "university" of Sankoré became a chief centre of Mohammedan culture for the peoples of the western Sudan

The riches of Timbuktu excited the cupidity of El Mansur, sultan of Morocco, who, in 1590, sent an army across the Sahara under an "Andalusian" Moor (that is, a Moor descended from those expelled from Spain), which captured Timbuktu (1591) and completely broke up the Songhoi empire. For about 20 years after the conquest the pasha who ruled at Timbuktu was nominated from Morocco, but the distance of the Niger countries from Marrakesh enabled this vast viceroyalty to throw off all allegiance to the sultan of Morocco. The Niger Moors, known as *Rumas* after El Mansur's musketeers, quarrelled continually among themselves, and oppressed the negro tribes. By the end of the 18th century two hundred years of oppression had reduced Timbuktu to comparative desolation and poverty By this time the whole country was in a state of anarchy, and in 1800 the Tuareg swooped down from the desert and captured the place. They were in turn (1813) dispossessed by the Fula, who in 1840 gave place to the Tukulor (*See* SENEGAL, *History.*)

At this period European interest in the region had revived. Maj. Gordon Laing, who had reached Timbuktu from Tripoli in 1826, had been murdered by order of the Fula; but René Caillié, coming from the south, had been in the city in 1828 and had returned in safety. Heinrich Barth, an officially accredited representative of the British Government, reached Timbuktu from the Central Sahara in 1853 and some effort was then made to bring the place under British influence. El Backay (Bakhai), the sheikh who received Barth, gave him letters professing much friendship for the British, and in a letter to El Backay, dated April 15, 1859, Lord Clarendon, secretary of State for foreign affairs, said that "the friendship binding us shall not diminish through the centuries" and "as our Government is very powerful we will protect your people who turn to us" A nephew of El Backay's went to Tripoli, saw the British consul and was told that a British steamer was ascending the Niger and that the Government had recommended those on board "to make every effort" to reach Timbuktu. But no one from the lower Niger reached El Backay, whose influence appears to have declined after Barth's visit; and no further attempt appears to have been made by the British to keep in touch with Timbuktu. Indeed, between Barth's visit and the French occupation only one white man, Oskar Lenz, in 1880, reached Timbuktu and he crossed the desert from Morocco. It was in the following year, 1881, that the French, thrusting forward from Senegal, began the conquest of the countries of the Niger bend. When they reached Timbuktu in December 1893 they found that the town had again fallen beneath the rule of the Tuareg. The townsfolk, indeed, from the time of the decay of the Ruma power being at the mercy of all comers, were content to pay tribute to each in turn and sometimes to more than one simultaneously, for which they indemnified themselves by peaceful intervals of trade whenever the land routes were open and the Niger clear of pirates. But at times even the short tract separating the town from Kabara was so beset with marauders that it bore the ominous name of "Ur-immandess," that is, "He (God) hears not." Little wonder then that the townsfolk freely opened their gates to the French as soon as Lieut Boiteux reached Kabara in command of a small flotilla

The occupation of the town, against orders, was a daring exploit of a handful of marines. The force which "garrisoned" Timbuktu consisted of seven Europeans and twelve Senegalese The somewhat larger body left with the gunboats was attacked by the Tuareg (Dec. 28) and suffered severely Col. T P E Bonnier, who was at Mopti, 200m. to the south-west, marched to the relief of Boiteux and entered Timbuktu without opposition on Jan. 10, 1894. He then set out with about 100 men to chastise the nomads In the night of Jan 14–15 his camp was surprised and the colonel and nearly all his men perished The enemy did not follow up their victory, and within a short period French rule was firmly established in Timbuktu In 1903 the French authorities placed commemorative tablets on the houses occupied by the four travellers, Laing, Barth, Caillié and Lenz, during their stay in Timbuktu Under French rule the town has regained a measure of importance

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TIMBY, THEODORE RUGGLES (1819–1909), American inventor, was born on April 5, 1819, in Dover, New York. His most noted invention was the revolving turret, which he first conceived in 1841. He first constructed a small model and displayed it in Washington. Later he built a steam-propelled model in Syracuse, N.Y (1842). This he exhibited in the city hall, New York, where it was inspected by President Tyler and his cabinet. In 1843 he obtained a caveat from the patent office. During the [illegible] agreed to pay him $5,000 on each turret built. Soon afterwards, with Ericsson as engineer of the design and construction, the battleship "Monitor" was completed. When she met the "Merrimac" and gained her famous victory, Ericsson was given general recognition as the inventor of the revolving turret No serious efforts were made to correct the misapprehension until Timby's death. From 1861 to 1891, Timby invented and patented, at home and abroad, a system of coast defences, such as the sighting and firing of heavy guns by electricity; the tower and shield; the cordon across a channel; the planetary and subterranean systems, and numerous modifications of the turret system. He died in Brooklyn, N Y., on Nov. 9, 1909.

See the *Memorial to the 57th Congress for Recognition of T. R. Timby* by the Patriotic League of the Revolution (1902), and the *Memorial to T. R. Timby* (1911) by the Timby Memorial Trust.

TIME, the general term for the experience of duration For time in its psychological sense *see* SPACE-TIME; for time in music, *see* below, for the methods of reckoning time *see* CALENDAR; DAY; MONTH, TIME MEASUREMENT; TIME, STANDARD.

In Music, time is a term signifying the number of beats in a measure or bar. When there is an even number of beats, as 2 or 4, the music is said to be in common or duple time. When there are 3 beats in a measure it is said to be in triple time Further, when the beats are of the value of an aliquot part of a semibreve the time is termed simple. Thus four crotchets, or their equivalents, in a measure constitute simple common time, while three crotchets, or their equivalents, constitute simple triple time When, on the other hand, the beats are of the value of dotted notes, and therefore not aliquot parts of a semibreve, the time is termed compound. Thus four dotted crotchets in a measure constitute compound common time, while three dotted crotchets in a measure constitute compound triple time. The time of a composition is indicated at the beginning by what is termed the "time signature," in the shape of a fraction specifying the number of aliquot parts of a semibreve which each measure contains, as $\frac{4}{4}$ (= 4 crotchets) or $\frac{3}{8}$ (= 3 quavers).

TIME, STANDARD. In an isolated community clocks and watches would be set to the local mean time (*see* TIME MEASUREMENT), and before the period of railway communication the different towns as a rule kept local time. The need for a more systematic plan of standard times was chiefly felt in the United States. While the railways in England were run by Greenwich time, and the railways in France by Paris time, it was not to be expected that railway systems in the middle and western States would adopt Washington time, differing by several hours from the local time of the region which they served Hence each railway had its own time, or, in the case of the longer lines, several different time zones, and great confusion arose at overlapping points. The question of bringing order out of chaos through a system of standard time was actively discussed in the principal commercial nations during the decade before 1880, Sandford Fleming in Canada and Charles F. Dowd in the United States being the principal proponents of the system. This involved adopting for the whole earth 24 standard meridians 15° apart in longitude, starting from Greenwich. These meridians were to be the centres of 24 time zones; in each zone the time adopted would be uniform, and it would change by one hour in passing from one zone to the next. After long discussion railway managers of the U S and Canada decided to adopt the system. Zone time based on the Greenwich meridian is now adopted almost everywhere except in Holland In most countries the time differs by an integral number of hours from Greenwich time, in accordance with the original plan; but in some of the British dominions, also in Venezuela and Uruguay, a compromise involving half-hour differences has been adopted. European countries (except Holland) are ranged in three groups, keeping respectively Greenwich time, mid-European time (one hour fast), east European time (two hours fast). In the U.S. and Canada there are five time-zones: Atlantic, Eastern, Central, Mountain, Pacific respectively 4, 5, 6, 7, 8 hours slow on Greenwich time. A full list of standard times of the different countries, as well as of those keeping non-standard time is published year by year in the *Nautical Almanac* In the summer months some countries advance their time by one hour, or, as we may put it, adopt the time of the next zone to the east. Thus legal time in Britain is Greenwich time in winter and mid-European time in summer This plan was first brought into practice in Germany early in 1916, closely followed by Austria, Holland, Denmark and Norway. These countries, except Holland, have since abandoned it. In England a movement in favour of this plan of "daylight saving" had existed for some years, led by William Willett; a bill to introduce it passed the second reading in 1908, and again in 1909. Under pressure of war economy and persuaded by the example of Germany, parliament adopted the measure in May 1916. The advantage of *summer time*, as it is called, depends very much on the latitude, and it is scarcely suitable for more northerly or southerly countries; it is rather unpopular in agricultural communities, but is widely favoured in urban areas.

The advantage of adopting a continuous reckoning of the hours from 0 to 24 instead of using the divisions A.M. and P.M. is obvious; this reckoning is used generally by the army and navy and for radio communication, and is in universal use in some countries For civil purposes the reckoning starts from midnight. In astronomy, however, there exists a reckoning, called astronomical time, beginning from noon; thus March 10 7^h astronomical time is 3 A.M. on March 11 by civil time. Up to 1925 astronomical reckoning was used in the national ephemerides; but it was found that this caused some difficulty and confusion to seamen, and an international agreement was made to adopt civil reckoning in the ephemerides from 1925 onwards It was recognized that this would probably lead to the abandonment (total or partial) of the astronomical reckoning by astronomers themselves Unfortunately, the decision was interpreted in some quarters as implying a change of nomenclature—that "astronomical time" was hereafter to mean civil time—a purposeless and confusing change for which there is no authoritative sanction The most prominent offender was the British Admiralty, who caused in this way a change in the use of the designation G.M.T. (Greenwich Mean Time) in the *Nautical Almanac* without authority. The situation was considered by the International Astronomical Union in 1928, who advised astronomers not to use the letters G.M.T. in any sense for the present The terms Greenwich Civil Time (G.C.T.), Weltzeit (W.Z.) and Universal Time (U.T.) denote time measured from Greenwich mean midnight and are not ambiguous. For time reckoned from mean noon the expression Greenwich Mean Astronomical Time (G.M.A.T.) is the most satisfactory. The Julian day is counted from Greenwich mean noon as heretofore

(A. S. E.)

TIME MEASUREMENT. The problem of the measurement of time demands a reference to its philosophical foundation, if it is to be viewed otherwise than as an empiric treatment of a practical necessity. Without touching the contention of relativists that time is in a certain sense merely a fourth dimension added to space, we may take it that to any individual it appears different and separate from his space, and is simpler than space to treat because it has merely one dimension. The difficulty arises precisely because of this fact, that it is fundamental and there is nothing similar or simpler to compare it with. Duration, permanence, existence even, all presuppose the lapse of time and therefore some means for its detection, or, what is the same thing, some primitive measure of it. The fact upon which all these ideas are based is the possibility of repetition of experience. When experiences are repeated, closely enough, we associate them with the ideas of things and reality. Such appears to be the psychological history of the construction of our world. We look then for the measurement of time to some process with recognizable repetitions, which may be counted. This replaces the impalpable idea of duration by counted steps and thus brings time into the class of measured quantities. Pulse beats, the alternations of day and night, the periods associated with definite spectral lines are instances of natural processes that have actually served this purpose, besides artificial instruments such as the balance watch and the pendulum clock; but to isolate the essential features we may idealize an instrument for the measurement of time as a gyroscope (A) mounted without friction inside a case (B), which may or may not itself rotate, and is held, friction free, at the common axis (O); or more abstractly still we may imagine two particles A, B, revolving at different angular speeds about a common centre O. Each new passage of A past B is a repetition, giving a countable step of time. This may be used for measurement of time precisely as a pair of compasses is used for measuring space. If we do not know that the revolution of A with respect to B is constant, that corresponds to the use of a pair of compasses not known to be stiff at the joint; the measure can still be made for what it is worth and may be the only one possible. If the lapse of time measured falls between two integral counts, we have the problem of subdividing the standard unit by constructing a smaller one which is standardized by comparing it with the standard. No new problem, theoretical or practical, is introduced thereby, and

known methods are applicable to its treatment. The parallel and contrast between the measurement of time and of one dimensional space may be probed further Measurement of the latter is effected practically through the construction of an (arbitrary) standard yard or metre, from which copies are taken and comparisons made If a copy A′ B′ is compared with the standard A B, the mark A′ is seen to agree with the mark A, at a particular time, and the mark B′ to agree with the mark B, *at a different time*, the difference being the time taken by the observer to travel from A to B. If we introduce mirrors at A′, B′, so that the congruences may be observed simultaneously, this does not abolish the time difference but only reduces it by making light the traveller. The difference is essential in kind. Now consider the standard for time measurement, a gyroscope in which there is a mark A, rotating within a case on which there is a mark B. Compare this with a copy A′, B′. The cases B, B′ may be in rotation, and the marks B, B′ cannot be brought into permanent coincidence Thus the step of time between two passages of A′ across B′ may be compared with that occupied between two passages of A across B, only with an allowance for the time taken for a signal to pass across the space between B and B′. If B and B′ are the same, as they may be if both are effectively the sphere of stars, then the allowance for the passage of the signal is abolished, and the comparison of the two standards of time is more perfect than that of two standards of distance; the reason for this is that for the two ends of a standard of space we cannot have the same time, but for two ends of a standard of time we can have the same point of space. We can pass to and fro in space but not in time.

If two points A_1, A_2 pass across B at an interval which is an ascertained fraction of the period of A_1, with respect to B, then, *knowing nothing else about them*, an hypothesis is required, in order to tell from this observation what fraction of four right-angles $A_1 A_2$ subtends at O. If A_1, A_2 rotate as if rigid and uniformly, the fraction is the same as the fraction of the period. If they rotate independently, say under the action of the same acceleration to the centre O, no conclusion can be drawn without further data. Generally it must be remembered that in order to define the motion, *e.g.*, in its relation to the right angle, it would be requisite to define first the metric of the space in which it takes place in addition to assigning its own "law." But in the absence of special statement, rigidity and uniform rotation will be presupposed, making the time interval and the angle A_1OA_2 equivalent measures.

Units of Time.—The practical standard for measuring time is the rotation of the earth, and is very close to the ideal one If we take the earth as the body A and the sphere of stars as the body B enclosing it, their relative period gives an observable unit of time, the so-named sidereal day. It differs from the mean solar day employed in civil reckoning in a way defined below. The stars are, of course, not quite fixed with respect to one another, but as they are their own standard of reference, their mean is fixed, and there appears to be no meaning to be attached to the idea that it is in motion, especially if we allow in the case of each star for all systematic apparent motions such as those due to the earth and the sun, and the individual motions peculiar to each star, leaving only an accidental residuum to cancel itself out. Taking then the mean of the sphere of stars as the zero, and supposing the local Euclidean geometry continued outwards to mark the positions of the stars, the rotation of the earth with respect to the sphere of stars becomes an absolute quantity, that is to say, a quantity completely defined. In describing it so, some practical qualifications are subsumed. Thus, small allowances varying in different latitudes and different times of the day and year require to be made on account of the finite velocity of light by which the stars are recognized. Also, it is convenient to measure from a slowly moving zero, the equinox, which is easier to identify than the mean of the stars. Reference is made to these and others below. The principle is unchanged.

A smaller unit than the day is provided by the pendulum clock, of which one beat or a semi-oscillation equals a second, of which there are $24 \times 60 \times 60 = 86,400$ in the day. Much loose writing is found in relativist literature about "clocks," as though the clock were a simple instrument which it was unnecessary to define further. Such is not the case. We may regard the clock as a machine to imitate the rotation of the earth If the 24-hours dial of a sidereal clock is imagined as set in a plane parallel to the equator, with the right side up, its index will continue to point always to the same star. The theory of the clock is complicated and has nothing primitive about it. It indicates, however, that the construction of a clock that shall go uniformly is possible; but the practical execution of clocks, though enormously improved recently, is not perfect. The going is liable to derangement from a number of causes, not all of which are clear. In short, the clock is in the position of a secondary standard only, which must be adjusted to the primary standard, viz., the sidereal day or observed rotation of the stars. The same remarks apply with increased force to portable watches and the marine chronometer, in which the beats are given by a balance wheel controlled by a spiral spring The method by which the clock is adjusted to the rotation of the earth is described below. To subdivide the second, given by the beat of the clock, various devices are employed which are described more particularly in the article CHRONOGRAPH. In principle, they all rely upon converting time measures into space measures, by introducing a machinery that shall move a recording paper at a sufficiently uniform speed, making the clock mark seconds upon this, or, alternatively, making a tuning fork or other rapid vibrator impress closer marks, and subdividing the distance between the marks by any device suitable for space measurement. When we go beyond times which the chronograph can record, we have passed out of the region of actually countable steps of time

For a larger measure than the sidereal day, we turn to the year The year can only be defined precisely by means of a curiously elaborate theory The year being the period of the revolution of the earth about the sun, we must define its motion and the point to which it returns. Since the motion is perturbed by the moon and the other planets, the orbit does not repeat itself, and any specification has no more than an "instantaneous" value at an assigned epoch. The process is to form a "theory of the sun," assigning its motion, for we may just as well contemplate geometrically a motion of the sun round the earth, as of the earth round the sun To do this, all the observations of the sun's position are assembled, over the whole period of time for which they can be considered sufficiently exact, and the orbit is determined of a character assigned by theory, and agreeing with the observations as well as they allow over the whole period. The outcome is an ellipse of changing shape in a changing plane The changes of course are small and slow, but by no means negligible The mean motion with respect to the stars may, however, be taken as unchanged, and this defines the length of the *sidereal year*. But as remarked elsewhere, a return relative to the stars is not convenient to identify. It is more convenient to count from the equinox, or point where the equator intersects the sun's path. A return to this point corresponds also with a return of the seasons. Hence we define the *tropical year*, which is slightly shorter than the other because the equinox is in regressive motion.

From the theory of the sun comes also the definition of a derivative but indispensable measure, viz., *mean solar time* The mean solar day is the mean period of rotation of the earth with respect to the sun The sidereal day is the period of rotation of the earth with respect to the equinox. If the sun makes a circuit of its orbit starting from the equinox, in a tropical year, the earth will have rotated just one time more with respect to the equinox than with respect to the sun in that period. The tropical year is found to contain 366·2422 sidereal days. Hence it contains 365·2422 mean solar days, and we have two parallel sets of units, days, hours, minutes and seconds, in the ratio of 1·002738:1, or 1:1—·002730, the solar unit being the greater. Moreover, the mean solar day starts at a different point from the sidereal day. The latter starts when the equinox is on the meridian. The former starts 12 hours before the "mean sun" crosses the meridian. The "mean sun" is an imaginary body defined for the purpose of keeping time in such a way that it moves in the equator in agreement with the apparent sun's mean motion in the ecliptic. The transit of this body across the lower meridian of Greenwich gives

the zero for "Greenwich mean time." As, of course, the "mean sun" cannot be observed, its reputed place with respect to the stars is calculated from the *theory of the sun*, in advance, in the ephemerides, and this permits us to observe other stars instead of it and to deduce the moment of its transit By these means any observatory, of known longitude, constructs for itself "Greenwich mean time" from its own observations In respect to the measurement of time the relations of the year with the system of mean time are more prominent than its use as a major unit of time In the latter connection it belongs to the subjects of the CALENDAR and CHRONOLOGY.

For astronomical purposes and for long measures of time the Julian day is to be preferred to the year, because it avoids all irregularities of chronology. The Julian day is simply the ordinal count of mean solar days, commencing at Greenwich noon. The number for 1925, Jan 1, mean noon is 2,424,152, following the system of Joseph Scaliger, who devised it and introduced it into chronology. The number for the beginning of any other year may be derived from this, but is tabulated also in the *Nautical Almanac*, the *American Ephemeris*, and elsewhere.

Rotation of the Earth.—The rotating earth is the prime time-keeper and can be readily idealized into a perfect time-keeper. It is therefore desirable to examine critically how closely it approaches an absolute standard It might be supposed that the links were few and easily dealt with Such is not the case They are numerous, and a fairly full outline of the treatment must suffice, referring for detail to the sources.

Let the position of the earth be defined by its principal axes of inertia (*OC*,*OA*,*OB*). If for the moment we suppose the earth rigid, these will be fixed in its body and evidently one may be called its polar axis (*OC*), while the other two (*OA*,*OB*) define the equator where they mark determinate longitudes. The instantaneous motion of the earth may be defined in a simple manner with respect to these axes, namely if *A'B'C'* are their positions after an interval δt, *A'B'C'* may be derived from *ABC* by rotations $\omega_3\delta t$, $\omega_2\delta t$, $\omega_1\delta t$ about the axes *OA*, *OB*, *OC*. It is less simple to connect *ABC*, the position at the time considered, with their position $A_0B_0C_0$ at an assigned moment or "epoch." It is done by means of the so-named Eulerian angles, θ, ϕ, ψ where $\theta = CC'$, $\phi = A_0C_0C$, $\psi = 180^\circ - C_0CA$. These angles serve also to express ω_1, ω_2, ω_3, viz.:

$$\omega_1 = \dot\theta \sin\psi - \dot\phi \sin\theta \cos\psi,$$
$$\omega_2 = \dot\theta \cos\psi + \dot\phi \sin\theta \sin\psi,$$
$$\omega_3 = \dot\psi + \dot\phi \cos\theta.$$

Further, by Euler's well-known theory of the rotation of a rigid body, ω_1, ω_2, ω_3 are given by the equations

$$A\dot\omega_1 - (B-C)\omega_2\omega_3 = L, \qquad B\dot\omega_2 - (C-A)\omega_3\omega_1 = M,$$
$$C\dot\omega_3 - (A-B)\omega_1\omega_2 = N,$$

where *A*, *B*, *C* stand for the principal moments of inertia and *L*, *M*, *N* are the couples applied to the body about the principal axes. In the case of the earth we have very approximately, at least, symmetry about the polar axis, and the main rotation taking place about the same axis. Hence $A \backsim B$, $N \backsim 0$, and ω_1, ω_2 are small. From the third equation, therefore $\omega_3 = n$, a constant, and the equations for ω_1, ω_2 become $A\dot\omega_1 + (C-A)n\omega_2 = L$, $A\dot\omega_2 - (C-A)n\omega_1 = M$. The solution of these two consists of a free oscillation of arbitrary amplitude and phase with period $\frac{2\pi A}{(C-A)n}$, supplemented by any particular integral of the equations. Leave aside for the moment the free oscillation or "complementary function," and direct attention to the particular integral. For simplicity consider first the sun alone. By differential attraction on the protuberant parts of the earth in the neighbourhood of the equator the sun produces a couple, say *P*, applied to the earth's body, the axis of which is in the equator and directed to a point *q*, perpendicular to the plane through the polar axis *C* and the position of the sun *S*. This couple is a maximum at either solstice and vanishes when the sun is at either equinox. It is easy to see that it does not change sign when the sun crosses the equator. The values of the components *L*, *M* are then $L = P \sin(\odot - nt), M = -P\cos(\odot - nt)$, where $\odot$ stands for the distance of the sun from the origin, measured along the equator. Now the equations for ω_1, ω_2 may be written

$$A(\dot\omega_1 - n\omega_2) + (Cn\omega_2 - L) = 0, \quad A(\dot\omega_2 + n\omega_1) - (Cn\omega_1 - M) = 0,$$

and the sun's position, and therefore *P* and $\odot$, change slowly compared with *nt*. Hence it may be seen that an approximate solution is

$$\omega_1 = \frac{-M}{Cn} = +\frac{P\cos(\odot - nt)}{Cn}, \quad \omega_2 = +\frac{L}{Cn} = +\frac{P\sin(\odot - nt)}{Cn},$$

which actually suffices for all purposes. The interpretation of this solution is that the pole *C* is at any moment turning in the positive sense with angular velocity P/Cn about the point *s* where *CS* meets the equator. Therefore the actual direction of the motion of *C* varies over two right angles, but the mean effect is a displacement of the north pole towards the vernal equinox, or what is the same thing, a regression of the equinoxes along the ecliptic. Besides its mean value, *P* contains also a reference to the actual positions or the sun and moon. Hence all the inequalities that are required to specify their positions figure as periodical inequalities in ω_1, ω_2, in special degree those of a more permanent character, such as the position of the node of the moon's orbit on the ecliptic, which will evidently affect the value of the couple contributed by the moon. All these inequalities combined constitute the *nutation*, an oscillation of the node of the equator upon the ecliptic, distinguishing at any date the *true* equinox from the *mean* equinox.

Since the motion of the equinox enters into every observation of position, other than merely differential ones, its determination is of the highest importance. It is an intersection of the equator with the ecliptic or plane of the earth's annual motion round the sun This itself is in motion since the earth is perturbed by the other planets, but the motion may be calculated and allowed for. It is, however, essential first to construct the "theory of the sun," already referred to, based upon a combination of all trustworthy observations of the position of the sun with respect to the fixed stars; and for the present object especial attention must be given to the two places in each year where the sun crosses the equator. This connects the equinoxes with the stars which can be observed with the sun, for the most part a small number of the brighter stars, and therefore not characteristic of the whole. But they again may be connected with a larger mass of fainter stars, and so on, gradually approximating to a reference to the mean of the whole body of stars which it is agreed to treat as fixed. As remarked above, it is from actual determination of the position of the equinox at different epochs that the period of the precession is deduced. It is a matter of astronomical convenience to take the sidereal day, not from a revolution with respect to the body of stars, but with respect to the true equinox. Hence the "sidereal day" as employed is not even of constant length; to reduce it to constant length we must remove from it the *nutation* which has been incorporated in it. The chief amount is an 18-year fluctuation, running for half the period in one direction and half in the other and dislocating the proper zero of the day by rather more than ±1sec. at maximum.

Return now to the question of a possible free oscillation of the axis of rotation of the earth, with respect to axes fixed in its body, We have so far supposed the earth rigid; but the earth, though very stiff in its main body, is not rigid If it were rigid and if we suppose the actual axis of rotation to depart slightly from the principal axis of greatest inertia, it follows from the foregoing equations of motion that the axis of rotation would describe in the body a circle about the axis of inertia in a period $\frac{2\pi A}{n(C-A)}$ days, which the ascertained period of the precession shows to be about 305 days. No such motion exists, whence for a long time it was falsely concluded that the two axes coincided so closely that observation could not separate them. This is not the case. Observations by F. Küstner, extended by S. C. Chandler, and now conducted internationally at a number of suitably placed

observatories, show that the axis about which the earth rotates moves around its mean position, at a distance of some 30ft or less (0″·3), in a complicated curve, which can be analysed into two main components, one with a period of about 432 days, and the other one year. Both are therefore greater than the period for a rigid earth. It was pointed out by S. Newcomb that the proper interpretation is found in a slight yielding of the body under rotational stress, such as would accord with the estimated rigidity, viz, a little greater than that of steel. The longer period probably refers to this cause. A period of a year might easily be furnished by some seasonal effect.

Change of Length of the Day.—The foregoing has assumed that the couple N, the resolved part of the whole couple about the polar axis, is zero, or say that its mean value is zero; which implies that the rotation period for the earth must be constant But reasons are known to be in operation that may change it Thus if the body of the earth had gradually shrunk, as pretty certainly it must have done, the coefficient c would have diminished. and the angular momentum remaining unaltered, the angular velocity would have increased. On the other side, the tides which in their phases generally follow the moon by a time that is fixed at any place, move in the same sense as the earth rotates, but much more slowly, so that they furnish a species of friction clutch or brake upon the earth and must slow down its rotation. A more general consideration of the earth-moon system and their secular changes of relative distance and relative motion shows that the slowing effect is divided between the earth's rotation and the moon's mean motion, but does not alter this consideration Hence it is very unlikely that the day. which we have used as a standard, is really constant The only tests we can apply to it are the other circulating bodies, the moon, Jupiter's satellites, the sun, the planets. Of these the moon is the most favourable It moves much more slowly than the inner satellites of Jupiter, but its theory though complicated accords much more closely with observation. Now there is another theoretical cause for secular acceleration in the moon's motion, but the theoretical value does not accord with the observational value. That the difference is really to be ascribed to a lengthening of the day is indicated by tracing a proportionately smaller unexplained secular movement in the sun and residuals from the planets Venus and Mercury, all of which are in general agreement with the unexplained residues from the moon.

The two causes of tidal friction and bodily changes in the earth affect in different degree the apparent accelerations of the moon, and the sun and planets. This permits us to determine separately the two effects by fitting their joint outcome to the observed residues requiring explanation in both cases These residues are remarkable In place of a smooth curve of regular progression, they correspond very closely to a broken series of straight lines, which would mean sudden changes of increase or decrease of the length of the day at definite dates. Thus in 1897 there was a sharp increase of the length by about 0·04sec. and in 1918 an equally sharp decrease by the same amount. The portion of these changes that must be attributed to tidal friction seems to accord numerically with what can be calculated. The loss of energy takes place almost entirely in the shallow seas, such as the Irish Sea, where turbulent motion ensues and, so to speak, the energy of the tide is trapped. As regards the other constituent, it is a different matter If the whole earth contracted proportionately, a decrease in the length of the day of the amounts mentioned above, would entail a shrinkage of half a foot in the radius over all the surface. This seems very improbable, and still more is the change that would account for the increase of the day in 1897.

The outcome of this criticism is that as far as astronomy is concerned, uniform duration is an abstraction, an idea; we cannot find any standard time-keeper that can be called absolute or even uniform. Certain abstract considerations, combined with peculiarities of astronomical observations, appear to indicate that the concept of uniform time cannot be related to the physical universe, and that the concept of *uniformly accelerated time* is a more useful one.

Practical Determination of Time.—Coming to the actual determination of time, we have a similar sequence of a direct method, simple and at first sight complete in theory, but requiring to be overlaid in practice with very numerous corrections in order to bring execution near to the idea As already pointed out, the *clock* is a secondary standard, which must be adjusted in subordination to observations of the earth's rotation The astronomical observation is thus often described as "finding the error of the clock" The astronomical observation, where any accuracy is aimed at, is always that of sidereal time. The beginning of the day at any place is the transit of the true equinox across the meridian Hence, as already remarked, it is affected by nutation. The equinox itself cannot be observed, being merely the intersection of two abstract lines upon the sky; but by a very long chain of observations, going back continuously to Hipparchus 150 B.C., and earlier, the relative spacing on the sky of all the lucid stars, and a great many more, has been determined with continually increasing accuracy, together with the "proper motion" belonging to each. Relative to this mass of material the position of the equinox on the ecliptic are assigned, or what comes to the same thing, the coordinates of each star are given relative to the equinox and equator. A collection of this kind is called a *star catalogue*. Star catalogues are of various grades. As far as measurement of time goes we need only consider the *fundamental catalogues*, which are based on an elaborate critique of all the material, and of which Kopff's, known as the FK 3, was adopted as the international standard about 1940. The places of the stars given in such a catalogue cannot be used directly. They are "mean places at the epoch," and require correction for (1) proper motion in the interval, (2) precession, (3) nutation, (4) aberration, (5) parallax where sensible, (6) refraction, before the data will accord with the true or apparent place on the day and at the place considered. As a rule these numerous and troublesome corrections (excepting the last) are computed and applied in advance of use and the results published annually. Imagining then the whole heavens to rotate in a piece about the polar axis, if we could observe correctly the passage of a single star across the meridian of the place and compare it with the time registered by the clock, we should have determined the error of the latter. But it is necessary, when precision is required, to observe several stars varying in number from perhaps 4 to 20. The separate observations are subject to small errors arising from temporary refraction anomalies and imperfections of the instrument and of the [illegible]

[illegible] in 1934 it became the standard instrument for the purpose. The *transit instrument*, used for field work, is merely a portable adaptation of the transit circle.

These instruments, differing much in detail, utilize the same general principle. The rays of a star, when it is near the meridian, are focused by a telescope, either on a reticule of fine spider lines, some of which are movable, or on a photographic plate. The clock times are observed when the star's image is at determinate points in the field (*see* CHRONOGRAPHS), the average of whose positions defines the meridian. The average of the clock times, compared with the known sidereal time of the star's passage, gives the clock error.

The telescope tube of the transit circle is mounted at right angles to its axis of rotation, which being pointed east and west, permits observation of stars anywhere along the meridian, but not elsewhere. The instrument must be so adjusted that (1) the line of sight is perpendicular to the axis, (2) the axis is horizontal and (3) directed exactly east and west, but these conditions are never exactly fulfilled. The small deviations are termed *instrumental constants*, and much labour must be expended in correcting the

observations for the errors thus introduced The form of the pivots at the ends of the axis must also be determined with the utmost precision possible

The reflex zenith tube is immovably mounted in a vertical position, so that observations are restricted to those stars that pass nearly overhead. One of the most troublesome features of the transit circle, the levelling of the axis, is eliminated in this instrument by its peculiar construction. On the other hand, the observations are limited to a small number of faint stars, whose positions have to be specially determined

The positions of the stars being assumed known, the clock error can be determined with a precision of a few thousandths of a second from a night's work with either instrument. But the best clocks run with an accuracy comparable to this, and even greater. The actual determination of time involves a continual series of adjustments between the indications of the clocks and of the astronomical observations. (*See* PROBABILITY AND ERROR) But the latter must be treated as primary sources and the former subordinated to them This is a matter of considerable delicacy, for the primary data, besides having erratic features, are also irregularly spaced owing to weather conditions. We must take a considerable number of primary determinations, and use the going of the clock to detect and reject their erratic features, before we use the mean run so found in order to assign the error of the clock.

When all this has been done, it is found that time determinations made at different observatories differ somewhat more than the precision of the observations would lead us to expect. The discrepancies are due to a combination of various causes, among which may be mentioned· variations in the longitudes of the several observatories due to the polar motion (*see* GEODESY· *The Variation of Latitude*) and possibly also to local shifts in the earth's crust; variations in the time required for the propagation of the wireless time signals; errors in the adopted positions of the stars; probable refraction anomalies; and small systematic errors remaining in the observations themselves.

Until 1925, Greenwich mean time commenced at noon; from the beginning of that year the meaning of the term was changed so that the reckoning commenced at the previous midnight and the hours 0-24 agreed with those reckoned for civil time Greenwich mean time, as defined after 1925, has been commonly known in the United States as Greenwich civil time, while this latter term, if used in England, would mean something quite different, viz., the time there used in civil life, which at various times has been one or two hours fast on Greenwich mean time The designation, universal time, generally used by astronomers, is synonymous with Greenwich mean time as used in England, and with Greenwich civil time as used in the United States.

It would be inconvenient to use local time strictly, for no two places in different longitudes have the same mean solar time. The variation amounts to one hour for 15 degrees of longitude, or about five seconds to the mile in middle latitudes. A system of zones was devised whereby within each zone the same mean time rules, but changes abruptly by one whole hour, or half an hour in some cases, at its borders Thus the local time at the Naval observatory in Washington is 5 hr. 8 min., 15 78 sec. late on the Royal observatory at Greenwich, but the mean time kept has usually been 5 hr. slow precisely. Mean solar time, so regulated, is called *zone time* or *standard time*. (*See* TIME, STANDARD) Another convention regulates the *date line*, in travelling across which a calendar day is dropped from the reckoning in passing westward, or is added in passing eastward The line is arbitrary; it runs for the most part along the 180th meridian, but deviates to the east to include Fiji and Tonga with Australasia, and to the west to include the Aleutian Islands with the continent of North America

At various times and in various places, during and after World War I, clocks were temporarily advanced one or two hours over the usual zone time, either by law, proclamation, or local ordinance. This attempt at conservation of artificial light was productive of considerable confusion when practised locally in the United States, as when 16 cities in one state were keeping time one hour fast on the rest of the state. The advanced time has been known in England as "summer time" or "double summer time," and in the United States as "daylight-saving time" and, during World War II, as "war time."

Time Dissemination.—Before the invention of the electric telegraph the time determined at an observatory could be made known elsewhere only by transportation of timepieces or by visible or audible signals. Time determination was a necessary part of the work of most astronomical observatories and signals were given by dropping of time balls, ringing of bells and blowing of whistles. The measurement of longitude, one of the chief concerns of the navigator and the surveyor, was attended with grave difficulties, for the longitude is simply the difference between the local time and the Greenwich time. With the spread of telegraph wires over the civilized world the determination of time gradually became the exclusive concern of the national observatories. But the mariner was forced to depend on his chronometer for the Greenwich time until the advent of wireless telegraphy, which introduced a new era in time distribution. Wireless time signals are emitted at frequent intervals from a large number of stations distributed over the world. Any person having the proper receiving set can obtain several times daily a signal direct from an observatory, accurate to about 0.01 second. Most persons do not require such great accuracy, but there are many commercial and scientific enterprises that demand it, and even greater accuracy. The errors of the signals are therefore carefully determined at the observatories, and published at intervals The results previously deduced from the signals can then be corrected. In England the British Broadcasting company furnishes signals at frequent intervals, direct from the Royal observatory In the United States a similar service is performed by the broadcasting companies, but the Naval observatory assumes no responsibility for the accuracy of any but its own time signals.

For the standard data regarding precession and the motion of the earth round the sun *see* S. Newcomb, "Tables of the Motion of the Earth," vol vi (1898), and "Determination of the Precessional Constant," vol. viii (1905) in *Astronomical Papers of the American Ephemeris*. Quoting those relevant to this article, we have

Tropical year	365.24220 mean solar days
Sidereal year	365.25636 mean solar days
General precession in one tropical year	50.2564" (epoch 1900)

From the length of the tropical year we deduce 1 mean solar day = 24 hr 3 min. 56.5554 sec , sidereal

1 sidereal day = 23 hr 56 min 4 091 sec. mean solar time

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(R. A. S.; G. M. CL.)

TIME SALES: *see* INSTALMENT SELLING.

TIMGAD, a ruined city 23 mi. S.E. of Batna in the department of Constantine, Algeria. Timgad, the Thamugas of the Romans, was built on the lower slopes of the northern side of the Aures

Mountains, and was situated at the intersection of six roads. It was traversed by two main streets, the Cardo Maximus running north and south, and the Decumanus Maximus east and west. The residential part of the town was on a lower level than the capitol and most of the other public buildings The ruins of the capitol occupy a prominent position in the south-west of the city Some of the columns of the façade (which are of the Corinthian order and 45 ft. high) have been re-erected The dimensions of the capitol correspond with those of the Pantheon at Rome Immediately north of the capitol are the remains of a large market; to the east are the ruins of the forum, basilica and theatre. The auditorium of the theatre, which held nearly 4,000 persons, is complete. A little west of the theatre are baths, containing paved and mosaic floors in perfect preservation. Ruins of other and larger thermae are found in all four quarters of the city, those on the north being very extensive.

Across the Decumanus Maximus just north-east of the market is the arch of Trajan—still erect, and restored in 1900. The arch is of the Corinthian order, and has three openings, the central one being 11 ft. wide. Each façade has four fluted columns 19 ft. high. The chief material used in building the arch was sandstone. The fluted columns are of fine white limestone and smaller columns are of coloured marble. At the other (eastern) end of the street are the remains of another triumphal arch. West of the capitol are the ruins of a large church, a square building with circular apse, built in the 7th century. There are also remains of six other churches. About 400 yd south of the city, the walls nearly entire, is a ruined citadel, a quadrangular building 360 ft. by 295 ft., with eight towers It was built (or rebuilt) by the Byzantine army in the 6th century. Near the northern thermae is the house of the director of the excavations and a museum containing small objects found in the ruins.

Numerous inscriptions have been found on the ruins, and from them many events in the history of Thamugas have been learnt In the year A.D. 100 the emperor Trajan gave orders to build a city on the site of a fortified post on the road between Theveste and Lambaesis. This city, called Colonia Marciana Traiana Thamugas (Marciana in honour of Trajan's sister) appears from the inscriptions to have been completed, as far as the principal buildings were concerned, in seventeen years In the 3rd century Thamugas became a centre of Christian activity, and in the next century espoused the cause of the Donatists. The city declined in importance after the Vandal invasion in the 5th century, and was found in a ruinous condition by the Byzantine general Solomon, who occupied it A.D. 535. It is believed that the Berbers from the neighbouring mountains destroyed the city, hoping thus to prevent it being used as a stronghold from which to harry them. Thamugas was, however, repeopled, and in the 7th century was a Christian city After the defeat of Gregorius, governor of Africa, by the Arabs in 647, Thamugas passes from history.

After centuries of neglect James Bruce, the African traveller, visited the spot (1765), made careful drawings of the monuments and deciphered some of the inscriptions Bruce was followed, more than a century later (1875), by Sir R. Lambert Playfair, British consul-general at Algiers, and soon afterwards (1875–1876) Professor Masqueray published a report on the state of the ruins Since 1881 Thamugas has been systematically explored, and the ruins excavated under the direction of the *Service des monuments historiques*.

Among the objects discovered are a series of standard measures—five cavities in a stone slab Seventeen miles west of Timgad, on the site of the Roman city Lambaesis, is Lambessa (*q.v.*).

See G Boeswillwald, R. Cagnat and A. Ballu, *Timgad, une cité africaine sous l'empire romain;* and A Ballu, *Guide illustré de Timgad* (Paris, 1905).

TIMISKAMING; *see* PRE-CAMBRIAN.

TIMIŞOARA (formerly TEMESVAR), a city of western Rumania, capital of the department of Timiş Torontal. Pop. (1930) 91,866, largely Magyar; (1948) 111,987. On the Béga canal and the river Béga, it consists of the inner town, formerly strongly fortified, and of four outlying suburbs, the intervening space, formerly the glacis, having been laid out in parks. Timişoara is the seat of a Roman Catholic and a Greek Orthodox bishop. Amongst its principal buildings are the Roman Catholic cathedral, built (1735–57) by Maria Theresa; the Greek Orthodox cathedral; a castle built by John Hunyady in 1442; now used as an arsenal; the town and county hall, the museum and large barracks. In the principal square rises a Gothic column, 60 ft. high, erected by the emperor Francis Joseph in 1851 to commemorate the successful resistance of the town to the siege of 107 days laid by the Hungarian revolutionary army in 1849 Timişoara is a centre of commerce

Timişoara is an old town, and although destroyed by the Tatars in 1242, it was a populous place at the beginning of the 14th century, and was strongly fortified by King Charles Robert of Anjou, who resided there several years The Hunyady family had also their residence there In 1514 the peasant leader, Gyorgy Dozsa, was defeated by the Transylvanian voivod, John Zápolya, near Timişoara, captured and executed. It was taken by the Turks in 1552, and recovered by Prince Eugene of Savoy in 1716. After this it grew steadily in importance, serving as the capital of the whole Banat. It was again besieged by the Hungarians in 1849, and occupied by Serbia in 1919, but ultimately allotted to Rumania.

TIMMINS, the principal town in the Porcupine gold mining area in northern Ontario, Canada, 268 mi. N. of North Bay, on the Mattagami river and the Ontario Northland railway. It is the centre of the most important gold mining area in Canada, where by the 1950s the output of gold amounted to about 1,000,000 oz annually, or one-quarter of Canada's total gold production. The most outstanding mine in the district is the Hollinger. Pop. (1951) 27,743; 1921 (3,843). (C. CY.)

TIMNE, a long-headed people of medium stature, skilled traders, in Sierra Leone, whose language is related to Landuman and Limba Their paramount chief traces his genealogy back to the beginning of the 16th century. Dowry and dower are both customary. Descent is patrilineal, and there is both family and personal property, the first inherited by the brother or nephew, the second by the son. The Timne are organized in clans.

See N. W. Thomas, *Anthropological Report on Sierra Leone* (1916).

TIMOLEON (*c.* 411–*c.* 337 B.C.), of Corinth, Greek statesman and general. As the champion of Greece against Carthage he is closely connected with the history of Sicily, especially Syracuse (*q.v.*). He was driven into exile for 20 years by the anger of his family at his acquiescence in the death of his brother Timophanes, who had made himself tyrant. In 344 (Plutarch, Diodorus gives 343–342) he was chosen to go to Syracuse in answer to an appeal to Corinth for help against factions within and the Carthaginians without He landed at Tauromenium (Taormina) and first attacked Hicetas, tyrant of Leontini, who was master of Syracuse at the time Carthage first supported Hicetas, then abandoned him, and he was besieged in Leontini and surrendered. Timoleon then reorganized Syracuse on the basis of the constitution of Diocles, and introduced new settlers from Greece About 340 Hicetas was reinforced by a new army from Carthage, which Timoleon defeated on the Crimissus, and a renewed attempt ended in Hicetas' final defeat and death in 338. A treaty was concluded confirming the dominion of Carthage to west of the Halycus. Timoleon then (337–336) retired into private life. He became blind some time before his death, but persisted in attending the assembly and giving his opinion, which was usually accepted as a unanimous vote. He was buried at the cost of the citizens of Syracuse, who erected a monument to his memory in their market-place, and a gymnasium called Timoleonteum.

Lives by Plutarch and Cornelius Nepos; *see* also Diod. Sic. xvi. 65–90; monograph by J. F Arnoldt (1850), which contains an exhaustive examination of the authorities; also SICILY *History;* and SYRACUSE, with works quoted.

TIMON, of Athens, the noted misanthrope, celebrated in Shakespeare's play, lived during the Peloponnesian War. He is more than once alluded to by Aristophanes and other comedians. Plutarch introduces a short account of his life in his biography of Mark Antony (ch. 70), who built a retreat called Timonium (Strabo xvii. 794) at Alexandria. Timon also gave his name to one of Lucian's dialogues.

TIMON (320?–230), of Phlius, Greek sceptic philosopher and satirical poet, a pupil of Stilpo the Megarian and Pyrrho of Elis Having made a fortune by lecturing in Chalcedon he retired to Athens, where he died His writings (Diogenes Laërtius, ix. ch 12) were numerous both in prose and in verse: he is said to have written epic poems, tragedies, comedies and satyric dramas, besides the Σίλλοι, three books of sarcastic hexameter verses, written against the Greek philosophers

The fragments (*c* 140 lines) are printed in F. W A Mullach, *Frag. phil graec.* i. (1860).

TIMOR, the largest of the Lesser Sunda Islands, in the Malay. archipelago, the northeastern part of which, with a small enclave in the south (Oecusse-Ambeno), belongs to Portugal, while the southwestern half belongs to the Netherlands and forms part of the Netherlands Indies. Dutch Timor, with Sumbawa, Sumba, Flores and the Alor and Solor Isles, forms a residency of the Netherlands Indies known as Timor and dependencies, with a population of 1,657,376. Timor stretches from S.W. to N.E. for 300 mi. and has a mean width of 60 m. It lies west of the Arafura sea. It is outside the great volcanic belt extending from Java eastward, but it is within the volcanic region and has a volcanic peak near the centre of the island. There are no active volcanoes, but mud geysers exist. It differs greatly from the other Lesser Sunda islands, being traversed by a series of parallel mountain chains, with outliers in many places, especially on the eastern coast, descending to the sea. The centre of the country is a confused mass of very steep mountains. There are ridges from 4,000 to 8,000 ft. in height, while the highest peak is Mt. Rameau, 9,600 ft., in the centre of Portuguese Timor. Mt. Durulau, near it, is 8,300 and Mt Suro 7,500 ft. More than 20 other mountains range from 3,500 to 6,500 ft. along or near the Dutch-Portuguese boundary.

The geological structure of Timor is Archaean rock, with Permian beds, chiefly of limestone, containing numerous fossils. Volcanic rocks are present. Off the southwestern coast are the islands of Semau, Rotti and Savu. Semau (which has some remarkable springs) is small and unimportant. Rotti, which is much larger, has well-developed Triassic beds and volcanic material. It has extensive plains, several streams useful for agriculture, and many inlets, of which Buka Bay is the largest. Savu is more than half the size of Rotti. The climate differs considerably from that of Java and Sumatra, there being a short rainy season and a prolonged dry period. The annual rainfall at Kupang is 57 in., the average number of rainy days 80.

Fauna and Flora.—The flora has Australian forms, such as the eucalyptus Vegetation is scanty and scrubby generally, though the uplands yield fairly under cultivation. The woodlands, which nowhere form fine forests, contain much excellent sandalwood. The fauna of Timor is of special interest since it proves, conclusively, that Timor has never formed part of Australia within recent geological epochs. The deep sea channel between has proved such an obstacle that only one Australian type is found—a marsupial, the cuscus (*Phalanger orientalis*), whereas Asiatic types include the grey monkey (*Macacus cynomolgus*), deer, wild pig, civet-cat, shrew mouse, bat and a particular species of wild-cat, *Felis megalotis*, which is found only in Timor and Rotti. As regards birds, there is a slight preponderance of Asiatic over Australian. Amongst the insects are few beetles, a rare rose-chafer (*Lomaptera timorensis*), such moths as the *Noctuae*, a new species of *Ophiodes*, *Remiga virbia*, and a humming-bird moth (*Protoparce orientalis*), and many butterflies, Pieridae and Lycaenidae being common, others including the rare and beautiful swallow-tails *Papilio aenomaus* and *P. liris*, and the deep purple-winged *Cethosia leschenaultii*. The very few land shells of Timor are allied to or identical with Moluccan and Celebes forms. There are snakes, and a species of crocodile.

The soil of the plains is poor and as the Timorese have a very scanty knowledge of irrigation and primitive means of ploughing, cultivation is backward. The mineral resources of Timor include gold, copper, gypsum and petroleum, but little or nothing has been done to use them.

The population of Timor is about 800,000, that of Rotti 46,823, and of Savu 27,365. It includes very few Europeans and Eurasians, or foreign Asiatics (the latter being mostly Chinese, with a small number of Arabs), and consists of Timorese, a much-mixed race, probably Malayo-Papuan-Polynesian. There is a more pronounced strain of Malayan blood in the people about the coast, while in the west (Kupang, Semau, etc), there has been intermingling with the people of Rotti and Savu, who are lighter-complexioned, good-looking, well-featured people, of Malayan (and probably Polynesian) stock. Inland amongst the mountains live the native Timorese, generally a dusky brown or blackish people, slender-figured and of tall or medium height Forbes mentions a race of dwarfish people living in the Fatu Matabia mountains There are small communities of Christian converts, Catholic and Protestant in Dutch Timor, Catholic in Portuguese Timor, and a few Mohammedans along the coast The people of Rotti and Savu are largely Christian, and Mohammedan Except along the coast, the Timorese have been little touched by civilization. They lead a very primitive life and are often at war with each other, there being numbers of small native kingdoms, under both Dutch and Portuguese rule The usual dress of the men consists of two pieces of patterned cottoned material, with a decorated belt, often a sort of shawl, thrown over the shoulder when not in full use, and sometimes a kind of turban headgear, and a cloth wallet is carried Women wear a *sarong*, also with a shawl, and they are fond of armlets of gold and silver, necklaces of glass, quartz or clay, and gold and silver chest plaques. Chiefs have special decorative garments. tattooing is practised. Weapons are the bow and arrow, spear (and shield), sword, and blow-pipe, for hunting; the use of the gun is known, and the men are very good horsemen. The usual Timorese house is built of wood, on piles, and is round in shape, with a roof of grass or palm-leaf thatch, and only one room, (except in the case of chiefs and other notables), villages, and sometimes houses often being stockaded. There was a special hut in which the leader of a successful head-hunting expedition underwent purification—to appease the ghosts of the slain Pomali, or taboo, is very prevalent in Timor, and apart from the custom of placing a palm branch, as a sign of taboo, before fruit-trees, houses, growing crops, etc., to protect them—an effective method of preventing robbery—villages possess a regular *pomali* house, known as the *Uma-Luli* It stands in a cleared space, within which not a stone may be overturned, or a twig plucked. The building itself is raised above the ground on pillars and has two doors, one at the side and one at the end. The presiding official at the ceremonies of *pomali* is known as the *Dato Luli*, and has great power Certain relics are preserved in the *pomali* house and there is a special part reserved where offerings are made to the *Vatu Luli*, or sacred stone Some houses have a *Luli* chamber, where sacrifices of animals (pigs) are made and where a bunch of rice is hung—to ensure a bountiful harvest. The dead are placed on a stage raised above the ground, sometimes covered with a roof, and kept until a burial feast can be arranged Stone carved seats for graves are known in Rotti.

Polygamy and concubinage are practised, but not cleanliness. Industry consists of weaving, plaiting and the manufacture of ornaments and weapons. Fishing and copra manufacture occupy people along the coast. Trade is mostly in Chinese, Arab and Malay (Bugis) hands. Many languages and dialects are spoken: Rotti and Savu have languages of their own.

History.—The first Dutch landing on Timor was in 1613 (the Portuguese had settled there nearly 100 years before), after a Portuguese garrison had been driven out of a fort on the neighbouring island of Solor. The Raja of Kupang permitted a settlement and from 1619 onwards the Dutch remained there Their chief enemies were the "black" Portuguese of Occussi, whose allies were the Timorese of Ambenu and Amarassi, and occasionally the white Portuguese, from Portuguese Timor In 1749 the whole combination Invested Kupang, but the Dutch succeeded in relieving the garrison and the Portuguese were almost annihilated. Twenty years later the Portuguese, whose headquarters had been Lifau, in Occussi, made Dilli their capital,

but the "black" Portuguese of Occussi continued their attacks on the Dutch at Kupang, who, beyond making a treaty with 15 of the neighbouring Timorese chiefs, did little to resist them. In 1797 the Dutch, who by this time had extended their influence as far as Atapupu, were in sufficient force to resist successfully a British attempt to take possession of Timor in the name of the Prince of Orange, which they repeated on the occasion of a second British attempt, in 1810, but after the capitulation of Java, the Dutch flag on Timor was hauled down, and during the period of British rule the Portuguese seized the Dutch district of Atapupu, being ejected therefrom by the Dutch when Timor was handed back to them by the Convention of 1814, though this led to many "incidents" and frontier disputes.

The Dutch claimed the western half of Timor, but no attempt had been made to delimit frontiers A Dutch offer to buy out the Portuguese was refused, and in 1851 the attempt of a Portuguese commissioner to fix a boundary was repudiated by his government. In 1859, however, a treaty was signed in which the main boundary through the centre of the island was described, and also the boundaries of the enclaves, claimed by both parties, though no previous survey had been made. In 1893 a convention was signed agreeing to carry out a survey of the main boundary and, if possible, abolish enclaves. In 1898 a boundary commission was set up, the main boundary was surveyed first, and then the boundaries of the enclaves, the task being complicated by dissensions among the native chiefs concerned, who forcibly prevented the survey of territories in dispute between themselves. In 1904 a treaty was made recording the new boundaries, but the ratification was postponed until the Occussi enclave survey could be carried out. A mixed commission formed in 1909 stopped work owing to a dispute about the meaning of an article of the Treaty of 1904, there were frontier affrays in 1913 and then came further treaty disagreement, resulting in recourse to arbitration In 1914 the Swiss plenipotentiary at Paris, M. Lardy, a member of the Hague Court of Arbitration, decided in favour of the Dutch view of the track of the eastern frontier of the Occussi enclave; Portugal accepted it and the Treaty of 1904 was then carried into effect.

Dutch Timor has an area of a little more than 19,000 sq km., with a population of (1930) 350,064, including 488 Europeans and 4,207 Chinese and other foreign Asiatics. The capital, Kupang, and the seat of the resident, is situated on Kupang bay, in the extreme west of the island. It has a harbour and is the chief port, the only other port being Atapupu, on the western coast, near the boundary between Dutch and Portuguese Timor. Both ports (also Baï, in Rotti, and Seba, in Savu), are ordinarily places of call for vessels of the Royal Packet Navigation company, giving communication with the other Lesser Sunda islands, with Celebes and with Java. Kupang, which has a population of 7,171 (342 Europeans and Eurasians, and 1,193 foreign Asiatics, mostly Chinese), is a difficult port during the northwest monsoon. Other towns are Sukubianaua, Sufa, Tiamplong, Putain, Lalogama and Atambua. Exports from Timor and Dependencies during 1939 were 87,000 and imports 81,000 guilders, consisting chiefly of sandal-wood, copra, ponies, cattle and hides. Lack of inland communication hinders the development of the country. There is a riding road across country from Kupang to Atapupu.

Portuguese Timor has an area of 18,989 sq.km. The population is (1936) 463,996, the most heavily populated district being that of Motael, in which the capital, Dilli, is situated. Until 1896 Portuguese Timor was joined administratively to the Portuguese colony of Macao, in China, but in 1896 it became autonomous, under a governor, who resides at Dilli, which is also the chief port of the colony and is served by vessels of the Dutch Royal Packet Navigation company, there being no Portuguese steamship service between Portuguese Timor and other parts of the Malay archipelago, but a small Portuguese steamer takes cargo to Kupang. Its population is 3,000. Other towns are Liquica, Manatuto and Baucan, on the west coast. Chief exports were coffee, copra, hides, cocoa, shells and wax; imports: cotton piece-goods, petroleum and wine. There is much smuggling from Portuguese Timor into Dutch Timor, from where goods are sent to other parts of the Indies.

Both Dutch Timor and Portuguese Timor were occupied by Japan in Feb. 1942

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TIMOR LAUT, TENIMBAR or **TENIMBER** (Dutch, TIMOR LAORT), a group of islands in the Malay archipelago, southwest of the Aru Islands, between 6° 20′ and 8° 30′ S, and 130° 40′ and 132° 5′ E They are on the Archaean ridge on which the Kei Isles stand, most are of recent coralline formation and some are volcanic. There are 66 islands, the largest being Yamdena, with an area of 1,100 sq.mi., 74 mi. long by 26. Thickly wooded hills extend along the east coast; the west coast is lower, where, opposite the island of Seira, a gulf extends far inland. In places there are precipitous cliffs, and a narrow foreshore is fringed with coco-nut palms and mangrove. There are many small islands off the western coast of Yamdena—Seira, Selu, Wuliaru, Wotar and Lailobar. The latter has a volcano over 1,500 ft. Off the northeastern coast of Yamdena is Larat (15 mi. by 6), with a rocky coast and high cliffs, and with thick vegetation along the foreshore. Beyond Larat lies Fordata, which is high, and off the southwestern coast, separated by Egeron Strait, Selaru, which is about 30 mi long, rather flat, and less wooded than Yamdena and Larat and with much grass land.

There are extensive swamps on many of the islands of the group, and the climate is not good, fever being very prevalent during the southeast monsoon. The soil supports crops such as maize, rice (in small stretches), coco-nut and sago palms, yams and fruit such as plantains, mangoes and papayas Maize is the staple food. There are practically no rivers and there is a lack of fresh water. The slight depth of soil prevents trees from attaining great height. The flora includes sterculias and fig trees (*Urostigma*), leguminosae (trees and shrubs), myrtles, the scarlet hibiscus, pandans, palms, and a species of bread-fruit tree There are rare and lovely orchids of many kinds, crotons, dracaenas and many varieties of ferns The fauna, a poor one, except in birds, comprises wild buffalo in large herds, wild pig, the cuscus, flying fox, many snakes, lizards and frogs, and 60 species of birds, including the scarlet lory (*Eos reticulata*), honey-eater (*Philemon timorlaoensis*), ground thrush (*Geocichla machiki*) and oriole (*Oroleus decipiens*)

Butterflies are numerous and include *Papilio aberrans*, and among the beetles is a gorgeous golden-coloured buprestid (*Cyphogastra splendens*).

The population of Timor Laut (1930 census) was 31,847. The people are undoubtedly a mixed race. Some of the men are tall and handsome-featured, with well-formed bodies, others are short and thick-set, the complexion of nearly all being a rich chocolate brown. Forbes thinks, and the writer, who has studied them, agrees, that they are Malayo-Papuan-Polynesian, the islands being, probably, the last occupied by the Polynesian race during its eastern migration to the remote archipelagoes of the Pacific, some being left behind—to mingle with Papuans and Malays, the former probably being the aboriginals and the latter settlers. There are still many pagans and a few Mohammedans Christianity is making rapid headway and has succeeded, with direct Dutch rule, in extirpating cannibalism, piracy, slavery, head-hunting and inter-tribal fighting.. Male Christians wear cotton coats and short breeches, or *sarong;* the women wear *sarong* and *kebayah*, or bodice.

The pagan costume consists of loin-cloth, with a girdle, and, as full dress, bangles, armlets, earrings, necklaces and a head-dress of bright-coloured cloth with bunches of flowers and bird plumes. The women wear a short *sarong*, suspended from a belt, have necklaces and earrings of bone, ebony and ivory, also of gold and silver, many bangles and artistically carved combs. They carry burdens in a basket on the back, suspended from

bands placed around the forehead. The men sometimes dye their hair a golden colour Tattooing is known They are a pleasant, trustful and fairly honest people, but the men are indolent, and the women do most of the work. Their artistic ability is high, and their houses of wood and *atap*, sometimes built in closely packed settlements, generally on piles and entered from underneath, have carved pillars and show much artistry of construction. The men are skilful boat-builders, use the spear and bow and arrow (with which they are adept in shooting fish), hunt, search for trepang and tortoise-shell, are agriculturists, keep pigs and work in iron, copper and gold. The women cultivate the fields after the men have prepared the soil, weave and dye *sarongs* and plait. Villages own an *Orang kaya*, or head man, but the people are communal and independent. A favourite idol is termed *Duadilah*, the Sun-god.

Timor Laut, with two divisions, Larat and Saumlakki, is attached to the residency of the Moluccas. The capital of Yamdena is Saumlakki, at the southwestern end of the island, and of Larat, the town of the same name, on a narrow strait opposite Yamdena.

The Timor Laut isles were first visited by Capt. Owen Stanley, in 1839, and became known to Banda traders in 1877. In 1878 H. O. Forbes, with his wife, visited the islands and stayed there three months, being warned before going, by the Dutch authorities, of the hostility and savagery of the inhabitants; for all practical purposes, he appears to have been the first European to have stayed any length of time in Timor Laut After his visit the islands were opened up by the Dutch, and the people proved very responsive to outside civilizing influences. The islands were occupied by Japan in Aug. 1942. (E E L ; X.)

TIMOTEAN, a considerable group of tribes of South American Indians, forming an independent linguistic stock. The Timotes and related tribes occupied the region about Merida and Truxillo and the valley of the Motatan river in western Venezuela. Most of them are now extinct. They were in general a warlike people, using javelins, spears and clubs, some also having poisoned arrows. A sedentary, agricultural folk, living in large communal houses, the men wore only a small cloth, the women either a very small apron or a cotton gown, belted at the waist.

See P. de Aguado, *Historia de Venezuela* (Madrid, 1918).

TIMOTHEUS, Athenian statesman and general, son of Conon, the restorer of the walls of Athens. From 378–356 B.C. he frequently held command in the war between Athens (in alliance with Thebes) and Sparta. In 375 Timotheus was sent with a fleet to sail round Peloponnesus by way of demonstration against Sparta. He gained over Cephallenia, secured the friendship of the Acarnanians and Molossians and took Corcyra, but used his victory with moderation. In 373 Timotheus was appointed to the command of a fleet for the relief of Corcyra, then beleaguered by the Spartans But his ships were not fully manned, and to recruit their strength he cruised in the Aegean. For this delay he was brought to trial but acquitted Having been superseded in his command he took service with the king of Persia. We next hear of him about 366, when, having returned to Athens, he was sent to support Ariobarzanes, satrap of Phrygia. But, finding that the satrap was in open revolt against Persia, Timotheus, in conformity with his instructions, abstained from helping him and turned his arms against Samos, then occupied by a Persian garrison, and took it after a ten months' siege (366–65). He then took Sestus, Crithote, Torone, Potidaea, Methone, Pydna and many other cities; but two attempts upon Amphipolis failed. An action was brought against him by Apollodorus, the son of the banker Pasion, for the return of money lent by the father. The speech for the plaintiff is still extant and is attributed (though not unanimously) to Demosthenes. In the course of the Social War Timotheus was dispatched with Iphicrates, Menestheus, son of Iphicrates, and Chares to put down the revolt The hostile fleets sighted each other in the Hellespont; but a gale was blowing, and Iphicrates and Timotheus decided not to engage. Chares, disregarding their opposition, lost many ships, and in his dispatches he complained so bitterly of his colleagues that the Athenians put them on their trial. Timotheus, who had always been disliked for his arrogance, was condemned to pay a very heavy fine. Being unable to pay, he withdrew to Chalcis, where he died soon afterwards The Athenians showed their repentance by remitting the greater part of the fine to his son Conon. His remains were buried in the Ceramicus and statues erected to his memory in the agora and the acropolis.

See Life by Cornelius Nepos; Diodorus Siculus xv., xvi ; Isocrates, *De permutatione;* Pseudo-Demosthenes, *Adversus Timotheum;* C. Rehdantz, *Vitae Iphicratis, Chabrae, Timotheï* (1845) ; and especially Holm, *Hist. of Greece* (Eng. trans., vol. iii.).

TIMOTHY or **TIMOTHEUS** in the New Testament was one of the younger companions of the Apostle Paul. He was connected with Lystra in Lycaonia, born of a pagan father and of a Jewish mother called Eunice, his grandmother being also a Christian. When the apostle came across him at home, he was still uncircumcised, but a full member of the church at Lystra (Acts xvi 1f , 2 Tim. i. 5f.). When the defection of Barnabas and Mark left St. Paul alone, he took Timotheus with him as a colleague, first of all circumcising him out of respect to the prejudices of the communities in which he was to do mission work. This was a matter of convenience, not of principle. He accompanied St. Paul and Silas to Europe, where he was employed by them on various missions, especially among the Macedonian churches which he helped to found. But Corinth as well as Thessalonica and Philippi drew out his activities as an "apostle" in the wider sense of the term (*2* Cor. i. 19, etc) From Corinth he appears to have accompanied the apostle to Ephesus and Asia Minor (Acts xix. 22, 1 Cor. xvi. 10 *seq*). He is then associated with St. Paul in his imprisonment, as the collocation of his name in the titles of Colossians, Philemon and Philippians indicates, whether that imprisonment was at Rome or elsewhere. In the Pastoral Epistles (*q v.*) he is absent from his chief, in charge of work at Ephesus, and there is a notice of him in Hebrews (xiii. 23) which chronicles his release from imprisonment, though there is no clue to its date or place.

Tradition, probably based on inferences from the New Testament, made him bishop of Ephesus, where it is said he was martyred under Domitian, one legend asserting that he was clubbed to death by the mob for protesting against the orgies of Artemis worship.

The Greek martyrology celebrates his death on Jan. 22, the Latin on Jan. 24. (J. MOF.)

TIMOTHY, EPISTLES TO: *see* PASTORAL EPISTLES.

TIMPANI (It.), in music, the Italian name for kettledrums. (*See* DRUM.)

TIMUR (*Timur i Leng*, the lame Timur), commonly known as TAMERLANE (1336–1405), the renowned oriental conqueror, was born at Kesh (modern Shahr-i-Sabz, "the green city"), 50 mi S. of Samarkand in Transoxiana The Timurid tradition (which is highly suspect) represents his father Taragai as head of the Barlas tribe and a descendant of a certain Karachar Noyan, described as the powerful minister of Jagatai, son of Jenghiz Khan, and a distant relative of the latter. The apocryphal *Memoirs* of Timur display him as a leader of expeditions during the disturbances that followed the death of Amir Kazgan, the governor of Transoxiana, in 1357. After the invasion of Tughlak Timur, the khan of Kashgar (1361), and his appointment of his son Ilyas Khoja as governor of Transoxiana, Timur was selected as his minister, but shortly afterward he fled and rejoined his brother-in-law Amir Husain, the grandson of Kazgan After many wanderings and adventures, graphically described by the chroniclers (*see* Gibbon, *Decline and Fall*, chap. lxv), they defeated Ilyas Khoja (1364) and set out to conquer Transoxiana. About 1370 Timur joined in a revolt against his ally Husain, besieged him in Balkh and, after his assassination, proclaimed himself at Samarkand sovereign of the Jagatai and restorer of the Mongol empire.

For the next ten years Timur was engaged in a struggle against the khans of Jatah (eastern Turkistan) and Khwarism, finally occupying Kashgar in 1380 He then gave armed support to Toktamish, khan of the Crimea, a refugee at his court, against the Russians (who had risen against the khan of the Golden Horde, Mamai); and his troops occupied Moscow and defeated the Lithu-

anians near Poltava (1380).

In 1381 Timur began his conquests in Persia with the capture of Herat The political and economic situation of Persia at this time was precarious in the extreme The signs of recovery visible under the later Ilkhans (*see* MONGOLS) had been followed by a setback after the death of the last Ilkhan, Abu Sa'id (1335). The vacuum of power was filled by rival dynasties, torn by internal dissensions the Mongol Jala'irs, who held Baghdad and Tabriz; the Perso-Arab Muzaffarids in Fars and Isfahan, the Ghorid Kurts in Herat; or local religious or tribal associations, such as the Serbedars in Khurasan and the Afghans in Kerman; and minor princes in the outlying regions. These warring principalities could put up no joint or effective resistance to Timur Khurasan and all eastern Persia fell to him in 1382–85; Fars, Iraq, Azerbaijan and Armenia in 1386–87 and 1393–94; Mesopotamia and Georgia in 1394. In the intervals he was engaged with Toktamish, now khan of the Golden Horde, whose forces invaded Azerbaijan in 1385 and Transoxiana in 1388, defeating Timur's generals. In 1391 Timur pursued Toktamish into the Russian steppes, defeated and dethroned him; but the khan raised a new army and invaded the Caucasus in 1395. After his final defeat on the Kur river, Toktamish gave up the struggle; Timur marched into Russia and occupied Moscow for a year. The revolts which broke out all over Persia during these campaigns were repressed with ruthless vigour, whole cities were destroyed, their populations massacred and towers built of their skulls.

In 1398, when Timur was over 60 years of age, he invaded India, on the pretext that the sultans of Delhi were showing excessive tolerance to their Hindu subjects He crossed the Indus [illegible]

[illegible] seizure of eastern Anatolia. After restoring his control over Azerbaijan, he marched on Syria; Aleppo was stormed and sacked, the Mameluke army defeated and Damascus occupied (1400), the deportation of its artisans to Samarkand being a fatal blow to its prosperity. In 1401 Baghdad was taken by storm, 20,000 citizens massacred and all its monuments destroyed. After wintering in Georgia, Timur invaded Anatolia, destroyed Bayezid's army near Ankara (July 20, 1402) and captured Smyrna from the Knights of Rhodes. Bayezid died in captivity, but the story of his confinement in an iron cage seems to be legendary. Having received offers of submission from the sultan of Egypt and from John VII (then co-emperor of the East with Manuel II Palaeologus), Timur returned to Samarkand (1404) and at once began to make vast preparations for an expedition to China He set out at the end of December, fell ill at Otrar on the Syr-darya west of Chimkent and died on Jan. 19, 1405. His body was embalmed, laid in an ebony coffin and sent to Samarkand, where it was buried in the sumptuous tomb called Gur Amir Before his death he had divided his territories among his two surviving sons and his grandsons, and after years of intestine struggles they were reunited by his youngest son Shahrukh.

During his lifetime Timur had a record kept of all his acts, and arranged for the preparation of an official biography. This survived in the contemporary recension of Nizam ud-Din Shami, ed. by Tauer (Prague, 1937) and in the more florid version of Sharaf ud-Din Yazdi, trans. by F Petis de la Croix (1723) The opposite point of view, bitterly hostile to Timur, is given by another contemporary, Ibn 'Arabshah, trans by J H. Sanders, *Tamerlane; or Timur, the Great Amir* (1936). The supposed *Memoirs* (*Malfuzat*), tr. by C. Stewart (1830), and *Institutes* (*Tuzukat*) of Timur are generally held to be forgeries, and the circumstance of their alleged discovery and presentation to Shah Jahan in 1637 was itself open to suspicion.

There are supposed paintings of Timur in Persian works; these are idealized Persicized portraits and in no way resemble the authentic description of him as very tall, with a large head, highly coloured and white-haired since childhood

In the absence of a critical historical study of Timur the following works may be consulted L Bouvat, *L'Empire mongole, 2° phase* (Paris, 1927), Ruy Gonzalez de Clavijo, *Embassy to Tamerlane*, trans. by G. Le Strange (1928); Harold Lamb, *Tamerlane, the Earth Shaker* (1932); *see* also PERSIA· *History*; MONGOLS; TURKS.

(H A R G.)

TIN, a metallic chemical element, symbol Sn (Lat. *stannum*), atomic number 50, atomic weight 118 70. It has ten naturally occurring isotopes (*see* ISOTOPES), more than any other element. Of these the one with mass number 124 is radioactive, disintegrating by double β decay with a half life of about 6×10^{16} years. Several radioactive isotopes have been prepared, some by nuclear reactions and some in the fission of uranium

History.—Bronzes containing tin were made more than 30 centuries before Christ, but whether metallic tin was first isolated and then combined with copper, or tinstone was added to copper under reducing conditions is not known. In early writings words that now designate tin may have had a different meaning, making it difficult to establish with certainty when tin was first recognized The word "tin" in English Bibles, for example, corresponds to the Hebrew *bedhil*, which is a copper-tin alloy. The Greek *κασσιτερος* and the Latin *stannum* seem to have gradually assumed their present meanings, but by different routes. The biblical *bedhil* was translated into Greek as *κασσιτερος*, indicating that the latter at one time meant bronze. Homer distinguishes between tin and bronze in his *Iliad*, and Herodotus discusses the existence of the Cassiterides (*q v*), or tin islands, from which tin was said to have been imported in his time. By the 1st century *κασσιτερος* definitely meant tin. Pliny the Elder referred to tin and lead as *plumbum candidum* or *plumbum album* and *plumbum nigrum*, respectively. He also used the term *stannum*, but this apparently referred to a silver-lead alloy. An imitation *stannum* was made at that time which contained two-thirds *plumbum candidum*, and by the 4th century the meaning of *stannum* had changed to tin.

The earliest known objects made of pure tin are a ring and a pilgrim bottle found in Egyptian tombs of the 18th dynasty (1580–1350 B C) However, tin ores are not found in Egypt, so the tin must have been imported. About 1000 B.C. the Cornwall (Eng) deposits were worked by the Phoenicians, but references to the Mediterranean tin trade of this era are scanty. The Cornish tin industry was dated back to 300–200 B C. by the discovery of tin containing slag in excavations made at the castle of Chun near St. Just, and tin was imported from Cornwall into Italy after, if not before, the invasion of Britain by Julius Caesar That tin was known to the South American Indians prior to the advent of the Europeans was shown by the discovery of pure tin at Machu Picchu Peru. It was not used for the manufacture of artifacts as such, however, but for the preparation of bronzes with compositions varied according to ultimate use. Hernan Cortes found small pieces of tin used as money among the natives of Taxco when he arrived in Mexico

Geochemistry.—Tin, although not an extremely rare element, is nevertheless not as abundant as several less familiar elements such as lithium, vanadium and titanium It occurs to the extent of 40 g per ton in the earth's crust, while in meteorites the abundance is 100, 15 and 5 g per ton in the iron-nickel, troilite and silicate phases, respectively Because of the distribution in these meteorite phases, tin is classed as a siderophile, or iron lover. It is probable that tin is more abundant in the iron-nickel core of the earth than in the crust When the earth's crust formed by crystallization of the molten rocks, the tin compounds were among the last to solidify. In low temperature deposits the tin crystallized in sulphidic minerals, whereas in high temperature deposits the oxide crystallized. The tin deposits are in or closely connected with granite or acid-eruptive rocks of the same type. The minerals of tin are listed in Table I

All the commercially important tin-bearing deposits contain cassiterite (*q.v.*), or tinstone, as the predominant tin mineral with the exception of the Bolivian ores which contain both cassiterite and a variety of sulphidic ores.

TABLE I.—*Minerals of Tin*

Name	Formula	Occurrence
Cassiterite	SnO_2	*See* text
Cylindrite	$Pb_3Sn_4Sb_2S_{14}$	Bolivia
Franckeite	$Pb_5Sn_3Sb_2S_{14}$	Bolivia
Stannite	Cu_2FeSnS_4	Bolivia, Cornwall, central Europe
Arandanite	$Sn_6(OH)_8(SiO_4)_3$	
Canfieldite	Ag_8SnS_6	Bolivia, Saxony
Cuprocassiterite	$Cu_2Sn(OH)_6$; SnO_2	With stannite (weathered stannite?)
Hulsite	$10(Fe,Mg,Ca)O$; $2Fe_2O_3$; SnO_2 ; $3B_2O_3$; $2H_2O$	Alaska
Native tin	Sn	New South Wales, Stromboli
Nordenskioldine	$CaSn(BO_3)_2$	Norway
Paigeite	$10FeO$; $5Fe_2O_3$; $5SnO_2$; $8H_2O$	Alaska
Plumbostannite	$Pb_2Fe_2Sn_3Sb_2S_{11}$	Peru
Stokesite	$H_2CaSnSi_2O_{10}$	Cornwall (one specimen)
Teallite	$PbSnS_2$	Bolivia, Saxony

Mining and Metallurgy.—The tin deposits are of two kinds, the primary deposits found as veins traversing granite and related acid igneous rocks and the secondary, alluvial deposits formed by the disintegration of the primary deposits. Cassiterite is very resistant to weathering and is found unaltered in the secondary deposits. The greatest part of the world's tin ore comes from secondary deposits. These alluvial deposits are worked by panning, open cut mining and dredging, whereas the primary deposits, mainly the Bolivian ores, are worked by lode mining. Subsequent treatment of the ore depends upon its other components. Those ores which contain only cassiterite, iron oxides and quartz feldspars are termed simple ores; while the sulphidic ores and other ores containing metals such as copper, iron, tungsten and lead are complex ores. The ores generally contain 1% to 5% SnO_2 and must therefore be concentrated prior to reduction. The high density and the nonmagnetic character of cassiterite are the properties used in the concentration processes. The simple ores are dressed to a concentrate by multiple sluicing, followed, in some cases, by magnetic separation to remove tungsten minerals, iron oxides and other magnetic impurities. The complex ores require more extensive treatment to break down the sulphidic minerals and to remove a large part of the other metals present. This treatment involves grinding, roasting, gravity concentrations and magnetic separations.

In the Federated Malay States the ore is smelted at Penang and Singapore and shipped as the metal; however, the Bolivian and Thailand concentrates are shipped to the United States and the United Kingdom, the Indonesian concentrates to the Netherlands and the United States, the Nigerian concentrates to the United Kingdom and the Belgian Congo concentrates to Belgium. Prior to World War II the main smelters were in the United Kingdom, the Netherlands, Malaya and Batavia. During the war the Japanese overran the Asian smelters and the Germans took over the continental European smelters. As a result the Longhorn smelter was constructed at Texas City, Tex., in 1941 and extensive smelting was begun in the United States, mainly with Bolivian ores. After the war the continental European and Malayan smelters were again put into operation, but the Batavian smelters were not immediately reactivated. The leading tin smelters are in the Federation of Malaya, the United States, the United Kingdom, the Netherlands and Belgium.

Metallic tin is obtained by reducing the ore concentrate with coal in blast or reverberatory furnaces. Little preliminary treatment is required for the simple ore concentrates, but the complex ore concentrates still contain other metals which are removed in part by roasting and leaching prior to reduction. The crude tin which comes from the furnaces is purified by liquation, poling, tossing, boiling, electrolysis, or a combination of some of these processes. Liquation takes advantage of the low melting point of tin compared to the usual impurities to separate molten tin from the unmelted impurities. This is accomplished by slowly heating the crude tin to a temperature just above the melting point of tin and collecting the part that melts. Lead and bismuth melt with the tin and must be removed by subsequent treatment. Poling and boiling oxidize the impurities and part of the tin by a strong bubbling action caused by stirring the molten metal with poles of green wood or by agitating the metal with compressed air.

In tossing the oxidation is accomplished by pouring the molten metal from ladles at a height back into the kettles, so the impurities are oxidized by the air. In all these oxidation processes the oxidized impurities and tin oxide form a scum on the surface of the molten tin which is skimmed off and reprocessed. During the smelting of tin much of the metal is either entrapped in the slag or reacts with the fluxes, because of the amphoteric nature of stannic oxide, and goes into the slag as tin compounds. Molten tin, moreover, is a mobile liquid and tends to escape from the furnaces through small openings. Consequently, the recovery of tin from slags, furnace linings and drosses is an important phase in the metallurgy of tin, and these materials are always processed before being discarded.

Because there is not sufficient tin to supply all demands, the recovery of tin is of considerable importance. Some waste materials may be reworked by a combination of liquation and smelting, tin plate scrap is detinned, however, by electrolytic or chemical oxidation of the tin. Dry chlorine, which attacks tin more readily than iron, and oxidizing alkaline solutions are the most widely used chemical reagents. The secondary, or recovered, tin is obtained in the form of metallic tin or tin compounds and is generally sold in the form recovered.

Uses.—By far the largest part of the tin produced is used as the metal, the major uses being for plating and in alloys. Tin is less active than iron and will serve as protection only if it completely covers the iron object, whereas zinc, which is more active than iron, will protect the object even if the coat is not perfect. Tin plating, therefore, has to be more thorough than galvanizing to be effective. An object may be plated by electrolysis, chemical displacement or hot dip processes. The hot dip process gives a heavier plate than the other methods; electrolytic plating gives a dull surface which has to be polished if a bright plate is desired. Terneplate, a protective coating of a tin-lead alloy applied by hot dip processes, is also used as a protective coating (*see* TIN PLATE AND TERNEPLATE).

The alloys of tin belong to two major classes, the bronzes and the white metals. In general, the bronzes are copper base alloys which contain tin and smaller amounts of other elements to give alloys with specific properties (*see* BRONZE) while the white metals are tin base alloys; such as antifriction metal (*q.v.*), Babbitt's metal (*q.v.*), Britannia metal (*q.v.*), pewter (*q.v.*) and tin base die casting alloys, and alloys with other bases, such as type metal (*q.v.*), low-tin bearing metals, die casting alloys with lead or zinc bases and low melting alloys (*see* FUSIBLE METAL). Solder (*q.v.*) is an alloy of tin and lead with composition varying from 20% to 80% tin.

Tin metal is also used in the construction of block tin stills and tin pipes for the distillation and circulation of distilled water, for thin foil to wrap various objects and for collapsible tubes to dispense tooth paste, ointments, etc. Because there is not sufficient tin available, substitutes replaced tin in many of its uses. Low tin alloys began to replace high tin alloys, and other metals were substituted for tin in some applications. Aluminum foil and tubes in large part supplanted tin foil and tubes for most uses, but in some cases, such as the packaging of alkaline substances, aluminum is not satisfactory. Lead is also substituted for tin, but it is not a satisfactory replacement in many instances because of its toxicity.

TABLE II.—*Composition of Typical Tin Alloys*

Alloy	% Sn	% Cu	% Pb	% other elements
Bronzes				
Bell metal	15–25	85–75		
Gun metal	8–14	92–86		
Colinage bronze	4	95		Zn 1
White metals				
Britannia metal	90–94	3–1		Sb 8–5
Babbitt's metal	80	3		Sb 7
Pewter	82			Sb 18
Bearing metal	75	12 5		Sb 12 5
Fine solder	60		40	
Eutectic fusible alloy	50		32	Cd 18
Plumber's solder	33 3		66 7	
Type metal	20	1	58	Sb 15
Wood's metal	12 5		25	Bi 50, Cd 12 5

Compounds of tin used commercially represent less than 1% of the tin consumption The main uses are in textile manufacture, dyeing and in glasses, ceramics and porcelains The compounds used industrially are SnO_2 (tin ash), $SnCl_2.5H_2O$ (butter of tin), $SnCl_2.2H_2O$ (tin salt), $(NH_4)_2SnCl_6$ (pink salt), $Na_2SnO_2.10H_2O$ (preparing salt), $SnSO_4$, SnC_2O_4, $SnC_4H_4O_6$, $Sn_3(PO_4)_2$ and $Sn_2(PO_4)_4$.

Physical Properties.—Tin is a soft, ductile, white metal which is readily extruded, drawn, stamped and spun Although it does not work-harden appreciably, it has a low elastic limit. When bent, the cast metal emits a creaking sound called the "cry of tin". This is thought to be caused by the grinding of crystals of the metal against one another when the bar is bent The metal has at least two allotropic modifications. In the usual commercial form it is a white massive metal, but, when exposed to temperatures below 13° for sufficient time, it becomes brittle and may be readily crushed to a gray powder. Tin objects eventually crumble to this gray powder spontaneously if kept in a cold climate for years Before the change was understood, it was named tin pest or tin disease, for the transformation appears to be contagious It is autocatalytic, and a single grain of the gray form in contact with a piece of white metal below the transition temperature will start the transformation. The gray and white modifications have been designated α tin and β tin Another modification, termed γ tin, has been reported to form at 161° and exist up to the melting point, but authorities disagree as to its existence. It is not generally accepted as an allotrope of tin.

TABLE III.—*Some Physical Properties of Tin*

Property	Value	Remarks
Melting point	231·9° C	National Bureau of Standards standard
Boiling point	2,270° C	
Transition temperature	13·2° C 161° C	gray to white white to γ (?)
Critical temperature	1726° C	
Critical pressure	890 atmospheres	
Density	7·311 (30°/4°) 7·85	white gray at 15°
Hardness	1·8	white on Von Moh scale
Electrical conductivity	14·0	silver=100
Thermal conductivity	31·2	silver=100
Coefficient of linear expansion	2·03 x 10⁻⁴	white, 0°–95° C
Heat of fusion	14·4 cal./g	
Heat of vaporization	452 cal./g	
Heat of transition	4·46 cal./g 0·02 cal./g	gray to white white to γ
Specific heat	0·0534+7·0×10⁻⁵t (t=0 to 100° C)	cal./g. White
Ionization potential		
I	7·30 e.v.	
II	14·5 e.v.	
III	30·5 e.v.	
IV	39·4 e.v.	
Electrode potential		
$Sn-Sn^{++}$	0·136 volts	
$Sn^{++}-Sn^{++++}$	−0·15 volts	
Radius		
Covalent	1·40 Å (1 Angstrom = 10^{-8} cm.)	single bond
	1·30 Å	double bond
Sn^{++}	1·02 Å	
Sn^{++++}	0·71 Å	

Tin is a member of Group IV of the periodic table (*see* PERIODIC LAW, THE), being associated with carbon, silicon, germanium and lead It falls between germanium and lead in atomic weight and resembles these two elements the most closely The four valency electrons of tin occupy the $5s^2$ and $5p^2$ orbitals and consist of two sets from the consideration of the energy required to remove each electron. Accordingly, tin forms two series of compounds, one [the stannous or tin(II) series] in which tin has an oxidation number of +2 after losing only the 5p electrons, and a second series with oxidation number +4 corresponding to the loss or sharing of all four outer electrons Tin also forms a few compounds in which it can be considered to have the oxidation number −4. In these compounds the outer electron shell is built up to eight electrons by sharing electron pairs with other more electropositive atoms. The electrode potentials show that tin is oxidized to Sn^{++} by the hydrogen ion, but that hydrogen is oxidized to the hydrogen ion by Sn^{4+}.

The simple cation Sn^{++} exists in moderately acidic solutions, but there is some question about the existence of the simple cation Sn^{4+} because of extensive hydrolysis. In most solutions the stannic ion is undoubtedly present as some kind of complex ion because it has a high charge density, but there is some evidence that Sn^{4+} may be present in certain sulphuric acid solutions For the most part, however, compounds containing tin (IV) are either covalent in nature or else contain tin in a co-ordinated cation or anion. In both oxidation states tin is amphoteric, but $Sn(OH)_2$ is a stronger acid than $Sn(OH)_4$ as would be expected for the smaller, more highly charged tin(IV) ion Although it has been customary to write ions such as SnO_3^{--} in the stannate solutions, the salts isolated from such solutions retain their original nature only when dehydrated as far as the composition illustrated by $K_2SnO_3.3H_2O$ Further dehydration, which is more difficult, gives salts which have lost ready solubility in water; so it is probable that the stannate ion is $Sn(OH)_6^{--}$. The stannites are much less stable than the stannates and are efficient reducing agents. They also tenaciously retain sufficient water of hydration to indicate that the stannite ion is $Sn(OH)_4^{--}$.

Binary compounds of tin in both oxidation states have been prepared with the halogens, oxygen, nitrogen, sulphur, selenium and tellurium. The hydride and phosphide of tin(IV) are also known. The salts of the common oxyacids have been reported, for the most part in both series, although the tin(IV) salts are more difficult to prepare because of hydrolysis and in some cases have not been isolated Co-ordination compounds containing tin generally have a co-ordination number of four for tin(II) and six for tin(IV); however, a few compounds with co-ordination number six for tin(II) and eight for tin(IV) are known Some examples of compounds of these kinds are $K_2SnCl_4.2H_2O$ and $(NH_4)_2SnBr_4$ [tin(II), co-ordination number four], $Na_2SnBr_6.6H_2O$ and $K_2Sn(OH)_6$ [tin(IV), co-ordination number six], $(NH_4)_2SnBr_6.H_2O$ [tin(II), co-ordination number six] and $H_2Sn(C_6O_4)_4$ and $Sn(C_9H_6ON)_4$ [tin(IV), co-ordination number eight].

TABLE IV.—*Some Chemical Reactions of Metallic Tin*

Reagent	Product	Conditions of reaction
Air	superficial tarnish	room temperature
	SnO_2	high temperatures
Oxygen	SnO_2	accelerated by water and heat
Hydrogen, nitrogen	no reaction	
Fluorine	SnF_4	100° C
Chlorine, bromine	$SnCl_4$, $SnBr_4$	room temperature
Hydrobromic acid	feeble attack	
Hydrochloric acid	$SnCl_2$	slow if dilute, more rapid if hot, concentrated
Hydrobromic, hydriodic acids	$SnBr_2$, SnI_2	hot
Chloric acid, aqua regia	$SnCl_4$	room temperature
Sulphuric acid	$SnSO_4$	cold, dilute (slow)
	$Sn(SO_4)_2$	hot, concentrated
Nitric acid	$Sn(NO_3)_2$	dilute
	$SnO_2.2H_2O$	concentrated
Alkali hypochlorites	basic stannic chlorides	
Sulphur	SnS or SnS_2	heat
Hydrogen sulphide, Sodium sulphide, or Sulphur dioxide	SnS	heat
KOH	$K_2Sn(OH)_4$	heat

TABLE V.—*Some Properties of Typical Tin Compounds*

Formula	Melting point	Boiling point	Density	Colour	Solubility
SnO	decomposes	>1265° C	6·9	black	alkali, acid
Precipitated SnO₂		1,132° C	6·6–7·0	white	alkali, acid
$SnCl_4$	−33° C.	114° C	2·3	colourless	water, organic solvents
SnF_4	sublimes	705° C	4·6	white	water
$SnCl_2$	246·8° C	605°–606° C	2·6	white	water, organic solvents
$SnBr_2$				white	water, alkali, fluoride
SnS	880° C.	1,230° C	5·2	brown	concentrated HCl, $(NH_4)_2S_x$
SnSe	decomposes		4·5	yellow	basic sulphides, concentrated HCl
$K_2SnCl_6.H_2O$			2·5	white	water
$(NH_4)_2SnCl_6$	decomposes		2·4	white	water
$Sn(C_2H_5)_4$	−112° C.	181° C	1·2	colourless	organic solvents
$(CH_3)_2SnI_2$	43° C.	228° C	2·9	white	hot water, organic solvents
$Sn(C_6H_5)_4$	226° C.	>420° C	1·5	colourless	hot organic solvents
SnH_4	−150° C.	−52° C		colourless	concentrated H_2SO_4, concentrated alkali

The stereochemistry (*q.v.*) of the various tin compounds is, in general, what is expected from bonding considerations. In those compounds with four covalent bonds linked to tin(IV), such as $SnCl_4$ and the organotin(IV) compounds, the bonds are directed to the four

corners of a tetrahedron as with carbon and other elements which form compounds using sp^3 orbitals for bonding The resolution of methylethylpropyl tin iodide into optically active isomers is classical evidence for the tetrahedral structure of these tin compounds In compounds such as K_2SnCl_6 the six chlorine atoms are arranged in octahedral fashion about the tin atom in the same way the chlorine atoms are arranged around the platinum atom in K_2PtCl_6 The configuration in $K_2SnCl_4.H_2O$ is that of infinite chain ions of composition $SnCl_4^{--}$ formed by $SnCl_6$ octahedra sharing two opposite edges In the gaseous state molecules such as $SnCl_2$ are angular in shape, a configuration to be expected because the 5s electron pair is still present in the outer electron shell of tin, so the p orbitals, which are at a 90° angle, determine the configuration. Stannous oxide, SnO, also shows the effect of this inert pair of electrons It has a layer structure in which four oxygen atoms are arranged in a square bonded to one side of the tin and the inert pair occupies the other side, thus forming the apex of a tetragonal pyramid. The oxide SnO_2 has the rutile structure in which the tin atoms are surrounded octahedrally by six oxygen atoms, gray tin has the diamond lattice and white tin has a metallic lattice.

Under the proper conditions compounds corresponding to stannic acid can be isolated Two stannic acids, one prepared by the acidification of stannate solutions and the other by the action of concentrated nitric acid on tin, have been said to exist and were named α and β stannic acids or stannic and metastannic acids, respectively Stannic acid prepared by the two methods differs in properties (the α form is readily soluble in acids and bases, whereas the β form is soluble difficultly in these reagents), but the reason for the differences has not been definitely established. X-ray diffraction patterns for the two forms are the same and identical with that of cassiterite, so the difference is not one of isomers It is probably essentially one of particle size and amount of adsorbed water with the β form a modification with larger particles. The conversion of α to β occurs readily, whereas the reverse transformation is more difficult. Treatment of a stannic acid with hydrogen peroxide yields a peroxy acid of tin with the formula $H_2Sn_2O_7.3H_2O$. Sodium and potassium salts of this acid are also known Stannic sulphide also possesses amphoteric properties, being soluble in basic sulphide solutions to give thiostannates, but stannous sulphide is so much less acidic than the tin(IV) compound that it is insoluble in basic sulphide solutions.

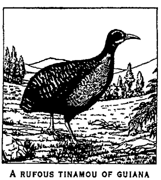
Tin resembles silicon and germanium in the compounds it forms which are analogous to the extensive series of organic compounds of carbon. The hydride SnH_4 (*see* Hydrides) is the only gaseous binary hydride known to be formed by tin, but chains of tin atoms occur in the organometallic compounds with the formula $(CH_3)_3Sn[Sn(CH_3)_2]_n$-$Sn(CH_3)_3$ in which n may be 0, 1 or 3 A large number of organotin compounds have been prepared in which tin is bonded to form one to four alkyl or aryl groups In those compounds containing tin(IV) the other bonds may be to halogens, hydrogen or oxygen. A few organotin compounds have been prepared which contain tin(II), but they disproportionate fairly easily to tin and tin(IV) compounds. Metallic tin dissolves in a liquid ammonia solution of potassium to give a blood- [illegible] pounds are prepared by the reaction of tin halides with the Grignard reagent or organozinc compounds. To prepare metallic tin in the laboratory an insoluble compound is fused with potassium cyanide and carbon or a solution of a soluble compound is treated with zinc

Analysis.—In the field cassiterite is usually recognized by its high density and extreme hardness. A chemical test that distinguishes it from those minerals with which it might be confused is the treatment of the mineral with cold dilute hydrochloric acid or sulphuric acid in the presence of zinc or iron. This reduces the surface oxide to a gray coating of metallic tin which can be washed and rubbed to a silvery surface. The minerals most frequently confused with cassiterite are zinc blende, ilmenite, rutile, hematite, wolframite, tantalite, columbite, zircon, garnet, tourmaline and axinite. In the usual wet qualitative analysis scheme both Sn(II) and Sn(IV) are separated as insoluble sulphides in dilute hydrochloric acid The sulphides are then dissolved in a basic sulphide solution containing polysulphide to oxidize Sn(II) to Sn(IV). Arsenic and antimony are the only elements of those considered in most qualitative schemes which go into solution with tin These elements are recovered as sulphides, and tin sulphide is then separated from the arsenic and antimony sulphides by various procedures, most of which depend upon the solubility of stannic sulphide in concentrated hydrochloric acid, the stability of the oxalate complex of tin, or the selective reduction of tin(IV) to tin(II). Several spot tests have been suggested for tin, the most satisfactory of which are reported to be the violet colour formed by Sn(II) with cacotheline, the blue colour imparted to a colourless Bunsen burner flame when hydrogen generated from zinc and hydrochloric acid in the presence of tin compounds (except highly refractory compounds) is burned, and the blue colour formed by the reduction of molybdophosphoric acid by Sn(II) Quantitatively, tin is determined gravimetrically as the ignited oxide after the removal of other ions or as the electrolytically deposited metal Titrimetric determinations are made by the iodometric titration of Sn^{++} or $K_2SnS(C_2O_4)_2$ with iodine in the presence of starch The titrimetric method is generally considered the superior quantitative procedure

Deposits and Production.—The important tin deposits are confined to the following geographical locations (1) Burma, Thailand, Malaya and Indonesia, (2) Bolivia, (3) Nigeria and the Belgian Congo, (4) west England, Brittany and the Erzgebirge and (5) Australasia. The major ore-producing areas, with approximate 1950 production in short tons indicated in parentheses, are: Malaya (64,440), Indonesia (35,950), Bolivia (35,000), Belgian Congo (15,340), Thailand (11,600) and Nigeria (9,250) The deposits at Cornwall, Saxony and Bohemia, major producers in the 18th and 19th centuries, are almost depleted and are mainly of historical interest although some ore is still obtained from them Other sources of lesser amounts of tin ores are Portugal, Spain, the Union of South Africa, Burma, China and Australia. North America is the only continent which does not have commercially important deposits of tin ores. Both Canada and Mexico produce small tonnages, but North America depends almost entirely on imports for its tin

Bibliography—A thorough treatment of the industrial and historical aspects of tin may be found in *Tin: Its Mining, Production, Technology, and Applications* by C L. Mantell, 2nd ed (1949). The chemistry of tin is discussed in *The Chemical Elements and Their Compounds* by N V. Sidgwick, pp 551–627 (1950). (B. P. B.)

TINAMOU, the name of a group of birds peculiar to South America, having some superficial resemblances to the partridge The elongated bill, small head and slender neck are diagnostic The plumage is some shade of brown, variously barred with darker tints. The wings are short and rounded and the male incubates the highly-burnished eggs. They are exceedingly stupid but are excellent to eat More than 60 species are recognized. They are considered a group of palaeognathine birds and form the family Tinamidae. The little tinamou (*Crypturus pileatus*) ranges from the Amazon to Mexico, while the rufous tinamou (*Phychotus rufescens*) inhabits southern Brazil and Paraguay.



A RUFOUS TINAMOU OF GUIANA

TINDAL, MATTHEW (d 1733), English deist, the son of a clergyman, was born at Beer Ferrers (Ferris), Devonshire, probably in 1653. He studied law at Lincoln college, Oxford, under the high churchman George Hickes, dean of Worcester; in 1678 he was elected fellow of All Souls college About 1685 he became a Roman Catholic, but returned to the Church of England at Easter, 1688. His early works were an *Essay of Obedience to the Supreme Powers* (1694); an *Essay on the Power of the Magistrate and the Rights of Mankind in Matters of Religion* (1697); and *The Liberty of the Press* (1698). The first of his two larger works, *The Rights of the Christian Church Asserted Against The Romish And All Other Priests Who Claim An Independent Power Over It*, pt i, appearing anonymously in 1706 (2nd ed, 1706; 3rd, 1707, 4th, 1709), is a forcible defense of Erastianism. Author, publisher and printer were prosecuted, but this did not prevent the issue of a fourth edition and gave the author the opportunity of issuing *A Defence of the Rights of the Christian Church*, in two parts (2nd ed, 1709). The book was, by order of the house of commons, burned, along with Henry Sacheverell's sermon, by the common hangman (1710) It was the object of denunciation for years, and Tindal scented in a pastoral letter by Edmund Gibson, bishop of London, a charge of having undermined religion and promoted atheism and infidelity He replied in the anonymous tract, *An Address to the Inhabitants of London and Westminster* (2nd ed, 1730). In this he defends the

deists, and anticipates his *Christianity as Old as the Creation; or, the Gospel a Republication of the Religion of Nature* (London, 1730, and ed , 1731; 3rd, 1732, 4th, 1733), which was regarded as the "Bible" of deism He died at Oxford Aug. 16, 1733.

TINEA VERSICOLOUR or PITYRIASIS VERSICOLOUR is a harmless skin disease caused by the deposition of a fungus of the ringworm group, *Microsporon furfur*. It thrives on the trunk of adults and forms slowly spreading brown patches with fine branny scaling. Sunshine bleaches the brown patches, and after continued exposure the normal skin becomes darker than the bleached spots because the fungus colonies hinder the penetration of the tanning sun rays. Hence the name "versicolour" which means changing colour. The fungus deposits itself only on the skin of a few specifically susceptible persons and is not transferable by contact (S. ROS.)

TINEO, a town of Spain, in the province of Oviedo; on a tributary of the Narcea, among the northern outliers of the Cantabrian mountains, and on the high road from Cangas de Tineo to the Biscayan port of Cudillero. Pop. (1940), 1,308 (mun., 21,338). Mining, agriculture and stock-rearing are the principal industries.

TINGUIAN, a tribe of north Luzon, in the Philippines, of Malayo-Indonesian stock. More brachycephalic, and probably belonging to a later wave of immigration than the Igorot (*q.v.*) group, and showing stronger traces of Indian influence on culture probably traceable to Sumatran origin. The same influence appears in rice-cultivation methods, and irrigated terraces are less elaborate than those of the Igorot, who do not use the buffalo. Marriage restrictions are based on blood-relationship only, not on clan, and the polity is democratic. A Creator is believed in, and spirits of various functions good and bad, some of which inhabit guardian stones. The home of the dead, where life goes on as on earth, is sometimes placed in a mountain. The dead are dried before burial. Mediums, usually female, communicate with spirits.

See Cole, *The Tinguian* (1922).

TINNÉ, ALEXANDRINE PETRONELLA FRANCINA (1839–1869), Dutch traveller in Africa, born at The Hague on Oct. 17, 1839, was the daughter of Philip F. Tinné, a Dutch merchant who settled in England during the Napoleonic wars. Her father died when she was five years old, leaving her the richest heiress in the Netherlands. After travelling in Norway, Italy and the East, and visiting Egypt, when she ascended the Nile to near Gondokoro, Miss Tinné left Europe again in 1861 for the Nile regions. Accompanied by her mother and her aunt, she set out from Cairo on Jan. 9, 1862. After a short stay at Khartum the party ascended the White Nile to a point above Gondokoro, and explored a part of the Sobat, returning to Khartum in November. Baron Theodor von Heuglin (*q.v.*) and Dr. H. Steudner having meantime joined the ladies at Khartum, the whole party set out in Feb. 1863 for the Bahr-el-Ghazal.

Ascending the Bahr-el-Ghazal the limit of navigation was reached on March 10. From Meshra-er-Rek a journey was made overland, across the Bahr Jur and south-west by the Bahr Kosango to Jur Kogo, on which river one of the Niam-Niam communities. During the journey the party was [illegible] Steudner died on April 21. Miss Tinné and [illegible] reached Khartum in July 1863, where Miss Tinné's mother died. Miss Tinné returned to Cairo by Berber and Suakin. In January she sailed from Trieste with a view to return to make a journey to Lake Chad. Before she could leave Nile for Europe, however, owing to the failure of her health she was induced, together with two Dutch friends, the Lutzes who believed that [illegible]

See John A. Lutzes, *Geographische Ergebnisse einer Reise in Central Africa by these Dutch Lovers* (Leipzig, 1865), and Sir H. H. Johnston, *The Nile Quest*, ch. xvi. (London, 1903).

TINNED FOODS: *see* FOOD PRESERVATION.

TINNEVELLY, a town and district of India, in the Madras presidency. The town is on the left bank of the Tambraparni river, on the other side of which is Palamcottah, the administrative headquarters of the district. Pop. (1941) 60,676. It is on the South Indian railway, 444 mi. S.W. of Madras. A branch line was opened to Tiruchendur in 1923. Its most noteworthy building is a beautifully sculptured temple of Siva.

The DISTRICT OF TINNEVELLY has an area of 4,342 sq.mi. It is for the most part a plain with an average elevation of 200 ft. sloping to the east with slight undulations. It is watered by numerous short streams, the principal being the Tambraparni with a length of 80 mi. The chief irrigation work is the Srivaikuntam anicut or dam on this river. In the north the scenery is unattractive and the soil poor; in the south red sandy soil prevails in which little save the Palmyra palm will grow. This palm yields toddy as well as a coarse sugar. Along the banks of the rivers are rice fields; cotton, millet, pulse and oilseeds are grown, and cloth, mats, lace and sugar manufactured. There is a trade in cotton stuffs, and fishing is carried on. The district contains many ancient and magnificent buildings. In 1941 the population was 2,244,543. The number of Christians was 262,909.

The Society for the Propagation of the Gospel and the Church Missionary Society have important stations at Tinnevelly town and Palamcottah, as also have the Jesuits.

It was here that St. Francis Xavier began his preaching in India.

The early history of Tinnevelly is mixed up with that of Madura and Travancore. Down to 1781 it is a confused tale of anarchy and bloodshed. In that year the nawab of Arcot assigned the revenues to the East India Company, which then undertook the internal administration. Several risings subsequently took place, and in 1801 the whole Carnatic, including Tinnevelly, was ceded to the British.

TIN PLATE AND TERNEPLATE. Tin plate is a sheet of iron or steel which has been thinly coated with tin by being dipped in a molten bath of that metal. Terneplate is a sheet of iron or steel coated with a lead-tin alloy containing about 85% lead and 15% tin. The word terne was applied to this plate because of its dull appearance due to the large proportion of lead in the coating. The purpose of the tin in terneplate coating is to act as a binder between the lead and the iron, which do not alloy.

There are two processes for tinning. In the "palm-oil" process, which is the older, the plates, after being properly annealed, are scoured with sand and water and pickled in dilute sulphuric acid alternately until they are perfectly clean and bright. They are then washed in water, and after being boiled in palm oil to remove all traces of acid and water are dipped into a bath of molten tin, covered with oil to prevent oxidation. They are then taken to a second bath containing purer tin than the first. After this they are scoured with a hempen rubber and dipped in a third bath containing the purest tin of all; then they are passed through rolls to finish the surface and regulate the thickness of the coating. In the "acid process" only a single bath of tin is required The molten metal is covered with a layer of muriate of zinc, which acts as the flux, and by means of rolls the plates are passed through this down into the tin, to be brought out at another point in the bath where there is a layer of oil on the surface.

The process of coating terneplate is very similar to the galvanizing process. (*See* GALVANIZED IRON AND STEEL.) The sheets, after having been pickled, are placed in the same kind of an acid solution, except the acid is somewhat weaker. The sheets first pass into a neutralized solution of zinc chloride. This flux enables the lead-tin mixture to adhere better to the base metal. Burners located under the intake side of the "kettle" keep its temperature at about 700 to 725° F. The metal passes through the lead-tin alloy, under the flux, at the bottom of the kettle. As the sheets emerge through the exit rolls, they pass through palm oil. The rolls serve to pull the sheets through, and, together with the oil, they wipe off the excess metal and produce a smooth coating. This entire process is now completed by one machine; formerly it was necessary to dip and redip the sheets by hand. Tongs are used to push the sheets down through the flux box until they are gripped and pulled out by the rolls. As the sheets leave the oil bath, an air spray cools them. They then pass through a set of flannel disk rolls that squeeze off the excess oil, and on to a conveyor. They pass from the conveyor to cleaning machines, con-

sisting of flannel disk rolls and brushes, using sawdust, peanut hulls, meal or bran further to absorb and to clean off the oil. The weight of coating is more difficult to control than it is in galvanizing. It is affected by the heat of the bath, speed of the machine, the kind of rolls used and the surface of the sheet coated The temperature limits of the operation are very narrow.

The sheets employed in the manufacture of tin plate and terneplate are known as "black plates." Formerly iron alone was used, and was of two grades, coke-iron and charcoal-iron; the latter being the better, received a heavier coating of tin, and this circumstance is the origin of the terms "coke-plates" and "charcoal plates" by which the quality of tin plate is still designated Later steel was used but it was found that iron plate was more durable. Now both iron and steel plates are available. (*See* SHEETS, IRON AND STEEL.) It has been attempted to lower the price of terneplate by using coatings entirely too light Although much of this light-coated terneplate is still used, high grade plate, properly coated, is obtainable. The service pure iron renders will, no doubt, cause more and more of this product to be used as the base for terne roofing plate as well as long ternes. Two different types of finishes are obtainable; "bright dry" or "dark oil." These different effects are imparted as it travels through the machine.

Long ternes are similar to terneplates except that the sheets are larger, and the tin content usually runs about 12½% The lead in the lead-tin alloy makes long terneplate ideal for fabrication into caskets, automobile gasolene tanks and other products in the manufacture of which deep drawing and stamping (*see* PRESSED METAL) is necessary. The lead serves as a lubricant in forming operations, causing the sheets to flow uniformly under the dies.

(B. CHA)

TIN PRINTING: *see* LITHOGRAPHY.

TINTAGEL (tin-tăj'ĕl) or **TREVENA,** village, Cornwall, England, 4½ mi. N.W of Camelford Pop. (1931) 1,255 It stands on a bare upland, close to the sea; and below it is Tintagel Haven, or Porth, a small cove surrounded by cliffs of almost black slate. Ruins of a castle, the reputed birthplace of King Arthur, are built partly on the mainland, partly on a rugged promontory, Tintagel Head, united by a narrow peninsula to the shore. The Norman walls are so weathered that, from a little distance, they seem a part of the rock itself. During excavations in 1933 the remains of a Celtic monastery were unearthed, thus carrying the story of Tintagel back beyond the earliest records The church of St. Marcelliana, on a high cliff west of the castle, retains traces of Saxon workmanship in the chancel, besides two Norman doorways, a font of the same period, a stone altar bearing five crosses and a fine 15th century brass. In the churchyard the graves are buttressed, storms being frequent and violent. For a time the church belonged to Fontevrault abbey in Normandy; but it was made over by Edward IV to the collegiate church of Windsor. A 9th century roodstone stands in the village.

Tintagel (Tintajol, Dundagel) is a parish a portion of which appears in Domesday as Bossiney (Botcinnu). The castle probably existed in pre-Saxon times, and under the Norman earls of Cornwall was rebuilt It was in a ruinous condition in Leland's time (*c.* 1540). The borough of Bossiney, which apparently owed its existence to the castle, shared its fortunes. Its charter was surrendered to Charles II and a new one obtained from his brother in 1685.

Bossiney acquired the right of electing two members of parliament in 1553 In 1784 the vicar of Tintagel, as mayor and only qualified elector, enjoyed the probably unique privilege of returning two members to the house of commons. In 1832 there were ten resident legal voters within the borough and nine out-voters. The Reform act transferred their votes to the county.

TINTERN ABBEY, in Monmouthshire, one of the most famous ecclesiastical ruins in England, on the River Wye. The abbey was founded by Walter de Clare in 1131 for Cistercian monks. The existing church, however, dates from the latter part of the 13th century, it is unroofed, and the nave is imperfect, but many of the finest details of a style transitional from Early English to Decorated are preserved The church is cruciform. Cloisters and other monastic buildings, of which there are considerable remains, lay to the north of the church The foundation was dissolved by Henry VIII

TINTOMETER, a commercial instrument which makes it possible to register colours (*e g*, of oils) by matching them against the light transmitted by one or more of a set of coloured glasses, each glass being of a slightly different tint from those on either side of it in the set. (*See* COLOUR.)

TINTORETTO, JACOPO ROBUSTI (1518–1594), one of the greatest painters of the Venetian school, was born in Venice in 1518, though Ridolfi says in 1512. His father, Battista Robusti, was a dyer, or "tintore", hence the son got the nickname of "Tintoretto," little dyer. His father, noticing his artistic bent, took him to the studio of Titian. Ridolfi is our authority for saying that Tintoretto had only been ten days in the studio when Titian sent him home once and for all The reason, according to the same writer, is that the great master observed some very spirited drawings by the boy and it is inferred that he became at once jealous of so promising a scholar. This, however, is mere conjecture From this time forward the two always remained upon distant terms—Robusti being indeed a professed and ardent admirer of Titian, but never a friend, and Titian turning the cold shoulder to Robusti, who sought for no further teaching, but studied on his own account with laborious zeal from casts, bas-reliefs etc He placed over his studio the inscription "Il disegno di Michelangelo ed il colorito di Tiziano" (Michelangelo's design and Titian's colour). He is said to have studied more especially from models of Michelangelo's "Dawn," "Noon," "Twilight" and "Night," and from Sansovino's statues, and to have modelled in wax and clay small figures, which he suspended in a box with an aperture for a candle. Thus, according to Ridolfi, Robusti's art was self-taught. More recent criticism, however, has averred that he probably proceeded to some other painter's studio on leaving Titian's. Berenson and Thode have suggested that Bonifazio may have been his master while Hadeln thinks Bordone more likely. However, he had a hard struggle to obtain recognition He assisted Schiavone in his studio and undertook every commission which offered itself. One of Tintoretto's early pictures still extant is in the church of the Carmine in Venice, the "Presentation of Jesus in the Temple." In 1547 he painted the "Last Supper" in the Church of S Marcuola The "Christ Washing the Apostles' Feet" painted for the same church is now in the Escorial For the Scuola della Trinità he painted four subjects from Genesis Two of these, now in the Venetian Academy, are "Adam and Eve" and the "Death of Abel," both noble works of high mastery, which leave us in no doubt that Robusti was a consummate painter.

In 1548 he was commissioned for four pictures in the Scuola di S Marco—the "Finding of the body of St. Mark in Alexandria" (now in the Brera, Milan), the "Saint's Body brought to Venice," the "miraculous preservation of a Saracen sailor at sea by the Saint" (these two are in the library of the royal palace, Venice), and the highly and justly celebrated "Miracle of the Slave" These works were greeted with general applause, including that of Titian's intimate, the too potent Pietro Aretino. The painter's straits and obscure endurances were over He married Faustina de' Vescovi, daughter of a Venetian nobleman, and settled in a house in the Fondamenti de Mori near the church of the Madonna dell' Orto Here he painted three of his leading works—"The Worship of the Golden Calf," "The Presentation of the Virgin" and the "Last Judgment."

The next conspicuous event in the professional life of Tintoretto is his enormous labour and profuse self-development on the walls and ceilings of the Scuola di S Rocco, a building which may now almost be regarded as a shrine reared by Robusti to his own genius. The building had been begun in 1524 by Sante Lombardi, after the design of Bart. Buono and was very deficient in light, so as to be particularly ill-suited for any great scheme of pictorial adornment. The painting of its interior was commenced in 1560 In that year five principal painters, including Tintoretto and Paul Veronese, were invited to send in trial-designs for the centre-piece in the smaller hall named Sala dell' Albergo, the subject being S. Rocco received into Heaven. Tintoretto produced not a sketch but

a picture, and got it inserted into its oval. The competitors remonstrated, not unnaturally; but the artist, who knew how to play his own game, made a free gift of the picture to the saint, and, as a by-law of the foundation prohibited the rejection of any gift, it was retained *in situ*—Tintoretto furnishing gratis the other decorations of the same ceiling (This is one version of the anecdote. there is another version, which has the like general bearing.) In 1565 he resumed work at the scuola, painting the magnificent "Crucifixion," for which a sum of 250 ducats was paid. In 1576 he presented gratis another centre-piece—that for the ceiling of the great hall, representing the "Plague of Serpents", and in the following year he completed this ceiling with pictures of the "Paschal Feast" and "Moses striking the Rock." Robusti next launched out into the painting of the entire scuola and of the adjacent church of S. Rocco. He offered in November 1577 to execute the works at the rate of 100 ducats per annum, three pictures being due in each year. This proposal was accepted and was punctually fulfilled, the painter's death alone preventing the execution of some of the ceiling-subjects. The whole sum paid for the scuola throughout was 2,447 ducats. Disregarding some minor performances, the scuola and church contain fifty-two memorable paintings, which may be described as vast suggestive sketches, with the mastery of finished pictures, "Adam and Eve," the "Visitation," the "Adoration of the Magi," the "Massacre of the Innocents," the "Agony in the Garden," "Christ before Pilate," "Christ carrying His Cross" and the "Assumption of the Virgin" are leading examples in the scuola; in the church, "Christ curing the Paralytic."

It was probably in 1560, the year in which he began working in the Scuola di S. Rocco, that Tintoretto commenced his numerous paintings in the ducal palace; he then executed there a portrait of the doge, Girolamo Priuli. Other works which were destroyed in the great fire of 1577 succeeded—the "Excommunication of Frederick Barbarossa by Pope Alexander III." and the "Victory of Lepanto." After the fire Tintoretto started afresh, Paul Veronese being his colleague. In the Sala dello Scrutinio Robusti painted the "Capture of Zara"; in the hall of the senate, "Venice, Queen of the Sea" and two others; in the Sala del Collegio 4 pictures among which the "Espousal of St. Catherine", in the Sala dell' Anticollegio, four decorative masterpieces—"Bacchus, with Ariadne crowned by Venus," the "Three Graces and Mercury," "Minerva discarding Mars," and the "Forge of Vulcan"—which were painted towards 1578; in the Antichiesetta, "St. George and St. Louis, with St. Margaret," and "St. Jerome and St. Andrew"; in the hall of the great council, nine large compositions, chiefly battle-pieces. We here reach the crowning production of Robusti's life, the last picture of any considerable importance which he executed, the vast "Paradise," in size 74 ft. by 30, reputed to be the largest painting ever done upon canvas. It is a work so stupendous in scale, so colossal in the sweep of its power, so reckless of ordinary standards of conception, so pure an inspiration of a soul burning with passionate visual imagining and a hand magical to work in shape and colour, that it has defied the connoisseurship of three centuries, and has generally (though not with its first Venetian contemporaries) passed for an eccentric failure. All Venice applauded the superb achievement. Robusti was asked to name his own price, but this he left to the authorities. Robusti died on May 31, 1594. The register of deaths in S. Marciliano states that Tintoretto died of fever, aged seventy-five years, eight months and fifteen days—thus bringing us to Sept. 16, 1518 as the true date of his birth. He was buried in the church of the Madonna dell' Orto by the side of his favourite daughter Marietta (*c.* 1556–1590?) who had herself been a portrait-painter of considerable skill, as well as a musician, vocal and instrumental. In 1866 the grave was opened, and the remains were moved to the chapel on the right of the choir.

Tintoretto painted his own portrait at least twice (Uffizi, Florence and Louvre, Paris). It is a face somewhat blunt and rugged, but yet refined—concentrated and resolute, its native ardours of frankness and energy welded down into lifelong laboriousness, with a pent look as of smouldering fire. The eyes are large, dark and round; the grizzled hair close and compact.

In 1574 he obtained the reversion of the first vacant broker's patent in a fondaco, with power to bequeath it—an advantage granted from time to time to pre-eminent painters. For his phenomenal energy in painting he was termed "Il Furioso." An agreement is extant showing that he undertook to finish in two months two historical pictures each containing twenty figures, seven being portraits. The number of his portraits is enormous; their merit is unequal, but the really fine ones cannot be surpassed. The Venetians said that he had three pencils—one of gold, the second of silver and the third of iron. The only pictures (if we except his own portrait) on which he inscribed his name are the "Miracle of Cana" in the church of the Salute (painted originally for the brotherhood of the Crociferi), the "Miracle of the Slave," and the "Crucifixion" in the Scuola di S. Rocco; the last was engraved in 1589 by Agostino Caracci.

Of pupils Robusti had very few; his two sons and Martin de Vos of Antwerp were among them. Domenico Robusti (1560–1635) whom we have already had occasion to mention, frequently assisted his father in the groundwork of great pictures. Some of his works are to be seen in the academy at Venice and in S. Maria degli Angeli at Murano.

We conclude by naming a few of the more striking of Tintoretto's very numerous works not already specified in the course of the article. In Venice (S. Giorgio Maggiore), a series of his later works, the "Gathering of the Manna," "Last Supper," "Entombment," "Resurrection"; (S. Cassiano) a "Crucifixion," the figures seen from behind along the hill slope; (St. Mark's) a mosaic of the "Baptism of Christ." In Milan (the Brera), "St. Helena and other saints." In Florence (Uffizi) three fine portraits including that of the sculptor Jac. Sansovino; (Pitti Gallery), "Venus," "Vulcan" and "Cupid." In Dresden "The Rescue." In Cologne (Wallraff-Richarts Museum), "Ovid and Corinna." In Munich (Pinakothek) eight paintings executed (1579–1580) for the Duke of Mantua, illustrating historical scenes—one of the siege of a fortified town is astonishingly fine. In England (Hampton Court), "Esther and Ahasuerus," and the "Nine Muses"; (the National Gallery), "The Origin of the Milky Way," a memorable *tour de force*, "Christ washing Peter's Feet," also a spirited smallish work, "St. George and the Dragon." A fine portrait of a Doge has recently been acquired by the Melbourne Gallery from Prince Lichnowski's collection. In the Ca d'oro museum, Venice, are a number of distinguished portraits of Venetian Senators. Tintoretto's unparalleled mastery of the human form is revealed in his drawings of which a volume has recently been published (D. von Hadeln, *Handzeichnungen des Tintoretto*, 1922).

See C. Ridolfi, *Meraviglie dell Arte* (ed. by D. v. Hadeln 1924); Ruskin, *Stones of Venice* (1863); F. Preston Stearns, *The Life and Genius of T.* (1894); H. Thode, *Tintoretto* (Leipzig, 1901); J. B. Stoughton Holborn, *Jacopo Robusti* (1903); E. M. Phillipps, *Tintoretto* (1911); F. P. B. Osmaston, *The Art and Genius of Tintoret* (1915); Ev. d. Becken und A. L. Meyer, *Jacopo Tintoretto* (Munich 1923). (W. M. R.; X.)

TIPASA, a town and commune on the coast of Algeria, in the department of Algiers, 30 mi. W. of the capital. Pop. (1936 census) 845 (town); 3,808 (commune). The modern village, founded in 1857, is a favourite tourist spot, with Roman and Byzantine ruins (the former are more interesting), and summer resort with its beach and pleasant situation, facing across a bay the small summer resort of Chenoua. Plage at the foot of the impressive Chenoua mountain. The Roman ruins are on the western edge of the town. Mosaics of artistic interest may still be excavated. The Byzantine ruins are just to the east of the town. Of the houses, few traces remain, but there are remains of three churches, two cemeteries, baths, theatre, amphitheatre and nymphaeum.

Tipasa was founded by the Phoenicians, was made a Roman military colony by the emperor Claudius, and afterwards became a municipium. Christianity was early introduced, and in the third century Tipasa was a bishop's see. In 484 the Vandal king Huneric (477–484) sent an Arian bishop to Tipasa; whereupon a large number of the inhabitants fled to Spain, while many of the remainder were cruelly persecuted. After this time the city disappears from history.

See S. Gsell, *Promenades archéologiques aux environs d'Alger* (1926);

Id. *Les monuments antiques do l'Algérie*, 2 vol. (1901); Id. *Atlas Archéologique de l'Algérie* (1911).

TIPPERA, a district of Pakistan, in the Chittagong division of Bengal. Area, 2,531 sq mi.; pop. (1941) 3,860,139. The administrative headquarters are at Comilla, pop. (1941) 48,462. The district has a flat and open surface, with the exception of the isolated Lalmai hills (100 ft.), and is for the most part laid out in well-cultivated fields, intersected by rivers and creeks. The principal rivers are the Meghna, or estuary of the Brahmaputra, Gumti, Dakatia and Titas.

Tippera formed part of the Tripura state (*q.v.*) till 1733 when it was conquered and annexed to the Mogul empire by the nawab of Bengal. When it came under the East India company in 1765, more than a fifth of its modern area was under the immediate rule of the raja of Tripura, who paid a tribute of ivory and elephants.

In 1860 there was a raid by the Kukis or Lushais, who burned down 15 villages, killed 185 persons, and carried off 100 prisoners.

TIPPERARY, a county of Ireland in the province of Munster, bounded northwest by Galway, northeast by Offaly county, east by Leix county and Kilkenny, south by Waterford and west by Cork, Limerick, Clare and Galway. The county is the sixth in size of the Irish counties, having an area of 1,051,292 ac., or about 1,643 sq.mi. Pop. (1946) 136,014. Sandstone heights stand out above the limestone plain. The Knockmealdown mountains on the southern border reach an elevation of 2,609 ft To the north of this range are the Galty or Galtee mountains (Galtymore 3,018 ft.). To the east, bordering Kilkenny, are the Slieveardagh hills, and near Templemore the Devil's Bit mountains (1,577 ft.) with a curious gap on the summit. In the northwest is Keeper hill, 2,278 ft. The folded character of the Carboniferous limestone is seen in the anticlinal hoss on which stands the acropolis of Cashel. The Suir has its source in the Devil's Bit mountains, and flows southward and eastward by Templemore, Thurles, Caher and Clonmel. The Nore, which also rises in the Devil's Bit mountains, soon passes into Leix county, and the Shannon forms part of the western border. The Mitchelstown stalactite caverns were discovered accidentally in 1833. They are in the extreme southwest of the county, take their name from the neighbouring town of Mitchelstown, 6 mi. distant in County Cork, and were explored by M. Martel in 1895.

Tipperary is one of the counties generally considered to have been formed by King John in 1210; in 1328 Edward III made it a county palatine in favour of the earl of Ormonde; and, though the king shortly afterward resumed his regal prerogative, the county was regranted in 1337. In 1372 the grant was confirmed to James Butler, earl of Ormonde, the lands belonging to the Church retaining, however, a separate jurisdiction, and being known as the county of Cross Tipperary, or the Cross of Tipperary. In 1621 James I took the county palatine into his own hands. It was, however, restored in 1664 to James, 12th earl and 1st duke, whose regalities were further made to include the county of the Cross. On the attainder of James, 2nd duke, in 1715, the jurisdiction reverted to the Crown, and the last Irish palatinate thus ended.

The subsoil in the lower grounds is limestone, which is overlaid by a rich calcareous loam. The Golden Vale, the most fertile district in Eire, stretches from Cashel to the town of Limerick. There is some mining. The lead ore mined for many centuries at Silvermines south of Nenagh is silver-bearing and is associated with zinc blende. Indications of ore have been traced along the junction of the limestone with the older rocks. Good slates are quarried in the Silurian area in Clashnasmuth townland on Slievenaman. There is a considerable number of meal and flour mills.

Communications are supplied by the Great Southern railway, the main line of which crosses the county from northeast to southwest by Templemore and Thurles. The Ballybrophy (Leix County) and Limerick branch from this line serves the north of the county by Roscrea (junction for Birr) and Nenagh. The Waterford and Limerick line passes through the south of the county by way of Clonmel and Tipperary, crossing the main line at Limerick junction. The two lines are also connected by the Thurles, Fethard and Clonmel branch.

The county has benefitted considerably from the electric power stations built along the lower Shannon. The administrative counties of Tipperary North Riding and Tipperary South Riding together return seven members to Dáil Eireann.

TIPPERARY, a town of County Tipperary, Ireland, near the Sleve na muck or Tipperary hills, a branch of the Galtee range, on the Great Southern railway, 3 mi. S.E. of Limerick Junction and 109 S W. of Dublin. Pop (1946) 5,267. Its butter market ranks next to that of Cork. Condensed milk is manufactured The town first acquired importance through the erection of a castle by King John, of which there are no remains. A monastery founded for Augustinians by Henry III gave a second impulse to its growth. The gatehouse is all that remains of this foundation Formerly Tipperary was a corporation from a grant made in 1310 by Edward II New Tipperary was founded outside the town in 1890.

TIPTON, a municipal borough (1938) mainly in the Wednesbury parliamentary borough, Staffordshire, England, 2 mi. N E. of Dudley. Pop (est. 1938) 36,980 Area 3.3 sq mi. It has an extensive trade in iron, especially heavy forgings and castings, and there are important coal mines. Much attention has been given to slum clearance. The modern town sprang up around Tibbington, mentioned in Domesday.

TIPU SAHIB (1750–1799), sultan of Mysore, son of Hyder Ali (*q.v.*), was born in 1750. He was instructed in military tactics by French officers in the employment of his father. In 1767 in the invasion of the Carnatic he commanded a corps of cavalry and fought against the Marathas on several occasions between 1775 and 1779. On the outbreak of the second Mysore War in 1780 he was put at the head of a large body of troops and defeated Brathwaite on the banks of the Coleroon in Feb. 1782. He succeeded his father in Dec 1782, and in 1784 concluded peace with the British and assumed the title of sultan. He subjugated the Nairs of Malabar in 1787–88 and in 1789 provoked British invasion by ravaging the territories of the rajah of Travancore. When the British entered Mysore in 1790, he retaliated by a counterinvasion, but was compelled by Cornwallis's victory near Seringapatam to cede half his dominions (March 16, 1792). When the British renewed hostilities in March 1799 he was shut up in Seringapatam and killed during the storming (May 4, 1799).

See L. B. Bowring, *Haidar Ali and Tipu Sultan* (Oxford, 1893); Mark Wilks, *Historical Sketches of the South of India*, 3 vol. (London, 1810–17).

TIRAH, a mountainous tract of country on the Peshawar border of the North-West Province of India. It lies between the Khyber pass and the Khanki valley and is inhabited by the Afridi and Orakzai tribes. It is chiefly notable as the scene of the Tirah campaign of 1897. It is a cul-de-sac in the mountains, lying off all the roads to India, and comprises an area of some six to seven hundred square miles and includes the valleys lying round the source of the Bara river. The five chief valleys are Maidan, Rajgul, Waran, Bara, Mastura. The chief passes are Sampagha pass (6,500 ft.), separating the Khanki valley from the Mastura valley; the Arhanga pass (6,995 ft.), separating Mastura valley from Maidan; Saran Sar (8,650 ft.), leading from the Zakka Khel portion of Maidan into the Bara valley; the Tseri Kandao (8,575 ft.), separating Maidan from the Waran valley; and the Sapri pass (5,190 ft.), leading from the east of the Mastura valley into the Bara valley in the direction of Mamanai. The whole of Tirah was thoroughly explored and mapped at the time of the Tirah campaign.

Tirah Campaign, an Indian frontier war in 1897–98. The Afridis had for 16 years received a subsidy from the Indian government for the safeguarding of the Khyber pass, in addition to which the government had maintained for this purpose a local regiment entirely composed of Afridis, who were stationed in the pass. Suddenly, however, the tribesmen rose, captured all the posts in the Khyber held by their own countrymen and attacked the forts on the Samana ridge near Peshawar. It was estimated that the Afridis and Orakzais could, if united, bring from 40,000 to 50,000 men into the field. The preparations for the expedition occupied some time, and meanwhile the Mohmand rising northwest of the Khyber pass was first dealt with.

The general commanding was Gen. Sir William Lockhart (*q v.*), commanding the Punjab army, he had under him 34,882 men, British and native, in addition to 20,000 followers. The frontier post of Kohat was selected as the base of the campaign, and it was decided to advance along a single line. On Oct 18 the operations commenced, fighting ensuing immediately. The Dargai heights, which commanded the line of advance, were captured without difficulty, but abandoned owing to the want of water. On the 20th the same positions were gallantly stormed by the Gordon Highlanders and 3rd Sikhs, with a loss of 199 killed and wounded. The progress of the expedition, along a wretched track through the mountains, was obstinately contested on Oct 29 at the Sampagha pass leading to the Mastura valley, and on the 31st at the Arhanga pass from the Mastura to the Tirah valley. The force, in detached brigades, now proceeded to traverse the Tirah district in all directions, and to destroy the walled and fortified hamlets of the Afridis. The two divisions available for this duty numbered about 20,000 men. A force about 3,200 strong, commanded by Brig.-Gen. Westmacott, was first employed to attack Saran Sar, which was easily carried, but during the retirement the troops were hard pressed by the enemy and the casualties numbered sixty-four. On Nov. 11 Saran Sar was again attacked by the brigade of Brig.-Gen. Gaselee. Experience enabled better dispositions to be made, and the casualties were only three. The traversing of the valley continued, and on Nov 13 Brig.-Gen. Kempster's brigade visited the Waran valley via the Tseri Kandao pass. Little difficulty was experienced during the advance, and several villages were destroyed; but on the 16th, during the return march, the rearguard was hotly engaged all day and had to be relieved by fresh troops next morning. The casualties numbered seventy-two. Almost daily the Afridis, too wise to risk general engagements, waged a perpetual guerrilla warfare, and the various bodies of troops engaged in foraging or survey duties were constantly attacked. On Nov. 21 a brigade under Brig.-Gen. Westmacott was detached to visit the Rajgul valley. The road was exceedingly difficult and steady opposition was encountered. The objects were accomplished, and the casualties during the retirement alone numbered twenty-three. The last important work undertaken was the punishment of the Chamkannis, Mamuzais and Massozais. This was carried out by Brig.-Gen. Gaselee, who joined hands with the Kurram movable column ordered up for the purpose. The Mamuzais and Massozais submitted immediately, but the Chamkannis offered resistance on Dec. 1 and 2, the British casualties numbering about thirty. The Kurram column then returned to its camp, and Sir W. Lockhart prepared to evacuate Tirah, despatching his two divisions by separate routes—the 1st under Maj.-Gen. W. Penn Symons to return via the Mastura valley, destroying the forts on the way, and to join at Bara, within easy march of Peshawar; the 2nd division under Maj.-Gen. Yeatman Biggs, and accompanied by Sir W. Lockhart, to move along the Bara valley. The base was thus to be transferred from Kohat to Peshawar. The return march began on Dec 9. The cold was intense, 21 degrees of frost being registered before leaving Tirah. The movement of the 1st division though arduous was practically unopposed, but the 40 miles to be covered by the 2nd division were contested almost throughout. The actual march down the Bara valley (34 miles) commenced on the 10th, and involved four days of the hardest fighting and marching of the campaign. The road crossed and recrossed the icy stream, while snow, sleet and rain fell constantly. On the 10th the casualties numbered about 20. On the 11th some 50 or 60 casualties were recorded among the troops, but many followers were killed or died of exposure, and quantities of stores were lost. On the 12th the column halted for rest. On the 13th the march was resumed in improved weather, though the cold was still severe. The rearguard was heavily engaged, and the casualties numbered about sixty. On the 14th, after further fighting, a junction with the Peshawar column was effected. The 1st division, aided by the Peshawar column, now took possession of the Khyber forts without opposition. Negotiations for peace were then begun with the Afridis, who, under the threat of another expedition into Tirah in the spring, at length agreed to pay the fines and to surrender the rifles demanded. The expeditionary force was broken up on April 4, 1898. A memorable feature of this campaign was the presence in the fighting line of the imperial service native troops under their own officers, while several of the best known of the Indian princes served on Sir W. Lockhart's staff. (C. J. B.)

TIRANA, the capital of Albania, lies at the southern end of the plain of Kroya (Albanian *Kruja*). The population of the town including troops as well as civilians in 1930 was 30,806. Nearly three-quarters of the total are Muslims, and the remainder divided between Orthodox and Roman Catholics. Tirana is beautifully situated at the foot of the richly wooded highlands inhabited by the Mirdite Albanians. It is a picturesque town, with many mosques, gardens and olive groves.

Tirana was founded early in the 17th century, and was long the seat of a Greek bishop, although the majority of its inhabitants are Muslims. It was occupied by Italy in 1939.

TIRARD, PIERRE EMANUEL (1827–1893), French politician, was born of French parents at Geneva on Sept. 27, 1827. In 1869 he was elected mayor of the 11th arrondissement of Paris and deputy for the Seine. In 1871 he sat among the extreme Left in the National Assembly at Versailles. In 1876 he was returned for the 1st arrondissement of Paris to the Chamber of Deputies. He held office in a series of ministries between 1870 and 1885, and when Carnot became president of the Republic in 1887 he asked Tirard to form a ministry. He had to deal with the Wilson scandal which had led to President Grévy's downfall, and with the revisionist agitation of General Boulanger. His refusal to proceed to the revision of the constitution of 1875 led to his defeat on March 30, 1888. He returned to power next year, and decided to bring Boulanger and his chief supporters before the High Court, but Boulanger fled. He also arrested Philip, duke of Orleans, who had visited France in disguise. He resigned office on March 15, 1890 on the question of the Franco-Turkish commercial treaty. He replaced M. Rouvier in the Ribot cabinet (1892–1893) as minister of finance, and died in Paris on Nov. 4, 1893.

TIRE (RUBBER) MANUFACTURE: *see* TYRE.

TIRHUT, a division of British India, in Bihar, situated between Nepal and the Ganges. The name was formerly applied only to a single district, which in 1873 was divided into the two districts of Darbhanga and Muzaffarpur. In 1908 the four northern districts of Darbhanga, Muzaffarpur, Saran and Champaran were detached from the Patna division and formed into a new division, to which the name of Tirhut was officially given. Total area, 12,594 sq mi.; total pop. (1941) 11,959,827. It is a continuous alluvial plain, traversed by many rivers and supporting a dense population. Tirhut is a corruption of Tirabhurti, meaning the river-side country, a name which has been found on seals of the 4th or 5th century A.D., discovered at Basarh in Muzaffarpur district. In its present limits it corresponds roughly with the ancient kingdom of Mithila (*q.v.*).

TIRIDATES or TERIDATES, a Persian name, given by Arrian in his *Parthica* (preserved by Photius, *cod.* 58, and Syncellus, p. 539 *seq*) to the brother of Arsaces I., the founder of the Parthian kingdom, whom he is said to have succeeded. But Arrian's account seems to be quite unhistorical. (*Cf.* PARTHIA.)

The king commonly called TIRIDATES II. was set up by the Parthians against Phraates IV. in 32 B.C., but expelled when Phraates returned with the help of the Scythians (Dio Cass. li 18; Justin xlii. 5 *seq* ; *cf.* Horace, *Od.* i. 26). Tiridates fled to Syria, where Augustus allowed him to stay, but refused to support him. During the next years Tiridates invaded Parthia again; some coins dated from March and May, 26 B.C., with the name of a king "Arsaces Philoromaios," belong to him; on the reverse they show the king seated on the throne, with Tyche stretching out a palm branch towards him. He was soon expelled again, and brought a son of Phraates into Spain to Augustus. Augustus gave the boy back to his father, but declined to surrender "the fugitive slave Tiridates" (Justin xlii. 5; Dio liii. 33; cf. *Mon. Ancyr.* 5, 54; in li. 18 Dio wrongly placed the son's surrender in 30 B.C.).

TIRIDATES III., grandson of Phraates IV, lived as a hostage in Rome and was educated there. When the Parthians rebelled against Artabanus II. in A.D. 35 they applied for a king to

Tiberius, who sent Tiridates. With the assistance of L. Vitellius Tiridates entered Seleucia, but could not maintain himself long (Tacitus, *Ann.* VI. 32 *sqq.*; Dio Cass. lvii. 26). (Ed M.)

TIRLEMONT (Flemish *Tʼienen*), a town in the province of Brabant, Belgium, 11 mi. S.E. of Louvain. Pop. (1939) 22,092. It still preserves its enceinte, 6 mi. in circumference. The principal church, Our Lady of the Lake, begun in the 12th century and enlarged in the 15th, is still unfinished. The church of St. Germain, also 12th century, contains a fine altar-piece by Wappers.

TIRMIDHI [Abū ʻIsā Mohammed ibn ʻIsā ut-Tirmidhi] (d. 892), Arabian traditionalist, was born at Tirmidh on the Jihūn. He travelled through Khurasan, Iraq and Hejaz. His *al-Jāmʻ us-Sahih* (published at Bulaq, 1875) is one of the six canonical collections of traditions. He included every tradition that had ever been used to support a legal decision. He also wrote the *Kitāb ush-Shamāʼil* (printed at Calcutta, 1846) on the character and life of Mohammed.

TIROL or Tyrol, an Austrian province, seized by Germany in 1938 and incorporated into the *gau* of Tirol-Vorarlberg, with an area of 5,007 sq.mi. It is almost wholly mountainous. Three distinct lithological belts exist. The northern third of the country is a limestone zone, including the Lechtal and N. Tirol Alps, which forms a series of parallel ranges that sink from heights exceeding 9,000 ft. (Parseier Spitz—9,963 ft.) northwards and eastwards. The porosity of this rock and the resultant steep slopes hinder tree growth and cultivation, so that more than half is either poor pasture or barren land. Only on old glacial deposits in the valleys do conditions improve and the deep groove of the Inn valley is therefore a striking contrast. Although the unifying thread of the human life of the province, it is throughout its longitudinal course a geological boundary and is floored with mixed débris derived from the flanking limestone to the north and the crystalline or schistose belts to the south As a result there is on its alluvial fans and drained lower terraces an intensive cultivation, helped by the *föhn* winds, and a number of settlements; nevertheless, the chief interests of its inhabitants are pastoral. In the cultivated districts maize, rye and fruit predominate in the west, rye and wheat in the lower valley.

South of the Inn valley, the twofold crystalline zone of the Central Alps appears, part granite and gneiss, part schist and slates, forming the main chain and including from west to east the glaciated Ötztal, Stubai and Zillertal Alps, and continues east of the transverse course of the river in the lower, unglaciated, slaty Kitzbühl Alps. In this zone *Almen* or summer mountain pastures, often above the tree line, dominate human life, 50% of the productive surface being so utilized, and numbers of cattle are exported to South Germany both for breeding and killing. Horse breeding, too, is common, the favourite breed being the Noric type for farm and other hard work. Forestry is not so important here as in the limestone zone where some 60% of the productive surface is forested, while, generally, methods are less scientific than elsewhere in Austria.



TOBLACHER SEE, IN THE VALLEY OF THE RIENZ, ONE OF THE MANY BEAUTIFUL LAKES IN TIROL

Industries.—Once an important mining centre for copper and rare metals, Tirol later raised only 1½% of the annual Austrian output. Salt takes first place and is worked at Hall, being conducted in the form of brine by a leat from the Salzberg, 5½ mi. distant. The raising of lignite, zinc ores (Imst), and oil shale (Kufstein), and the preparation of cement (Lower Inn valley) complete the list of important mineral interests.

In the development of manufactures Tirol is aided by its rich supplies of water power. Large electrical power stations exist at Landeck, Matrei, Wiesberg, etc., in some cases associated with the extraction of aluminium and the preparation of calcium carbide. Cotton manufacturing has spread across from Vorarlberg (*q.v.*) to the Western Tirol, woollen goods are important in Innsbruck and the Ziller valley, paper, wood pulp and cellulose works are found near and along the Inn, while small iron goods and metal wares are widely manufactured, the former in the Stubai valley, the latter principally at Innsbruck and Schwaz; in addition saw mills and breweries are widespread.



AUSTRIAN TIROL BOY

Population.—The population of Tirol-Vorarlberg (487,667 in 1939) is almost entirely German in speech, Roman Catholic, and advanced in education, having at Innsbruck (*q.v.*) one of the three universities of Austria. The greatest density of settlement is found along the great longitudinal trade route of the Inn, with a concentration at Innsbruck, where it is crossed by the transverse route from Germany to Italy by the Brenner Pass. The limestone zone is very scantily peopled in contrast to the well-watered crystalline belt on which isolated farms and small towns in the valleys are more common. The old isolation of these mountain valleys is fast disappearing under the swelling annual tide of tourists and, with its passage go many of the old customs and picturesque peculiarities of costume. The province had a large measure of local autonomy, centred at Innsbruck, but soon after Hitler's seizure of Austria in March 1938 a centralized administration was placed in the hands of a National Socialist district leader (*Gauleiter*) and governor (*Reichsstatthalter*).

See *Austria*; A. Steinitzer, *Geschichtliche und Kulturgeschichtliche Wanderungen durch Tirol und Vorarlberg* (Innsbruck, 1905), and M. Steinitzer, *Das Land Tirol* (Vienna, 1923). (W. S. L.; X.)

HISTORY

In 15–14 B.C. the country, later known as the Tirol, then inhabited by the Rhaetians (probably a Celtic race), was conquered by Drusus and Tiberius. The frontier of Italy was then advanced to a line running approximately from Gargazon to the Klausen Pass, the country north of this being organized into the province of Rhaetia. After 500 years of Roman rule, during which the country was probably almost completely Romanized, it fell a prey to the Teutonic invasions. The rich valleys of the upper Adige were colonized by Ostrogoths, from whom the present inhabitants are descended. A little later the Germanic Bajuvarii conquered and occupied the whole northern district, which was quickly Germanized. The Lombards, who entered the country almost simultaneously from the south, establishing a duchy in Trent, came in smaller numbers, and were absorbed in the Latin population; from this difference sprang the later ethnographical and political controversy. Lombardy became part of the Frank empire of the Carolingians in A.D. 774, Bavaria definitively in 788, but the Imperial administrative system developed with time into the feudal rule of semi-independent counts In 1004 the emperor Henry II. granted the county of Trent to the bishop of Trent. In 1027 Conrad II. enlarged this fief by the counties of Bozen and Vintschgau, bestowing the counties north of this line on the bishop of Brixen.

Unable themselves to exercise temporal authority, the bishops delegated their governmental powers to lay lords. The most powerful of these was a family deriving its name from the castle of Tirol, near Meran, who as early as 1150 were counts and bailiwicks of Trent, acquired extensive lands from the bishop of Brixen in 1248, and by 1271 had practically replaced the ecclesiastical power by their own throughout Tirol. This family became extinct with the famous Margaret Maultasch, and Tirol passed by arrangement to Duke Rudolph IV. of Austria (1363). From this date until 1918 Tirol formed part of the Habsburg monarchy. At first Tirol was held as an appanage of a junior branch of the family, but was finally united with the main Austrian possessions in 1665.

Tirol's geographical situation, the highway over the Brenner from northern to southern Europe, and the Arlberg route from east to west meeting at Innsbruck, gave it a great strategic importance, since command of the Brenner dominates the gate to Italy. Tirol was therefore frequently the theatre of severe fighting. Its sturdy population, however, guarded its liberties well. The spread of Protestantism in Germany occasioned a great peasants' rising in 1525, which forced concessions from the emperor. Although the Counter-Reformation afterwards made of Tirol the most wholly Catholic of all Austrian crownlands, the estates (in which, alone in Austria, the peasants were represented), always preserved an unusual degree of liberty, and Tirol always cherished a strong feeling of unity and local patriot- [illegible] definitely to Bavaria, the revolt was ruthlessly crushed by weight of numbers. Hofer was arrested, and finally shot at Mantua by Napoleon's express order (Feb. 10, 1810). The Treaty of Paris (1814) reunited Tirol and restored it to Austria



[illegible]

COSTUME OF THE PUSTERTAL

The South Tirol Question.—During World War I the valleys of the South Tirol were the scene of fierce fighting, and the Tirolese poured forth their blood and their money in defence of the Habsburg monarchy Nevertheless they were doomed to suffer even more severely at the hands of the victorious Allies than did their Austrian rulers. An irredentist agitation for the annexation of the Italian-speaking Trentino had begun in Italy even before 1848, growing stronger as time went on From the commencement of the war the Italian Government negotiated with both Austria and the Allies for a price for the co-operation of Italy in the struggle The Austrian cabinet agreed to cede the Trentino, but refused to yield to any further Italian demands. Italy therefore concluded the Treaty of London (May, 1915) with the allied powers by which she was promised, among other rewards, the Brenner frontier, which she claimed on strategical grounds. The Treaty of St Germain (*q.v.*) handed over to Italy not only the Italian-speaking Trentino but also the Upper Adige, inhabited by a population of purely German origin and speech, and numbering about 215,000 souls. As there were some 13,500 Germans in the Trentino, the total German population included within the new Italy amounted to approximately 229,000 This departure from the principle of national self-determination elicited strong but fruitless protests from the Tirolese communes. That a miscarriage of justice had been committed was subsequently acknowledged by one—President Wilson—of the statesmen responsible for it. If Italy could put forward a case for her acquirement of the Brenner frontier, based on strategical necessity, she could not honestly advance any racial or political claims to the Upper Adige; nor, indeed, did she advance such claims until the advent of the Fascist Government.

At the Peace Conference, Italy was not required to sign any treaty safeguarding the rights of minorities within her frontiers. (*See* MINORITIES.) Signor Tittoni, however, on December 27, 1919, declared publicly that Italy was under a moral obligation to apply the provisions of the Minorities Treaties towards her own minorities. Similar declarations were made on several occasions by responsible Italian statesmen, and the policy of the Italian Government towards their new subjects was at first not illiberal. Unhappily, both for Italy and the German minority itself, this policy was abandoned by the Fascists in favour of one of Italianization, inaugurated in July 1923—a policy that succeeded only in arousing a spirit of intense resentment and irredentism among the liberty-loving Tirolese. During Mussolini's war against Abyssinia many Tirolese fled secretly into Austria or Germany to escape military service. In 1939, Hitler and Mussolini negotiated an agreement by which most of the Tirolese under Italian rule were transplanted to Germany.

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(I. F. D. M.; X.)

TIRPITZ, ALFRED VON (1849–1930), German admiral, was born on March 19, 1849, at Kustrin, the son of a high Prussian magistrate, and in 1865 he entered the Prussian navy, the training for which followed the British model. In 1869 he became an officer, in 1888 postcaptain; in 1895 rear-admiral, in 1899 vice-admiral; in 1903 admiral; in 1911 Admiral of the Fleet. In 1897 he became secretary of state for naval affairs, and then, to his regret, had no further chance of practical service at sea. On March 15, 1916, for political reasons, he resigned all his offices.

From his 29th year he was employed only in important positions of organisation or leadership His creative talents were first utilised when torpedoes developed into an arm suitable for war, in building torpedo boats and in working out a tactical system for their mass employment. His work during this period proved of great value to him later when constructing a fleet of great battleships Here, and in constructing the fleet, he accomplished model work with a minimum of expense. After practical service at sea as captain, he became chief of staff of the Supreme Naval Command in 1892, and began the preliminary work for his plan of fleet construction by profound studies in the history and practice of naval warfare. The idea of the offensive use of arms was the guiding note of all Tirpitz's work. His memoranda, designed to educate the naval officers in modern ideas of their profession, fell into British hands and in this way influenced British tactical ideas also. He combined practical operations with model squadrons of useless ships with the elaboration of his tactical ideas. Simultaneously with this went on the transformation of the modern ship of war, with its technical complications, into an apparatus which worked with mechanical perfection He encouraged the education of crews to independent action in all emergencies. His tactical memorandum, No. 9 (printed in *Nauticus, Jahrbuch für Deutschlands Seeinteressen*, 1926), afterwards served to convince the reluctant Reichstag of the necessity of forming a German fleet according to definite laws

General Policy.—As a statesman, Tirpitz aimed at securing the growing maritime interests of the German people. He felt the building of a fleet to be a necessity and no luxury, since it made Germany a more acceptable ally and helped to create a sort of balance of power at sea. He considered that it was an economic and a social necessity that the working German people should gain greater independence from all political eventualities. He further saw in Germany the power of the future on which the smaller European powers might lean at sea. In view of the formation of great self-sufficient economic units in the world, he probably considered his ideas to be a consistent continuation of Bismarck's train of thought, and perhaps thought of a kind of economic Pan-Europa under a wise German leadership.

Tirpitz opposed the suggestion that Germany might annex Holland, one reason being that he was always anxious to spare the small Nordic states. He would also have been prepared to make the Danes concessions in Schleswig in order to win their friendship, and was anxious for Italy to have a considerable fleet. Tirpitz never asked for war and always believed that a war could only interrupt Germany's rise, but he supported a rapprochement with Russia as Bismarck wished it, and a German-Russian-Japanese understanding. He disapproved of the German Baghdad policy because it infringed simultaneously on the Russian and British spheres of influence. He was against irritating America in any way and disapproved both of the German intervention in Manila and of the British-German blockade of Venezuela. Moreover he saw clearly that in forming Germany into a sea power he would have to reckon with the opposition of Great Britain. He believed firmly, however, that it must be possible, if Germany proceeded with caution, to pass through the danger zone of the time of fleet construction without war, and that, finally, an honest understanding between Germany and Great Britain could only be advanced if Germany was a real power on sea as on land. Summing up British psychology and British love for everything straight and strong, he reckoned that Germanic England, whose statesmanship and power at sea he rated very highly, would in the end prefer a rapprochement with a strong Germany to any other political combination. It was only unwillingly and with hesitation that he adopted "the idea of risk" aimed at Great Britain in his naval estimate of 1900.

Even after the outbreak of the World War, Tirpitz did not change his opinion that, taking all in all, the rapprochement between Germany and Britain was advanced rather than hindered by the construction of the fleet, and that only the outbreak of the War, which was most unwelcome to him, had prevented the last maturing of his political aims. His naval programme always aimed at leaving Britain a *sufficient superiority*. He considered that the formula of the respective strengths of three to two suggested by Lloyd George, which Churchill later, although with reservations, altered to 16 to 10 or eight squadrons to five, gave Britain sufficient protection against aggressive German intentions.

The Naval Programme.—In organising the construction of the German fleet, Tirpitz thought out each step to its last consequences. He refused flatly to construct the greater cruiser fleet which the Emperor was anxious to have when he was appointed secretary of state, in view of the experience of the past with cruiser warfare and the lack of German foreign bases His aim was and remained the formation of a battle fleet. His naval estimates carefully avoided votes for new constructions of ships which depended on the momentary humour of the deputies. He aimed at securing legal authority for the number of ships of the fleet to be built, for their regular replacement and maintenance. Inevitably a certain stiffness thus came into the naval programme, which was at times a little inconvenient during the critical years. Tirpitz feared that his successor would abandon important principles of his programme. He believed that the diplomats did not grasp the real idea of his programme The squadron of eight ships as a tactical unit was the base of his naval programme. The first law of 1898 approved a double squadron of ships of the line with the necessary cruisers. The law of 1900 doubled the battle fleet. Supplementary laws of 1904, 1906 and 1908 reduced the maximum age of ships and thereby altered the plan of new construction. The foreign cruiser fleet and the torpedo-boat forces were increased, and account was taken of the British dreadnought programme. The Kiel Canal was widened to take battleships. The supplementary bill which Tirpitz introduced after Agadir in 1912 only increased the number of ships to be constructed by a little, but increased the strength of the active fleet. The supplementary law of 1912 was to be the last bill of the naval programme. The fleet of 1920 was to consist of one flagship of the fleet, five squadrons of battleships of eight ships each, 12 cruisers for home service, eight large cruisers for foreign service and 40 small cruisers, including 10 for foreign service Three squadrons of ships of the line with the necessary cruisers were to be always ready as a battle fleet. His construction programme was reduced after the negotiations with Haldane in 1912, and only provided for three new ships to be distributed over several years. Taking 61 great battleships and a life of 20 years, three large ships would be launched regularly every year on this plan.

If Britain had really recognised German sea-power, Tirpitz would probably have agreed to some arrangement on the lines of the later Washington agreement of 1922, dealing with the proportionate strength of the two Powers Tirpitz only became deeply interested in the construction of submarines after the Diesel engines were perfected for service in 1908. The ultimate strength of submarines was then fixed at 72 There was never any idea of mercantile submarine warfare. Tirpitz considered the battle fleet to be the best protection for the extensive German coast line, and spent little money on its fortification. But he modernised Heligoland, and expanded it into a fortified harbour. Parallel with the construction of the fleet, the state wharves were systematically expanded and grew to be industrial implements of the first order.

Political Relations.—Tirpitz's relations with the Emperor were peculiar. The Emperor could not do without him to organise the expansion of the fleet, although not really liking his rather stiff manner. Tirpitz energetically opposed fantastic plans of naval construction. He often was hampered by William II.'s political ways, but so long as he controlled the construction of the fleet he held firmly to his real aim Tirpitz was a convinced Monarchist and remained so after the War Up to the outbreak of the World War, Tirpitz enjoyed a steadily increasing popularity. The circle of his real co-workers and collegues was, however, always small. The number of his personal friends was even smaller. He was a good judge of men and exploited the special talents of his subordinates ruthlessly. He himself always retained his wide general view and never lost himself in details. In the corps of naval officers his aims were not always fully understood. He probably never revealed his ultimate aims to any of his friends, and, like all great men, was often compelled to stand alone. He was careful to keep up relations with deputies and with the press. He recognised very early the importance of publicity. Before the War Tirpitz exercised but little influence on the Admiralty staff But he controlled the construction of the ships. The orders to the fleet and army at the outbreak of War were not known to him. Before the War he purposely paid little attention to the mobilization plans of the fleet.

In politics Tirpitz seldom played an active part. He knew nothing of the British offer of an alliance at the close of the 19th century. Although he offered his advice to the chancellor von Bethmann Hollweg he was not consulted when important political measures were taken; for example, when a cruiser was sent to Agadir in 1911. At the end of 1911, he could have become chancellor of the Reich, but he never desired this office During the critical time of Lord Haldane's visit in 1912, Tirpitz stated that he would have given up his supplementary naval estimate completely for a real neutrality agreement with Britain. He did not entirely approve of the measures taken by the German Government after the murder in Sarajevo (1914) and was for avoiding the threatened war at all costs. Tirpitz did not share the opinion that Britain would stand out of the war, and foresaw that the sympathies of America would be on the side of Britain. He was in favour of a short war, and for putting the German fleet to a decisive battle. He believed that the intervention of America would in any case prevent a complete victory, but thought that if Germany exercised all her forces, the German Reich could remain a really great power, and at the worst acknowledge defeat whilst her forces were still unexhausted He was also against any form of annexation but was only anxious lest the Belgian coast should pass into the possession of Britain. In general, he saw the War as the last struggle of freedom against the world capitalism of the Anglo-Saxons.

At the beginning of the War Tirpitz offered to take over the entire control of the navy, including the military control, but this was refused. His advice was hardly listened to by the politicians and hardly ever taken. The naval battle for which he wished was not fought. He early recognised the importance of the new

U-boats for the issue of the War, but was against employing U-boats too early in the commercial War, and named the spring of 1916 as the right moment. He disapproved of the attitude of the German Government during the exchange of Notes with America on the occasion of the sinking of the "Lusitania" and the "Sussex," regarding it as weak. Tirpitz was not implicated in the declaration of the U-boat warfare in 1917, and later stated that had he guessed Russia's coming collapse and known of President Wilson's efforts for peace, he would probably have used his influence against U-boat warfare in 1917.

Post-War Activities.—After leaving his post in 1916, Tirpitz entered politics and helped to found the *Vaterlandspartei;* and from 1924 to 1928 was a Nationalist member of the Reichstag. He supported the Dawes Plan but opposed the Locarno Pact, feeling that co-operation with Great Britain and the United States was more important than *rapprochement* with France. He died at Eberhausen, near Munich, on March 6, 1930.

See article in Nov. 1925 issue of *Sud-deutsche Monatshefte* on attempts at a naval agreement with Great Britain, and Ulrich von Hassel, *Admiral von Tirpitz.* For his own statement of the case see his *Erinnerungen* (1918) and *Politische Dokumente; der Aufbau der deutschen Weltmacht* (1924). (C. Hol ; X.)

TIRSO DE MOLINA, the pseudonym of Gabriel Tellez (1571–1648), Spanish dramatist. Born at Madrid, he professed in the Order of Mercy on Jan 21, 1601. Sent by his superiors on a mission to the West Indies in 1615, he returned to Europe in 1617, and resided at the Mercenarian monastery in Madrid. His first publication, the incomplete *Cigarrales de Toledo* (1621?), is a miscellany, containing short tales, novels, verses and three plays; one of the novels, *Los Tres maridos burlados,* probably derived from Il Cieco da Ferrara's *Mambriano,* and the play entitled *El Vergonzoso en palacio* are admirable examples of witty contrivance. The preface to the *Cigarrales de Toledo* (the second part of which was never printed) states that Tirso de Molina had already written 300 plays, and at this period of his career he was second only to his friend Lope de Vega in popularity He rose to important positions in his order, became superior of the monastery at Trujillo in 1626, was elected later to the posts of reader in theology and *definidor general,* and in May 1632 was appointed chronicler of the Order of Mercy. His *Deleitar aprovechando* (1635) is a devout counterpart of the *Cigarrales de Toledo,* much inferior to its predecessor in interest; a sequel was promised to this collection of pious tales, pious lyrics and *autos,* but, as in the case of the *Cigarrales de Toledo,* the continuation never appeared. A first part of Tirso's plays was published in 1627, the third part (before the second) in 1634, the second and fourth in 1635, and the fifth in 1636 A sixth volume of dramatic pieces, consisting of light comedies, was announced; but the project was abandoned. As official chronicler of his order, Tirso compiled the elaborate *Historia de la merced,* which occupied him till Dec. 24, 1639, and still survives in manuscript, and on Sept. 29, 1645, he became superior of the monastery at Soria. He died there on March 12, 1648.

Only a fraction of his plays have been preserved. In 1624 he had written 300 plays, and in 1634 he stated that he had composed 400 within the previous 20 years; of this immense production not more than 80 plays are in existence Tirso de Molina is universally known as the author of *El Burlador de Sevilla y convidado de piedra,* the piece in which Don Juan is first presented on the stage; but *El Burlador de Sevilla* represents only one aspect of his genius. No less remarkable than his representation of perverse depravity in *El Burlador de Sevilla* is his dramatic treatment of a philosophical enigma in *El Condenado por desconfiado.* Though manifestly attracted by exceptional cases, by every kind of moral aberration, by the infamous and the terrible, his range is virtually unlimited. He reveals himself as a master of historical interpretation in *La Prudencia de la mujer,* and of tragical pathos in *La Venganza de Tamar;* his sympathetic, malicious wit finds dramatic expression in *El Vergonzoso en palacio* and *Don Gil de las calzas verdes,* and the fine divination of feminine character in *Averiguelo Vargas* and *La Villana de Vallecas* is incomparable. Tirso de Molina has neither Lope de Vega's inventive resource, nor his infinite seduction; he has neither Calderon's idealistic visions, nor his golden music; but he exceeds Lope in massive intellectual power and in artistic self-restraint, and he exceeds Calderon in humour, in creative faculty, and in dramatic intuition That his reputation extended beyond the Pyrenees in his own lifetime may be gathered from the fact that J. Shirley's *Opportunity* is derived from *El Castigo del penséque;* but he was neglected in Spain itself during the long period of Calderon's supremacy, and his name was almost forgotten till the end of the 18th century, when some of his pieces were timidly recast by Dionisio Solis and later by Juan Carretero. The renaissance of his fame, however, dates from 1839–42, when an incomplete but serviceable edition of his plays was published. He is now accepted as among the greatest dramatists of Spain

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TIRUPATI, a town of British India, in the North Arcot district of Madras, with a station on the Madras and Southern Mahratta railway, 84 m N.E. of Madras city. Pop (1931), 19,138 It is famous for a temple on the neighbouring hill of Tirumala, 2,500 ft. above the sea, which is one of the most frequented places of pilgrimage in southern India The town is noted for its brass-work and wood-carving.

TIRYNS (Gr. *Tē-rins,* anglicized *ti-rinz*), a prehistoric fortress and afterwards a small Greek city, on an isolated ridge of rock near the east side of the plain of Argos in Peloponnese, about 3 m. from the coast, and from the port of Nauplia There is a railway station close to the site. In Greek legend it was founded by Proetus, brother of Acrisius, king of Argos His successor, Perseus, founded Mycenae some 10 m. further inland. Later, Heracles here served Eurystheus in many "labours," and Tydeus and his son Diomedes held it. After the Dorian conquest (*see* Dorians) Tiryns, like Mycenae, declined as Argos grew; it sent its small contingent to fight at Plataea (*q v*) in 479; but about 460 it was destroyed by the Argives Pausanias (*c.* A D 170) was shown here the "palace of Proetus," and the "chambers of his daughters," and wondered at the "Cyclopean" walls, the *tēlurōs teikhesasa* of Homer *Il.* ii. 559. The same walls in 1884 attracted the attention of Heinrich Schliemann, the excavator of Troy (1871) and Mycenae (1875), who uncovered, with W. Dörpfeld, a prehistoric "palace" remarkable for many points of resemblance to the "House of Odysseus" in the *Odyssey;* but made only a few soundings into the stratified remains under its floors. These were carefully examined from 1908 onward by members of the German Archaeological Institute in Athens, and though their conclusions are not yet fully published, the following outline of the archaeology of Tiryns is assured.

The natural ridge on which Tiryns stands is about 330 yd from north to south, and 112 at widest from east to west; the greater height of its southern half now is mainly due to superstructures. From about 2000 B C. a small unfortified settlement can be traced on, and also around this ridge, with three superposed layers of mud-brick houses; on what was probably the summit (under the later *megaron*) was a remarkable round building, nearly 90 ft. across, also of mud brick but roofed with slates and tiles, probably for some public or official use

About 1600 B C. the southern half of the ridge was heavily fortified with rude but massive walls, to protect a new "palace" of which the plan is obscure (for it lies underneath its successor), but the arts and industries are derived, like those of the contemporary "shaft graves" at Mycenae, from the "Middle Minoan" culture of Crete (*q.v.*). The settlement which it dominated extended some hundreds of feet to south and east of the ridge Communication was by a gateway in the east wall, underneath the later "propylaea." About ½ m. away, on the hill called St. Elias,

cist graves and rock-chambers are found, of various dates, and on the same hill is a ruinous "beehive tomb" like those at Mycenae, Heraeum and Midea, and probably contemporary with them, but nothing has survived from its contents.

The "early palace" perished by violence and was succeeded, about 1300 B.C., by another, which occupied the whole area of the early citadel, and was in turn defended by the massive but rudely-fashioned walls which are now conspicuous. These considerably enlarge the area of the fortress and enclose also the whole of the northern half of the ridge. The latter, however, was not occupied by buildings (except a pot kiln and some workshops) but was levelled upwards with debris as a place of refuge for dependants and their cattle. The same principal entrance, heavily fortified, in the middle of the east side, served both this "lower citadel" and the "upper" section south of it, which was further protected by an inner gate with bolted doors, as at Mycenae, within which a covered porch (*propylaea*) panelled with wood above a stone plinth, gave access to a level outer court occupying the whole of the south end, and sustained by very thick substructures. These contain, on their east and south frontages, the famous "galleries" which served as store rooms in peace, and as casemates in war. As the "later palace" within these fortifications was not itself designed for defence, its construction was slighter, and it has perished above plinth level. Its plan, however, which has attracted the attention of commentators on Homer, since Schliemann's time, is completely traceable. The outer court gives access, through a second porch, to an inner one, about 53 ft. by 70 ft., containing a domestic altar, furnished to east and west by colonnades, and giving access northward through a deep portico with two columns to a vestibule (with three doors outward and one inward) and so to a great hall (which the Homeric name *megaron* is commonly applied). This hall, about 40 ft. by 30 ft., has a central hearth, between four column bases, which supported a roof with some kind of louvre or clerestory to let out the smoke. On the cement floor, which is ornamented with painted panels of octopus and dolphins, a space is marked out between the hearth and the east wall, as the place of honour; but there is neither dais nor any other doorway but that of the vestibule. From the latter a small door leads west to a bathroom, of which the floor is a single limestone slab draining to the main sewer, as at Cnossus (*see* CRETE: *Archaeology: Knossos, Plan*); in this room were found the remains of a clay bathtub.

This "later palace" also perished by violence, and parts of its mud-brick walls were so calcined that at first sceptical scholars acclaimed them as Byzantine, and there was, in fact, a small Byzantine church (now removed), with a graveyard near the south end of the site. As it evidently lay long desolate, little remains of its decorative splendour except fragments of fresco, and of an alabaster frieze inlaid with blue enamel like the *θρῃγκὸς Κυάνεο* of *Od.* vii. 87. The pottery is of degenerate Late Mycenaean style.

The frescoes of the "earlier palace," with rich spiral and floral designs, resemble those of contemporary Cnossus (*L M*, i ii); those of the "later" included a majestic procession of women bearing offerings, an elaborate hunting scene, in which a boar is attacked by hounds and men, and other animals are represented; an assault on a palace, a chariot procession, and bull-baiting gymnastic of the Cnossian kind. A small painted plaque shows the worship of an armed goddess; and a fragment with ass-headed personages may be a masquerade.

To the centuries after the destruction of the palace belong a series of graves with pottery of "geometrical" style, safety pins, and other objects of the Early Iron age. In the 7th century a temple was dedicated to Hera on the site of the Mycenaean *megaron*, and furnished with rude terracotta offerings.

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TISA (Ger. *Theiss*), tributary of the Danube, rises in the north-eastern Carpathian mountains in Ruthenia at a height of about 6,300 ft., and is formed by two streams, the Black Tisa (Cerna Tisa) and the White Tisa (Bílá Tisa) which unite above Rachovo where the mountain valley begins to widen. A few miles below Rachovo the river takes a generally westerly direction and makes a great curve around the Nyirség plateau entering Hungary near the top of the curve and then continuing southwest to Szolnok. From here its course across the Hungarian plain is parallel to the Danube, which it enters near the small plateau of Titel, 20 m. east of Novisad. The winding course is about 870 m. long and the basin, covering an area of 56,600 sq m., is shared by Czechoslovakia, Hungary, Rumania and Yugoslavia. Two of its tributaries, the Szamos and Maros, coming from the impermeable rocks of Transylvania, bring a great volume of water, but these and the main stream quickly lose their velocity on reaching the plain where the fall is less than 3 cm. per km. Two periods of high water occur on the middle and lower Tisa, one in spring due to snow melting, the other in June following the summer rain; to this the Kóros is a big contributor. The spring flood coincides with that of the Danube which, having a quicker flow, dams back the Tisa and causes extensive flooding sometimes felt as far as Szolnok. Huge canalisation and diking works have been undertaken to protect the surrounding lowland. The Tisa is navigable for steamers as far as Szolnok, 197 m., or as far as Tiszafüred, 255 m., depending upon the stage of the water, and for rafts and floating timber almost anywhere. It is joined to the Danube by the Francis Joseph canal and its tributary, the Béga, and is canalised to Titusoara.

See W. D. Hines, *"Report on Danube Navigation"* (League of Nations, Geneva, 1925); R. Milleker, *Mitteilungen der Kommission für Hematkunde: I. Die Hydrologie des Alfold*, and *II Die hydrotechnischen Arbeiten in Alfold* (Debreczen, 1925).

TISCHENDORF, LOBEGOTT FRIEDRICH KONSTANTIN VON (1815–1874), German biblical critic, the son of a physician, was born on Jan. 18, 1815, at Legenfeld, near Plauen, in the Saxon Vogtland. He was educated at the gymnasium of Plauen and the university of Leipzig, where he qualified as a lecturer in 1840 with a dissertation on the recensions of the New Testament text. These studies convinced him of the absolute necessity of new and exacter collations of mss. From October 1840 till January 1843 he was in Paris, studying in the great library, eking out his scanty means by working for other scholars and for the publisher Didot. The great triumph of these laborious months was the decipherment of the palimpsest *Codex Ephraemi Syri Rescriptus*, abandoned as illegible by earlier collators. The New Testament part was printed before he left Paris and the Old Testament in 1845. From Paris he had paid short visits to Holland (1841) and England (1842). In 1843 he visited Italy, and after a stay of thirteen months went on to Egypt, Sinai, Palestine and the Levant, returning by Vienna and Munich. (*See* his *Reise in den Orient* [Leipzig, 1845–46].) From Sinai he brought a great treasure, forty-three leaves of what is now known as the *Codex Sinaiticus*. He kept the place of discovery a secret, and the fragments were published in 1846 as the *Codex Friderico-Augustanus*, a name given in honour of the king of Saxony. He now became professor extraordinarius in Leipzig, and married (1845). In the same year he began to publish an account of his travels in the East (2 vols., 1845–1846). In 1850 appeared his edition of the *Codex Amiatinus* and of the Septuagint version of the Old Testament; in 1852, amongst other works, his edition of the *Codex Claromontanus*. In 1853 and 1859 he made a second and a third voyage to the East. In the last of these, in which he had the active aid of the Russian government, he at length got access to the remainder of the precious Sinaitic codex, and persuaded the monks to present it to the tsar, at whose cost it was published in 1862 (in four folio volumes). In 1859, he had been made professor of theology and biblical palaeography. The mss. brought to Europe on the first two journeys are catalogued in the

Anecdota sacra et profana (Leipzig, 1855, enlarged 1861) *See* also the *Monumenta sacra inedita* (Leipzig, 1846), and *Nova collectio* of the same (1855–1869). The 3rd volume of the *Nova collectio* gives the results of his last Eastern journey. Side by side with his industry in collecting and collating mss, Tischendorf pursued a constant course of editorial labours, mainly on the New Testament, until he was broken down by overwork in 1873. He died on Dec. 7, 1874, at Leipzig.

Four main recensions of Tischendorf's text of the New Testament may be distinguished, dating respectively from his editions of 1841, 1849, 1859 (*ed. viii.*), 1869–72 (*ed. viii.*). The edition of 1849 may be regarded as historically the most important from the mass of new critical material it used, that of 1859 is distinguished from Tischendorf's other editions by coming nearer to the received text; in the 8th edition the testimony of the Sinaitic ms received great (probably too great) weight.

His edition of the Roman text, of the *Septuagint*, with the variants of the Alexandrian ms., the Codex Ephraemi and the Friderico-Augustanus, was of service when it appeared in 1850, but, being stereotyped, was not greatly improved in subsequent issues. Besides this may be mentioned editions of the New Testament Apocrypha [*De Evangeliorum apocryphorum origine et usu* (1851); *Acta Apostolorum apocrypha* (1851), *Evangelia apocrypha* (1853; and ed., 1876); *Apocalypses apocryphae* (1866)] and various minor writings, in part of an apologetic character, such as *Wann wurden unsere Evangelien verfasst?* (1865, 4th ed., 1866), *Haben wir den echten Schriftsext der Evangelisten und apostelf* (1873), and *Synopsis evangelica* (7th ed., 1898).

See in addition to the handbooks on New Testament criticism, Carl Bertheau's article on Tischendorf in Herzog-Hauck, *Realencyklopädie* (3rd ed., 1907).

TISI, BENVENUTO (1481–1559), commonly called Il Garofalo, one of the most distinguished painters of the Ferrarese school, was born at Ferrara. His father, Pietro Tisi, head of the shoemakers' guild in that city, originally came from Garofalo, a village in the Polesine. According to Vasari, the boy first studied with Domenico Panetti, and then went to an uncle at Cremona, where he frequented the workshops of Boccacio Boccaccino. In 1499 he proceeded to Rome and remained 15 months with Giov. Baldini, a Florentine painter. Family affairs caused his return to Ferrara in 1501. Soon afterwards he may have worked under Lorenzo Costa in Mantua. In 1504 he was again at Ferrara, where he became friendly with the two brothers Dossi. Towards the close of 1509 he returned to Rome and made the acquaintance of Raphael and saw Michelangelo's frescoes on the vault of the Sistine chapel just completed. After 1512 we find him settled at Ferrara, never quitting the city for any length of time until his death in 1559. His earlier works recall the style of Panetti and Boccaccino. In his middle period he was influenced by his association with Dossi. Then Raphael's and Michelangelo's influence made itself felt. He was a prolific artist and almost every church of Ferrara was supplied with a picture from his brush. Garofalo's earliest dated picture, "The Minerva and Neptune" of 1512, in the Dresden gallery, displays the influence of Lorenzo Costa. His paintings in the Borghese and Doria collections are probably earlier, being in the manner of Dossi and Boccaccino. Other important works are "The Immaculate Conception" (1514) and "The Madonna del Pilastro" in the pinacoteca at Perugia and "The Mater Dolorosa" at Dresden. He did not always confine himself to sacred subjects, and one of his finest works dealing with mythology is "The Sacrifice to Ceres" in the National Gallery (Mond collection). He was also employed in decorating palaces of Ferrarese nobles. His paintings in monochrome in the Seminario at Ferrara are fine and well preserved, and those in the ceiling of one of the rooms recall Mantegna's ceiling in the Camera du Sposi at Mantua. He continued constantly at work until, in 1550, blindness overtook him.

See G. Morelli, *Italian Painters, The Borghese and Doria Galleries* (1892–93); J. E. G. Gardner, *The Painters of the School of Ferrara* (1911).

TISSAPHERNES (Pers. *Cithrafarna*), Persian soldier and statesman, son of Hydarnes. In 413 he was satrap of Lydia and Caria, and commander in chief of the Persian army in Asia Minor (Thuc. viii. 5). When Darius II. ordered the collection of the outstanding tribute of the Greek cities, he entered into an alliance with Sparta against Athens, which in 412 led to the conquest of the greater part of Ionia. But Tissaphernes was unwilling to take action and tried to achieve his aim by astute and often perfidious negotiations; Alcibiades persuaded him that Persia's best policy was to keep the balance between Athens and Sparta, and rivalry with his neighbour Pharnabazus of Hellespontic Phrygia still further lessened his energy. When, therefore, in 408 the king decided to support Sparta strenuously, Tissaphernes was removed from the generalship and limited to the satrapy of Caria, whereas Lydia and the conduct of the war were entrusted to Cyrus the Younger. On the downfall of Athens, Cyrus and Tissaphernes both claimed jurisdiction over the Ionian cities, most of which acknowledged Cyrus as their ruler; but Tissaphernes took possession of Miletus, where he was attacked by Cyrus, who gathered an army under this pretence with the purpose of using it against his brother Artaxerxes II. The king was warned by Tissaphernes, who took part in the battle of Cunaxa, and afterwards tried to destroy the Greek mercenaries of Cyrus by treachery. He was then sent back to Asia Minor to his old position as general in chief and satrap of Lydia and Caria. He now attacked the Greek cities, to punish them for their allegiance to Cyrus. This led to the war with Sparta in 399. Tissaphernes, who once again had recourse to subtle diplomacy, was beaten by Agesilaus on the Pactolus near Sardis (395); and at last the king yielded to the representations of Pharnabazus, strongly supported by the chiliarch (vizier) Tithraustes and by the queen-mother Parysatis, who hated Tissaphernes as the principal cause of the death of her favourite son Cyrus. Tithraustes was sent to execute Tissaphernes, who was lured to Colossae and slain in 395.

(ED. M.)

TISSERAND, FRANÇOIS FÉLIX (1845–1896), French astronomer, was born at Nuits-Saint-Georges, Côte d'Or, on Jan. 13, 1845. He entered the École Normale Supérieure in 1863, and in 1866 became *astronome adjoint* at the Paris observatory. In 1868 he took his doctor's degree with a brilliant thesis on Delaunay's method. He went to Malacca to observe the solar eclipse of Aug. 1868. In 1873 he became director of the Toulouse observatory, and while there published *Recueil d'exercices sur le calcul infinitésimal*. He went with the French expedition of 1874 to Japan, and of 1882 to Martinique, to observe the transits of Venus. In 1878 he became a member of the Académie des Sciences, and of the Bureau des Longitudes, and in 1883 he obtained the chair of celestial mechanics at the Sorbonne. In his principal work, *Traité de mécanique céleste* (4 vols., 1888–96), he coordinated the researches of Laplace and of subsequent workers in the same field, and gave a *résumé* of the state of knowledge in that department of astronomy at the end, as Laplace's *Mécanique céleste* did for the beginning of the 19th century. In 1892 he became director of the Paris observatory. He died suddenly on Oct. 20, 1896.

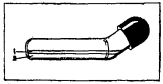
TISSOT, JAMES JOSEPH JACQUES (1836–1902), French painter, was born at Nantes on Oct. 15, 1836. He studied at the École des Beaux Arts in Paris under Ingres, Flandrin and Lamothe. In 1861 he showed "The Meeting of Faust and Marguerite," which was purchased by the state for the Luxembourg Gallery. He fought in the Franco-German War, and, falling under suspicion as a Communard, left Paris for London. Here he studied etching with Sir Seymour Haden, drew caricatures for *Vanity Fair*, and painted portraits as well as *genre* subjects. It was many years before he turned to the chief work of his career—the production of a series of 700 water-colour drawings to illustrate the life of Christ and the Old Testament. He disappeared from Paris, whither he had returned after a stay of some years in England, and went to Palestine. In 1895 the series of 350 drawings of incidents in the life of Christ was exhibited in Paris, and in 1896 in London. They were then published by the firm of Lemercier in Paris. He died at Buillon (Doubs) on Aug. 8, 1902.

TISSUE CULTURE. The body is composed of countless myriads of cells assembled in tissues and organs. The cells belong to several types: wandering cells such as blood leucocytes and tissue macrophages which roam through the entire organism; epithelial cells, the noblest elements of the body, which form the glands, brain, skin, etc; connective tissue cells present everywhere under various appearances, etc. They are the units of a strictly organized community. Their existence is bound to that of the whole. If the whole is taken apart, its component tissues and

organs die after a short time The cultivation of tissues consists precisely in maintaining in a condition of active life cells that have been removed from the body. The aim of this method is to study the innate properties of each cell type, and the mechanism of their organization into tissues and organs Its ultimate purpose is the discovery of the laws which express the relations between the tissues and the body fluids, and the building up of cell sociology.

History.—The method of tissue culture may be considered the indirect outcome of studies made independently by several biologists on the survival of cells outside of the organism. However, the first chapter of its history was written in 1907 by R G Harrison in the beautiful experiments where nerve fibres were caused to grow *in vitro* from fragments of the central nervous system of frog embryos. In 1910, these experiments were extended by other workers to adult and embryo tissues of birds and mammals, which were observed to survive in a drop of plasma But after a few days, degeneration began and death occurred In these experiments, as well as in those of Harrison, the tissues were not cultivated in the proper sense of the word They were only in a condition of survival A second chapter was begun in 1911 when A. Carrel developed a procedure by which the death of the surviving tissues could be indefinitely postponed and found, in 1912, that embryo proteins possess the power of promoting the unlimited proliferation of tissue cells. Then, it became possible really to cultivate cells, that is, to cause them to manufacture new protoplasm from the substances contained in their medium A long interruption occurred in the progress of these investigations due to the World War. But, in 1921, the development of procedures permitting the main cell types to be obtained in pure cultures opened a third and important period in the history of the method Blood and tissue macrophages, iris epithelium, cartilage cells, thyroid cells, Malpighian epithelium, lens cells, and several types of malignant cells were isolated from other tissue elements and maintained in a pure state. At the same time, it became possible to measure accurately the rate of growth of the strains of tissue cells New procedures were perfected by which living tissues could be maintained indefinitely in flasks where they were washed, fed, and measured without being disturbed and without danger of infection from bacteria These great practical improvements rendered the method of tissue culture very much easier, and widely extended its application to physiological and pathological problems. Although it has not as yet reached its complete development, it may be considered the most powerful instrument now possessed for the investigation of cell physiology.

Technique.—The handling of the delicate and minute structures which compose the tissues demands elaborate techniques and a long apprenticeship for their mastery. But the principles of these techniques are very simple. The cells are cultivated in flat, round flasks made of pyrex glass and varying in size from 3 to 8cm. in diameter (*see* fig) The flasks possess a wide, oblique neck 3cm. in length Dust and bacteria from the air do not fall into the flask when it is opened, but remain on the wall of the neck where they are destroyed by flaming. By means of a spatula, the tissue cells are conveniently handled inside the flasks. After being flamed, the neck is hermetically sealed with a rubber cap. It is thus possible entirely to protect the tissues against bacteria which are their deadly enemies, and also maintain in the air of the container the proper amount of humidity and of carbon dioxide. Through the bottom of the flask, the tissues may be examined with a microscope at a magnification of about 120 diameters. When the cells must be studied in greater detail, they are removed from the flask with a spatula, placed on a thin cover-glass, and examined while still living, at a magnification of 1,500 diameters.



BY COURTESY OF ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

FLAT ROUND FLASK, 3·5 CM. IN DIAMETER, FOR CULTIVATION OF TISSUES

1. Solid medium; 2. nutrient fluid medium

On the bottom of the flask is spread the medium which must supply the tissues with a scaffold for their growth and with the substances necessary for the synthesis of new protoplasm This medium is composed of two parts, one solid and the other fluid (fig 1). The solid part is made of coagulated blood plasma, that is, of a clot of blood from which the red and white corpuscles have been removed Such a plasma is obtained by freeing blood of its corpuscles by centrifugation. It then becomes a clear, citrin fluid which is introduced into the flask with a pipette. The tissue cells are next deposited by a spatula in this medium which coagulates after a few minutes Thus they become embedded in a transparent jelly, which they use as a scaffold, but not as a nutrient medium The fluid medium is placed on the surface of the coagulum Its rôle is to remove the waste products of the culture, and to supply the tissues with the necessary nutrient substances Every two or three days, the fluid is removed and replaced by a large amount of a saline solution composed of sodium, potassium and calcium chlorides, sodium phosphate and bicarbonate, and glucose, which is called Tyrode solution. After the tissues have been thoroughly washed, the fluid is removed and replaced by a small amount of nutrient medium This medium ordinarily consists of embryo proteins, or proteoses and peptones, or blood serum, according to the nature of the tissues. The tissues and fluids are handled with sterile instruments in rooms which are kept strictly clean It is most important that no bacteria be allowed to penetrate into the flasks. If infection of the medium takes place, death of the tissues soon occurs This accident is almost completely prevented by the recently developed techniques. After the preparation of the culture is completed, the flasks are placed in an incubator and maintained at body temperature.

Several cell types have so far been obtained in pure state: connective tissue cells or fibroblasts, epithelial cells, blood and tissue macrophages, and the malignant elements of a few tumors Strains of fibroblasts are cultivated easily from almost every embryo, or adult tissue of human beings, dogs, rats, mice, fowls, etc. They remain packed together while macrophages wander through the medium. In addition, they multiply more rapidly than epithelial cells. Therefore, it is easy to obtain colonies composed exclusively of them Fibroblasts are either polygonal or spindle-shaped with long, sharp processes, and with an oval nucleus which generally contains two smaller nucleoli. They aggregate in a dense tissue which doubles in volume every 48 hours when kept at body temperature in a medium composed chiefly of embryo proteins. They grow indefinitely. A strain of chicken fibroblasts isolated 16 years ago is multiplying to-day at the same rate as at the beginning of its life *in vitro*. When the flasks are taken from the incubator and kept at room temperature, the cells stop multiplying and remain in this condition for three or four weeks without dying. Therefore, living culture cells can be sent for long distances without inconvenience. Strains of tissue cells have been exchanged between laboratories located in New York and Berlin and after this long journey have promptly regained their usual rate of growth. Epithelial cells are more difficult to obtain in pure culture. Nevertheless, since Fischer isolated a strain of epithelium from the few cells of the iris which adhere to the lens of the chick embryo, pure cultures of thyroid gland, Malpighian epithelium, lens epithelium and several types of carcinomatous cells have been obtained by Ebeling, Kirby, Fischer and Carrel. Their rate of growth is less than that of the connective tissue cells, but they can be maintained in a condition of active life for several years. They keep their normal characteristics indefinitely. They grow in a thin layer at the surface of the solid medium, and rarely form a dense tissue. They readily digest the coagulum Leucocytes from the blood and wandering cells from the tissues have also been obtained in pure cultures. They do not aggregate as a tissue, but remain isolated from one another and scatter through the medium When they accumulate in a large number or are packed together, they generally die or become transformed into fibroblasts. Their growth is slow and they are less resistant than epithelial or connective tissue cells. However, they can live in flasks for several months. The malignant elements of sarcomata and carcinomata have also been isolated and maintained alive indefinitely outside of the body.

The rate of growth of the colonies of epithelial cells and of



FIBROBLAST STRAINS

1. A 17 month old strain of sarcomatous fibroblast (a cell forming connective tissue) of a rat (magnified 1,000 times). 2 Two colonies of 17 month old strain of malignant fibroblasts from a rat sarcoma (tumour of connective tissue), growing in a flask 3 5 centimeters in diameter (magnified twice) 3. Pure strain of normal rat fibroblasts (magnified 370 times). 4. A 16 year old strain of normal chicken fibroblasts

fibroblasts can easily be ascertained. The measurements are made by placing the flasks on a projectoscope and drawing the outline of the colony immediately after the preparation of the culture and subsequently every two days. The area of the colony at the different stages of its development is measured with a planimeter, and the ratio of the area of new growth to that of the original fragment is calculated. The relative increase of the colony in 48 hours expresses the rate of growth. The curve representing the continuous growth of a colony of epithelial cells or of fibroblasts in a flask containing a nutrient medium is a parabola. If the medium is non-nutrient, the curve is S-shaped. Modifications in the form of this curve indicate whether the medium contains substances that activate or depress the rate of cell multiplication. This method cannot be used for measuring the activity of wandering cells, because they never grow as a tissue, but remain at certain distances from one another and scatter on several planes. Their rate of multiplication can be approximately reckoned by the time taken by the cells to invade the entire area of the flask.

The growth energy of a colony at a given instant is a function of several independent variables: its growth energy at the preceding instant, and the concentration in the pericellular fluid of the substances that increase or decrease cell activity. It could be ascertained by the activity displayed during an instant by the cells in a medium containing neither activating nor retarding substances, if such a measurement were possible. But the residual growth energy, which was found to vary at the same time as the inherent energy, may be used as a measurement of the latter. The residual energy is expressed by the duration of life and the proliferative activity of the cells in Tyrode solution.

The morphology of the tissue cells growing *in vitro* is studied while they are living. Fragments of the coagulum containing cells are taken from the flasks and put on thin glass slides. They may also be readily cultivated in glass chambers especially constructed for cytological studies. The living unstained cells are photographed or cinematographed. When stained with neutral red, trypan blue, and Janus green, the cytoplasmic structures may be observed while in full activity. Cinematographic records can be taken at such a magnification that the details of the mitochondria, segregation apparatus, and surface membrane of the cells are clearly shown.

Mode and Rate of Growth of Tissues.—This method has already supplied some important information regarding the physiological properties of tissue cells, the rôle of blood serum toward the tissues, and the nature of the chemical substances that determine the unlimited multiplication of fixed cells. The rate of growth of connective tissue and of epithelial cells in a nutrient medium of unvarying composition remains uniform indefinitely. Such a law appears to be the expression of one of the more fundamental properties of tissue cells. Since their rate of growth remains unchanged as long as the medium does not vary, the cell colonies may be considered to be immortal. A strain is able to transform an unlimited amount of chemical energy. The energy spent by the cells must arise entirely from the substances contained in the culture medium, and will never be exhausted as long as the same medium is supplied to them. It appears that the potentialities of tissues are much greater than those they display within the normal organism, and that the manifestation of their activity is determined by the physico-chemical conditions of the pericellular fluid. The dependence of cells on the composition of the medium was further emphasized by a study of the rate of growth of colonies of fibroblasts or epithelial cells in media of varying composition. It was found that the activity of the colonies is a function of the concentration of nutrient substances within the medium, when waste products and other inhibiting substances are constantly removed. If cell colonies in different conditions of activity are placed in similar media, their rates of multiplication soon become identical. Fragments of connective tissue of chick embryos and adult chickens cultivated in a nutrient medium grew at first at varying rates, but after a few weeks no difference was observed in the activity of both colonies.

The residual energy of embryo tissues, which is always very large, varies in inverse ratio with the age of the animal from which the tissues have been extirpated. The duration of their survival *in vitro* may extend over a period of three months. On the other hand, the residual energy of the tissues of an adult animal is very small. The connective tissue cells of an old animal are in a dormant condition. If cultivated in a nutrient medium, a long time elapses before they begin to proliferate. Should their resting state be attributed to a factor preventing them from spending their energy, or to a complete lack of energy? An investigation of the behaviour of these tissues in a medium completely lacking in nutrient substances showed that they possess very little residual energy. This means that they have no reserves in store. However, they have not lost the power of accumulating the substances which supply them with energy. When they are placed in a nutrient medium, they begin to multiply and to store up reserves. Adult fibroblasts may be compared to a motor which possesses no energy of its own, but runs as soon as it is supplied with fuel.

The persistence of the essential characteristics of cells cultivated *in vitro* has opened a new field to histology. When the rate of growth and the constitution of the medium of a pure strain have been ascertained, the relations existing between the structure of the cells and their physiological state become apparent immediately. Blood monocytes, tissue macrophages and fibroblasts have been studied according to these principles. The appearance of the cells varies greatly with their nutritional condition. The anatomy of a cell type can be modified at will by simple changes in the nature and the concentration of the substances contained in its medium.

A profound transformation of classical cytology began when it became possible to identify cells not only by their morphology, but also by their physiological characteristics. Through the new techniques, a cell type is defined by the appearance of its colonies, its mode of locomotion as recorded by cinematography, its effect on the medium, its rate of growth, the nature of the substances which inhibit its multiplication, the nature and concentration of the substances required for proliferation, etc. The advantages of this conception of cytology are obvious. If all the manifested and hidden potentialities of every cell type were known, the behaviour of a tissue under given conditions could be predicted. The events in which the tissues take part are determined by the response made to the physico-chemical conditions of the medium by each cell according to its innate qualities. On the mode of response of a cell type to other cells and to the humours depend the characteristics of the community.

Physiological Factors of Growth.—The effect of blood plasma on tissue cells remained unknown until it was tested on pure cultures of fibroblasts and epithelium. These experiments showed that, first, blood serum is not a nutrient medium for epithelial cells and fibroblasts; it inhibits their proliferation when added to a nutrient medium. Secondly, blood serum is an excellent nutrient medium for monocytes, tissue macrophages, and sarcomatous macrophages. Thirdly, the proteins and amino acids of the blood do not promote the proliferation of connective tissue and epithelial cells. Serum proteins or lipoids possess the property of restraining cell proliferation. But blood serum taken from an animal a few weeks old neither stimulates nor inhibits the growth of colonies of fibroblasts. When the age of the animal increases, its serum becomes more and more growth-inhibiting. The progressive increase in the growth-inhibiting properties of blood serum takes place rapidly at the beginning of life and very slowly in old age. The curve expressing this phenomenon resembles that of the decrease in function of the age of the patient in the rate of healing of a wound, as expressed in du Noüy's equation. The age of an animal can be ascertained approximately by the growth index of its serum. The inhibiting power of serum is due chiefly to lipoids. After extraction of the lipoids, the remaining proteins are far less inhibiting than the whole serum. On the contrary, the isolated lipoids are toxic. In old age, the inhibiting effect of serum is augmented because both proteins and lipoids are more concentrated.

The nature of the substances responsible for cell multiplication remained unknown until fibroblasts and epithelium were found to multiply with great velocity in the presence of embryo juice.

This juice is a complete food For 16 years, a strain of fibroblasts has been fed on it, and has built up many thousands of colonies from the substances that it contains The substance responsible for the unlimited growth of the cells is a protein, which is mixed with a lipoid having some inhibiting power The primary split products of certain proteins produce as extensive a multiplication of fibroblasts as embryo juice does The incomplete digests of ox fibrin, casein, egg albumin, liver, testi, thyroid, thymus, pituitary gland, etc, increase the rate of growth of fibroblasts, epithelial cells and macrophages The split products of crystalline egg albumin, on the contrary, possess little growth-promoting power. When the digestion is carried further and the digests are composed chiefly of amino acids, their effect on the growth of tissue cells disappears almost completely. It is probable that the proteins of embryo juice are not absorbed as such by the cells after they have been hydrolyzed The power of tissue juice to cause growth may possibly be attributed to the ease with which its proteins can be transformed into polypeptides by the tissue ferments Monocytes and macrophages do not require embryo juice or protein split products in their medium in order to proliferate and manifest other forms of activity They are voracious cells and feed upon red blood corpuscles, protein precipitates and muscle fragments, and also on plasma, embryo juice and protein split products at a low concentration

Through the method of tissue culture, the fundamental characteristics of the main cell types and the mechanisms that make them an organized whole are being progressively elucidated Although the techniques will be still further improved, they have reached such a degree of development as to permit the construction of a new science of cytology based not only on the morphology, but chiefly on the physiological properties of the cells.

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TISTA, a river of northern India, which rises on the edge of the Tibetan plateau, has a tumultuous course southward through the mountain gorges of Sikkim and Darjeeling and flows through North Bengal and Cooch Behar for another 170 miles till it joins the Brahmaputra in the district of Rangpur. In the 18th century its course was due south to join the Ganges, but in 1787 great floods diverted the stream towards the south-east, and it made its way by a new channel into the Brahmaputra

TISZA, ISTVÁN (Stephen), Count (1861–1918), Hungarian statesman, was born on April 22, 1861, youngest son of Kálmán Tisza (*q.v.*). Educated at Berlin, Heidelberg and Budapest, he entered the ministry of the interior, where he specialized in agrarian matters. His *Magyar agrárpolitik* (Budapest, 1897), authoritative on its subject, was translated into German the same year. In 1886 Tisza began his long parliamentary career, and on June 17, 1903, he was entrusted with the formation of a ministry of pacification, but was unable to secure a majority. On Oct. 27, however, with the assistance of the Free Principles Party, he succeeded in composing a cabinet, in which he was minister of the interior as well as premier On Nov 16–18, to meet the obstruction of the opposition, he introduced new and stringent rules of procedure which he declared adopted, thereupon suspending the session. The Andrássy group, however, left him soon after, and after a stubborn battle with anarchical conditions in which legislation was impossible Tisza appealed to the country and was heavily defeated After Count Khuen-Hédervary became prime minister (Jan. 1910) Tisza reorganized the old Liberal party under the name of the National Party of Work with a programme of a return to the strict principles of the compromise of 1867 In the elections of June 1910 this party secured an overwhelming majority, due largely to Tisza's own personal suggestion and unceasing activity In view of the obstruction of the extreme Left against the army legislation, Tisza, considering that the threat of complications in the Balkans made it essential not to weaken the Austro-Hungarian army, had himself elected president of the Lower House in 1912, introduced new standing orders, and forced the Army bill through, ejecting the opposition from the House. A member fired three times at Tisza, who remained calm in his chair This scene made him very popular He had to fight some duels with his adversaries, including one with Count Michael Karolyi, which left the two adversaries bitter enemies

On June 15, 1913, Tisza was for the second time nominated prime minister. In his first memorandum on foreign policy, written after the second Balkan War, he deplores the growth of Serbia and the collapse of Bulgaria, Turkey and later Greece Rumania, where public opinion was growing hostile to the dual monarchy, should be assured its territorial integrity, but if it abandoned its alliance, Bulgaria should be brought to bear against it. War should be avoided. In home politics, Tisza was willing to favour such of the non-Hungarian nationalities as would support the State He attempted to reach an understanding with the leaders of the Transylvanian Rumanians, but without success

After the murder of the heir to the throne at Sarajevo, Tisza, in a letter to Francis Joseph (July 1) opposed Berchtold's suggestion for a sudden attack on Serbia. A week later he again urged his view that diplomatic steps were necessary and a severe ultimatum should be sent, but its conditions should not be impossible of acceptance To avoid the intervention of the Entente, Tisza carried a motion in the council of ministers (July 19) that the integrity of Serbia's territory should be respected even if war was declared Though the war against Serbia was declared, he exerted himself for peace by accepting Sir Edward Grey's last proposal (July 31). Afterwards he was anxious to miss no opportunity of concluding peace He was opposed to all German aspirations of territorial aggrandizement and to the introduction of unlimited submarine warfare. He was a true partisan of German alliance, but he admitted no interference with Hungary's sovereign rights and was strongly opposed to the German idea of an economic "Mittel Europa."

Tisza had many controversies with the Austrian Supreme Command and general staff He was convinced that the fate of Hungary was bound up with the dual monarchy, but equally intent on preserving Hungary's predominance within the monarchy. It was for this reason that he opposed the plans of Franz Conrad von Hötzendorf (*q.v.*) to annex further territory, and advocated moderate peace terms in Serbia and Belgium He refused, however, to make any territorial concessions to Rumania, such as might have kept her from joining the war against the Central Powers His influence was immense so long as Francis Joseph lived It was he who forced Berchtold to leave the foreign ministry although he refused himself to become foreign minister.

King Charles, however, was under the influence of Tisza's Austrian and Hungarian enemies. Their rancour was fostered by the participation of Tisza, a Calvinist, with the primate of Hungary in the act of coronation The pretext for Tisza's dismissal in June 1917 was his refusal to grant the suffrage to soldiers at the front and his opposition to the demands of the Socialists.

The new cabinet had but a minority in parliament. Tisza, now chief of the opposition and in the majority, framed a resolution in which he affirmed the necessity of the German Alliance and pointed out the ambiguous behaviour of the Czechs in the Reichsrath. Finding his position difficult, he went to the front. In the Bukovina and in Italy he commanded a regiment with distinction. During this time his only political action was his mission to Croatia and Bosnia (Sept. 1918). Returning to Budapest, he declared (Oct. 17) "We have lost the war," and thus gave the signal for the collapse. He wanted a peace with honour, not a treacherous one. His last two weeks he spent in attempting to unite different parties; he was even ready to accept Karolyi's leadership in order to save the country and to procure a good peace Too proud and too conscientious to allow the publication of his pacific endeavours, he was set as a mark for the defeatist soldiers and the mob Though warned of his grave danger, he remained in Budapest, working until his last moment to unite the historical parties. He was killed by soldiers on Oct. 31, 1918, the first day of Count Karolyi's revolution. His last words were, "It had to be."

See István Tisza, *Összes Müvei*, 2 vol., 1925 (Personal Recollections,

letters June to end of Dec. 1914, pub. by the Hungarian academy). The first volume of the letters was translated into German by O. von Wertheimer, *Graf Stefen Tisza, Brefe* (1928).

TISZA, KÁLMÁN [KOLOMAN] (1830–1902), Hungarian statesman, was born at Geszt on Dec. 10, 1830, the son of Lajos Tisza and the countess Julia Teleki, and educated at his father's castle. In 1848 he obtained a post in the ministry of instruction of the revolutionary Government. After the war he travelled abroad, afterwards (1855) becoming assistant curator of the Calvinist church at Nagyszalonta He publicly and vehemently opposed the Austrian "Patent" of Sept 1, 1859 and the "October Diploma" of 1860 In Aug 1860 Tisza married the countess Helen Degenfeld-Schomburg, a union which brought him into close connection with the Karolyis, the Podmanicskys and the Odescalchis. He was unanimously elected to represent Debreczen at the 1861 diet, and vice-president of the house at its second session, and became leader of the more radical party on the death of Count László Teleki.

From 1867 onwards his influence increased steadily, despite the rupture of his party, which he reconstructed at the conference of Nagyvárad (March 17, 1868), when the famous *Bihari pontok*, or articles of Bihar, were subscribed, which bound the Tisza party to repeal all laws or institutions contrary to, and to promote all measures necessary for, the national independence Thus the delegation system and the common ministries were marked out for attack, while every effort was to be made to procure for Hungary a separate army, a separate diplomacy and a separate financial system It was chiefly owing to the efforts of Tisza and his party that Austria remained neutral during the Franco-German War. In 1875 his party amalgamated with the followers of Deák into the *Szabadelvu párt* or Free Principles Party, which took office under Bela Wenckheim (1811–1879), whom (Oct 2) Tisza succeeded as prime minister, a post he held, with a few interruptions, for the next 15 years. In 1879 he materially contributed to the formation of the Austro-German alliance. Not till 1888, when the national army bill was introduced, did he encounter any serious opposition, but thenceforth his position became precarious, and he resigned office on March 13, 1890 It was owing to his influence, above all things, that Hungary acquired a consolidated government and a position of predominance in the dual monarchy. It is an open secret that, on the retirement of Andrássy, he was offered the chancellorship. He refused it because, to use his own expression, "I am as wholly and solely Hungarian as the river (Theiss, Hung *Tisza*) whose name I bear "

See G Gratz, *Kálmán Tisza* (*Modern Magyar Statesmen*, I) (Hung.; 1902); P. Busbach, *The Last Five Years* (Hung ; 1895).

TITANIC, LOSS OF THE. At 2.20 A.M. on April 15, 1912, the White Star liner "Titanic," at that time the largest ship afloat, on her maiden voyage, went to the bottom of the Atlantic after striking at full speed on an iceberg, with a loss of 1,513 souls out of 2,224 on board. The full record of the disaster is contained in the reports of the inquiries held at once in America by a committee of Congress under Senator Smith, and later in London by a special commission presided over by Lord Mersey (report issued July 30).

See British Parliamentary Papers. No. 2253, *Shipping Casualties (Titanic)* 1912 (ed 6352).

TITANIUM (symbol Ti, atomic number 22, atomic weight 48 1). In a substantially pure state, titanium has a very restricted commercial application The method adopted by Hunter is the standard one for the production of the pure element, but an impure product may be obtained from the dioxide by the application of Goldschmidt's thermit reaction (*see* below) or by reduction with carbon in the electric furnace. Pure titanium is silver-white with a fracture similar to that of steel. It is hard and brittle when cold, but at a low red heat it is malleable and can be forged readily like iron. The specific gravity is 4 5 and the melting point, according to Hunter, 1850°C. It is soluble in dilute sulphuric acid, in hot concentrated hydrochloric acid and in *aqua regia*, whilst hydrofluoric acid readily dissolves it. It combines with nitrogen with avidity. With oxygen and the halogens, compounds of quadrivalent titanium are produced.

The existence of the element known as titanium was discovered in 1789 by the Rev. William Gregor during an investigation of a peculiar black sand found at Menachan in Cornwall This black mineral he called menachanite (or meccanite) and the new element he named menachite Four or five years later, the German chemist, Klaproth, discovered a new metal whilst investigating the composition of the mineral rutile. On account of the strength of the chemical combination in which it was held, he gave to the new element the name titanium—an allusion to the Titans of Greek mythology, the incarnation of natural strength In 1797 Klaproth investigated the mineral ilmenite—which was identical with menachanite—and recognized that titanium and the menachte of Gregor were identical. Nevertheless, titanium is the name which is now universally adopted for the element Attempts to isolate titanium were first made by Lampadius in 1797 and later by Berzelius and other investigators The metallic-looking products isolated by early investigators were generally nitrides or carbides, for titanium has a pronounced affinity for oxygen, carbon, and nitrogen In 1895, Moissan published an account of his experiments on the reduction of titanium dioxide with carbon at the temperature of the electric furnace His final product was free from nitrogen and silicon but contained about 7% of carbon, probably as the carbide. Thus was the purest titanium isolated till the work of Hunter in 1910, who adopted a method previously used, unsuccessfully, by Nilson and Pettersson. By heating titanium tetrachloride with sodium in an air-tight steel cylinder, with exclusion of air, Hunter obtained titanium nearly 100% pure.

Although frequently regarded as one of the rare elements, titanium occupies the ninth place in Clarke's table of the estimated abundance of the elements in the earth's crust. This table discloses the interesting fact that titanium is more abundant than such common elements as carbon, phosphorus or sulphur, and much more abundant than the useful metals, lead, copper and zinc. There is, however, a distinctive difference between the mode of occurrence of titanium and that of these other metals, for whereas the greater part of the titanium is so widely diffused through the earth's crust as to make its recovery economically impossible, the less abundant metals are concentrated in segregated deposits (mineral veins, lodes, etc.) capable of satisfactory exploitation Hence, of all the numerous titanium-bearing minerals, only three or, at most, five are entitled to be classed as possible ores of titanium. They are rutile (TiO_2), ilmenite ($FeTiO_3$), titaniferous magnetite (magnetite is Fe_3O_4), and possibly titanite ($CaO{\cdot}TiO_2{\cdot}SiO_2$) and perovskite ($CaTiO_3$). Rutile occurs in igneous, in metamorphic, and in sedimentary rocks, and its mineral associates include a wide range of species Although widespread in occurrence, deposits of commercial importance are few in number and, so far, restricted to certain localities in the United States, Canada, Norway and South Australia. Rutile crystallizes in the tetragonal system, commonly as short, stout prisms or elongated prisms frequently showing striated prism faces. It is normally reddish-brown to red, the specific gravity of the ordinary red variety being 4 18 to 4 25. Titanium dioxide contains 60% of titanium and 40% of oxygen. Actually, the mineral usually contains from 54 to 59% of titanium with minute quantities of vanadium and iron. Rutile is infusible before the blowpipe and insoluble in acids, but fused alkalis and alkali carbonates bring it into solution. Ilmenite crystallizes in the hexagonal system as rhombohedra, but it is rarely seen as good megascopic crystals Commonly it occurs as embedded grains and masses, whilst it may also be found as a sand The mineral is iron-black with a metallic lustre. Although it is customary to assign to it the formula $FeTiO_3$, numerous analyses indicate the formula $FeTiO_3{\cdot}xFe_2O_3$ whilst others correspond to neither formulation. Ilmenite is both cheaper and more plentiful than rutile, and probably the most extensive deposits of the mineral are those of the province of Quebec, Canada, and the Ekersund-Soggendal district of Sweden. Other important deposits are found in the United States and South Australia, whilst ilmenite is a by-product from the crude monazite sands of Ceylon and Travancore, India. For industrial purposes the only distinction between ilmenite and titaniferous magnetite is in the titanium

content. Ore, classed as ilmenite, has a titanium content of 18 to 24% or more, whilst titaniferous magnetite seldom carries more than 15% of titanium.

Although titanium is unimportant commercially, yet when alloyed with other elements it forms a number of useful products. Four of these alloys—ferrocarbon titanium, carbon-free ferrotitanium, cuprotitanium, and manganotitanium—are in commercial use. Ferrocarbon titanium is made by reduction of ilmenite with coke in an electric furnace, or by charging rutile mixed with carbon into an electric furnace containing molten iron or steel The alloy so produced has a high carbon content (5 to 8%) but this can be reduced below 1% by remelting with rutile Ferrocarbon titanium normally contains Ti 15—18, C 7, Si 1·5%, the rest being iron and small quantities of impurities The carbon-free ferrotitanium is produced by the thermit process The finely-powdered ilmenite (or oxides of iron and titanium) mixed with aluminium powder, in the correct proportions, is ignited by means of a fuse A rapid reaction takes place in which the oxides are reduced to the elemental condition and an alloy of the following composition is produced. Fe, 67—69; Ti, 25, Al, 5—6, Si, 1—1·05; P, 0·05; S, 0·01%. Cuprotitanium is made by the alumino-thermic reduction of rutile to which copper has been added, and manganotitanium is similarly produced by the reduction of rutile to which manganese or its oxide has been added Titanium in the form of its alloys acts as a final deoxidizer and denitrogenizer for metals The addition of the ferro-alloys to steel yields a cleaner and sounder product, whilst the cuprotitanium and manganotitanium are used as deoxidizers in brass and bronze practice. Titanium in the form of its compounds finds many useful applications Ilmenite and rutile, as well as artificial titanium dioxide, have been used in the making of arc-lamp electrodes Titanium compounds have proved of value as pigments in the paint industry, dyes and mordants in the textile and leather industries, refractory colouring materials for use in ceramics and in the manufacture of artificial teeth. Titanium white, TiO_2, is put on the market as a pigment to compete with white lead and zinc white

Titanium forms a wide range of salts in which it exhibits valencies of 4, 3, and 2 Titanium tetrachloride, $TiCl_4$, which may be conveniently prepared by passage of chlorine over heated titanic oxide (TiO_2) and carbon, is a colourless liquid boiling at 136·4° C. It fumes excessively in the air and was used as a smoke-screen during the World War. By electrolytic reduction of a solution of the tetrachloride in hydrochloric acid, a violet solution of titanium trichloride is obtained This compound has pronounced reducing properties and has been utilized for many useful volumetric processes (Knecht and Hibbert, *New Reduction Methods in Volumetric Analysis*, 1910). Salts of quadrivalent titanium are normally colourless, but the titanous salts, containing tervalent titanium, are generally violet or green, and include some powerful mordants which produce brilliant and stable colours, *e.g.*, $Ti_2(SO_4)_3Na_2SO_4.5H_2O$. Hydrogen peroxide gives with titanium salts a yellow to brown colouration due to the formation of pertitanic acid, $TiO_3.xH_2O$.

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TITANOTHERE, the vernacular name for any member of the family Brontotheriidae, extinct, hoofed, herbivorous mammals of the order Perissodactyla, which also includes the horses, tapirs and rhinoceroses Titanotheres range from Early Eocene to Middle Oligocene in age and are known from North America, Europe and Asia. From small, hornless ancestors, the latest titanotheres became as large as elephants, with a transverse pair of great, bony, hornlike knobs above the nose (most genera) or a battering-ram extension of the nasal bones themselves (the Asiatic *Embolotherium*). (*See* PERISSODACTYLA) (G. G. SL)

TITANS, in Greek mythology, the children of Uranus (Heaven) and Ge (Earth). The Greek name is *Τιτᾶνες*, the etymology of which is uncertain. According to Hesiod (*Theog*, 133), the male Titans were Oceanus, Cocus, Crius, Hyperion, Iapetus and Cronus; the female, Thea, Rhea, Themis, Mnemosyne, Phoebe and Tethys. Later authors add other names. After the rebellion of Cronus and the birth of Zeus (*see* CRONUS), a struggle ensued between Zeus and Cronus in which the Titans nearly all sided with the latter, but were finally defeated, and imprisoned in Tartarus (Hesiod, *Theog*, 153–210, 617 et seq.)

The standard work on the subject is M. Mayer, *Die Giganten und Titanen in der antiken Sage und Kunst* (1887); *see* also the classical dictionaries *s.v.*

TITCHENER, EDWARD BRADFORD (1867–1927), Anglo-American psychologist, was born on Jan. 11, 1867, in Chichester, England, possibly a descendant of John Tychenor (1532) of Chichester. For four years he attended Malvern college in Worcestershire, and then at the age of 18 (1885) he became a member of Brasenose college at Oxford. Here for four years more he was senior scholar in classics and philosophy and senior Hulmean exhibitioner In his fifth year at Oxford he was a research student in physiology under Burdon-Sanderson, to whom he later acknowledged an intellectual debt. At this time physiological psychology as a laboratory science was just becoming established in Germany and America, and Titchener, trained in philosophy and physiology, turned to the new science and went to Wundt (*q.v.*), the "founder" of experimental psychology, at Leipzig, where was the first and the leading psychological laboratory Here he received his Ph D degree in 1892. Then, with the Wundtian impress upon him, in the days when psychological laboratories were still rare, he accepted the post in the laboratory at Cornell university, Ithaca (N.Y.), where he remained until his death 35 years later His chief work is the *Experimental Psychology*, the most thorough and extensive encyclopaedic handbook of experimental psychology that has been written in English The first two volumes, covering qualitative psychology, appeared in 1901; the third and fourth volumes, treating of quantitative psychology or psychophysics, were published in 1905

In America, Titchener always represented the Wundtian traditions, he never became part of the American trend in psychology, a trend that emphasizes individual differences among persons and the application of psychology to human welfare Titchener stood for the "pure" scientific psychology of the generalized, normal, adult mind. In the early days he thus became the exponent of the school of structural psychology which opposed functional psychology; in later times he represented the opposition to behaviourism and to the psychology of mental tests. His systematic contributions to theoretical psychology are to be found in his *Lectures on the Elementary Psychology of Feeling and Attention* (1908), *Lectures on the Experimental Psychology of the Thought-Processes* (1909), *Text-book of Psychology* (1910) and, to a less extent, in his *Beginner's Psychology* (1915). He died in Ithaca (N.Y.), Aug. 3, 1927

See the biographical sketches, under the title "Edward Bradford Titchener," by H. C. Warren, in *Science*, vol lxvi. (1927), and by E G. Boring in *The American Journal of Psychology*, vol. xxxviii. (1927); also "Titchener at Leipzig," by Frank Angell, in *The Journal of General Psychology*, vol. 1. (1928). (E. G BOR)

TITE, SIR WILLIAM (1798–1873), British architect, the son of Arthur Tite, a Russian merchant, was born in London in Feb 1798, and died on April 20, 1873. The rebuilding of the Royal Exchange, opened in 1844, was Tite's greatest undertaking. He was M.P. for Bath (1855–73) and president of the Royal Institute of British Architects (1861–63 and 1867–70).

See *Journal, Royal Institute of British Architects*, pp. 209–212 (London, 1873–74)

TITHES, a form of tribute consisting of a tenth of a man's property or produce, connected politically with taxation, and religiously with the offering of "firstfruits" to deity. This custom was almost universal in the ancient world, and can be traced in Babylonia, Persia, Arabia, Egypt, Greece, Rome and even in China The tax probably originated in a tribute laid by a conqueror or ruler on his subjects; and we may assume that the custom of dedicating a tenth of the spoils of war to the gods led to a religious extension of the term, the original offerings to deity being "firstfruits" Among the early Hebrews, for example, the king could exact a tithe from cornfields, vineyards, and flocks

(1 Sam viii. 15, 17); and on the religious side the oldest laws (*e.g.* Exod xxxiv. 26) speak of bringing the firstfruits of the land to the house of Yahveh. By the 7th century (Deuteronomy) the word "tithe" has come to be used regularly for religious dues But the analysis of tithe-legislation in the books ascribed to Moses is a complicated problem, owing to the way in which strata of legislation belonging to different periods are combined in the Pentateuch as we now have it; and for detailed investigation reference should be made to the works mentioned below Ultimately the tithe system became a means of contributing to the regular support of the priests, as ministers of the public ritual

Tithes in Christendom.—The earliest authentic example of anything like a law of the State enforcing payment appears to occur in the capitularies of Charlemagne at the end of the 8th or beginning of the 9th century. Tithes were by that enactment to be applied to the maintenance of the bishop and clergy, the poor, and the fabric of the church. In course of time the principle of payment of tithes was extended far beyond its original intention Thus they became transferable to laymen and saleable like ordinary property, in spite of the injunctions of the third Lateran Council, and they became payable out of sources of income not originally tithable.

The Council of Trent definitely enjoined payment of tithes, and excommunicated those who withheld them (Sessio xxv. 12) In England the earliest example of a legal recognition of tithes appears to be in a decree of a synod in 786 (quoted by Selden, *History of Tithes*, ch viii. 2) Other examples before the conquest occur in the laws of Alfred, Athelstane, Edgar, and Canute. It was Selden's denial of the divine right of tithes which brought down the wrath of the Star Chamber upon his head (1618), and he was forced to retract his opinion.

Tithes in English Law.—Two chronological divisions may conveniently be made.

(i.) Before the Commutation Acts (1836 *sqq*). Tithes were classified by origin, as "prædial," or arising immediately from the ground, *e.g.*, grain of all sorts, hay, wood and the like; "mixed," or arising from things immediately nourished by the ground, *e.g.*, colts, lambs, eggs and the like, or "personal," namely, of profits arising from the honest labour and industry of man, and being the tenth part of the clear gain, *e.g.*, fishing, mills and the like; or according to value, as great, *e.g.*, corn, hay and wood; or little, which embraced all others Of common right tithes were only payable of such things as yield a yearly natural increase and generally only once a year. They were recoverable by a writ against the owner of the tithable property usually brought in the ecclesiastical courts, the jurisdiction of which in this respect was confirmed by the statutes *Circumspecte agatis* (13 Edw. I.), *Articuli cleri* (9 Edw II.), and others of Henry VIII and Edward VI.; and an act 2 and 3 Edw. VI made any person refusing to set out tithes liable to pay double the value in the ecclesiastical court or treble in a common law court. At the time of the Commutation Acts, it was common for a tithe-owner to accept a fixed sum of money or fixed quantity of the goods tithable in place of the actual tithes, whether in respect of a whole parish or only of particular lands within it; and this could be sued for in the ecclesiastical courts. In the City of London there were customary tithes; in other towns and places there were compositions for tithes which were confirmed by local acts of parliament; and according to a return presented to the House of Commons in 1831, there were passed between 1757 and 1830 no less than 2,000 local acts containing commutation clauses.

(ii.) The principle of the Tithe Commutation Acts (1836–1860) is to make permanent and general the system which had been only partial or temporary (in most cases), and to substitute a corn rent (known as a tithe rent charge), permanent in quantity and payable in money, but fluctuating in value, for all tithes, whether payable under a *modus* or composition or not, which may have heretofore belonged either to ecclesiastical or lay persons (Phillimore, *Eccles. Law*, ii. 1161). Commissioners (now the board of agriculture) are appointed to execute the acts; a rent charge on all lands liable to tithes at the time of the passing of the first act is substituted for those tithes, of which the gross amount is ascertained either by voluntary parochial agreement, or, failing that, by compulsory award confirmed by the commissioners; and the value of the tithes is fixed in the latter case by their average value in the particular parish during the seven years preceding Christmas 1835, without deduction for parochial or county and other rates, charges and assessments falling on tithes, the rent charge being liable to all the charges to which tithes were liable. The rent charge is apportioned on all the lands liable in the parish, and such apportionment may be altered or a new one made; and the value of the rent charge is fixed at the value (at the time of confirmation of the apportionment) of the number of imperial bushels and decimal parts of bushels of wheat, barley and oats as the same would have purchased at the prices so ascertained by the advertisement (of prices of corn) to be published immediately after the passing of the act 6 and 7 Will. IV *c.* 71, in case one-third part of such rent charge had been invested in the purchase of wheat, one-third part in the purchase of barley, and the remaining third part in the purchase of oats; and the respective quantities of wheat, barley, and oats so ascertained shall be stated in the draft of every apportionment. The price at which the conversion from money into corn is to be made at the time of confirmation of such apportionment, according to the provisions of the said act, are 7s 04d for a bushel of wheat, 3s. 11¼d for a bushel of barley, and 2s 9d for a bushel of oats (7 Will IV. and 1 Vict c. 69), the average price of the bushel of each grain is now computed by substituting for the "advertisement" above the statement of the septennial average price of the imperial bushel of British corn made under the Corn Returns Act, 1882; and thus the value of the statutory amount of corn is now fixed for each year at the beginning thereof at the average price of the three components of corn for the previous seven years

The method of recovering rent charge under the Commutation Acts was distraint where the rent charge is in arrear for 21 days after the half-yearly days of payment, and entry and possession with power of letting if it is in arrear for 40 days This power of distress and entry extends to all lands occupied by the occupier of the land whose tithe is in arrear as owner or under the same landlord; but no action lies against the owner or occupier of the land personally. If a tenant quits leaving tithe unpaid, the landlord may pay it and recover it from him. The tithe-owner cannot recover damages from the tithe-payer for not cultivating the land. Special provision is made for the recovery of the rent charge in railway lands.

The act of 1891 shifted the responsibility from the occupier to the landowner by making the latter solely responsible. The landowner became liable to pay the rent charge in spite of any contract to the contrary between him and the occupier; the rent charge if in arrear for three months is recoverable by an order of the county court, whatever its amount may be; if the land is occupied by the owner, the order is executed by the same means as those prescribed in the Tithe Acts, but if it is not, then by a receiver being appointed for the rents and profits of the land. Appeal lies to the High Court on points of law; and a remission of rent charge may be claimed when its amount exceeds two-thirds of the annual value of the land. The act does not apply to the particular kinds of rent charges mentioned above.

The Tithe Acts do not apply to the city of London, which has always had its own peculiar customary payment regulated by episcopal constitutions of 13 Hen. III. and 13 Ric II. and statutes of Henry VIII confirming a decree of the privy council, under which the rate of tithes was fixed at 16½d for every 10s. rent, and at 2s. 9d. for every 20s rent of houses, shops and the like by the year. Provision was made by statute after the fire of London for certain annual tithes to be paid in parishes whose churches had been destroyed. Parliament in 1936 passed an act for the extinction of tithes.

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TITHING. Formerly throughout England, except in the north and west, every man had to be enrolled in a group of ten men, called a tithing, who were responsible for his appearance in court if he were accused of any offence. This was known as the system of frankpledge (*q.v.*). If the offender was not forthcoming, enquiry was made whether he was in frankpledge; if he were not, and had no right of exemption, the township was amerced, but if he were in a tithing, then it was upon the tithing that the amercement fell. South of the Thames the tithings were districts normally identical with the township which discharged the duties of the frankpledge. Some townships, however, contained more than one tithing. There are also indications that in the ancient kingdom of Mercia the tithing was originally a district and not a mere association of persons.

TITHONUS was, in Greek legend, according to Homer, the son of Laomedon, king of Troy and husband of Eos (the Dawn). In the Homeric *Hymn to Aphrodite* Eos is said to have carried him off because of his great beauty. She entreated Zeus that he might live for ever; this was granted, but she forgot to ask for immortal youth for him. He became a hideous old man; Eos then shut him up in a chamber; his voice "flowed on unceasingly," but his limbs were helpless.

A later development is the change of Tithonus into a grasshopper, after Eos had been obliged to wrap him like a child in swaddling-clothes and to put him to sleep in a kind of cradle. In some versions she is said to have carried him away to the land of Ethiopia near the ocean streams.

See O. Gruppe, *Griechische Mythologie*, 1 313, n. 16, who attributes a Milesian origin to the story; also the classical dictionaries.

TITI, a name properly applied to the small South American monkeys of the genus *Callicebus*. The titis, of which there are numerous species, inhabit the forests of Brazil and the neighbouring countries and feed on fruits, insects and even small birds. The tail is long and bushy, and is not prehensile. They are very vociferous, though less so than the howler (*q.v.*) monkeys of the same region. The name titi (also spelt teetee) is also sometimes used for the spider-monkeys (*Saimari*), small, richly coloured, largely insectivorous forms, inhabiting Central and South America. (*See* SPIDER MONKEY.)

TITIAN (*c.* 1477–1576), Tiziano Vecellio, or Vecelli, one of the greatest representatives of the Venetian school of painting. The house at Pieve di Cadore where he was born is now a small museum. Titian, one of a family of four, was the son of Gregorio Vecelli, a distinguished councillor and soldier, and of his wife Lucia. The date of his birth is generally given as 1477. Vasari in one passage (at variance with Ridolfi) says that Titian was born in 1480; while Titian himself, writing to Philip II. in 1571, professed to be ninety-five years old.

He was still a child when sent by his parents to Venice, to an uncle's house. There, according to Lodovico Dolce, he was placed under Sebastiano Zuccato, a mosaicist and painter. He next became a pupil of Gentile Bellini, and then of Giovanni Bellini. The youth was a contemporary of Giorgione and Palma Vecchio, who influenced him at first; when his period of pupilage expired, he is surmised to have entered into a sort of partnership with Giorgione. A lost fresco of "Hercules" on the Morosini Palace is said to have been one of his earliest works. In 1507–1508 Giorgione was commissioned by the state to execute frescoes on the re-erected Fondaco de' Tedeschi (warehouse for the German merchants). Titian worked along with him, as is known to us only by engravings. Towards 1511, Titian went to Padua, and painted in the Scuola di S. Antonio a series of frescoes, representing the life of the saint. Another fresco, dated 1523, is "St. Christopher carrying the Infant Christ," at the foot of the staircase in the ducal palace of Venice. From Padua Titian in 1512 returned to Venice; and in 1513 he obtained a broker's patent and became superintendent of the government works, being charged to complete the paintings left unfinished by Giovanni Bellini in the hall of the great council in the ducal palace (destroyed by fire). He set up an atelier on the Grand Canal, at S. Samuele. It was not until 1516, upon the death of Bellini, that he came into actual enjoyment of his patent, which yielded him an annuity of 120 crowns—and exempted him from certain taxes—he being bound in return to paint likenesses of the successive doges of his time at the fixed price of eight crowns each. The actual number which he executed was five. The year 1516 witnessed Titian's first journey to Ferrara. Two years later was completed, for the high altar of the church of the Frari, one of his most world-renowned masterpieces, the "Assumption of the Madonna." It excited a vast sensation.

Titian was now at the height of his fame; and in 1525, he married a lady of whom only the Christian name, Cecilia, has come down to us; he hereby legitimized their first two children Pomponio and Orazio. Pietro Aretino, the literary bravo, of influence and audacity, arrived in Venice in March 1527 and soon became intimate with Titian who sent a portrait of him to Gonzaga, duke of Mantua, in June 1527. In 1530 he painted in Bologna a portrait of the emperor Charles V., and was created in 1533 a count palatine and knight of the Golden Spur, his children also being made nobles of the empire—for a painter, honours of an unexampled kind.

The Venetian government, dissatisfied at Titian's neglect of the work for the ducal palace, ordered him in 1538 to refund the money which he had received for time unemployed; and Pordenone, his formidable rival of recent years, was installed in his place. At the end of a year, however, Pordenone died; and Titian was reinstated after having applied himself diligently to painting in the hall Barbarossa's Victory at Spoleto, erroneously referred to as Battle of Cadore. This great picture, which was burned with several others in 1577, represented in life-size the moment at which the Venetian captain, D'Alviano, fronted the enemy, with horses and men crashing down into the stream. Fontana's engraving, and a small copy in the gallery of the Uffizi in Florence, record the energetic composition. A visit was paid to Rome in 1546, when he obtained the freedom of the city and painted the portrait groups of Pope Paul III. and his two grandsons, the Cardinal Alessandro and the duke Ottavio Farnese. The picture now at Naples was left unfinished and Titian returned to Venice in the same year. In Jan. 1548 and again in 1550–51 he went to Germany to paint Charles V and others, in Augsburg. He executed the portraits of the elector of Saxony (Vienna) and of Philip II (now lost; copy in Madrid), which was sent to England and proved a potent auxiliary in the suit of the prince for the hand of Queen Mary. In 1554 his beloved daughter Lavinia, whom he painted various times, married Cornelio Scarcinelli of Serravalle; she had succeeded her aunt Orsa, now deceased, as the manager of the household, which, with the lordly income that Titian made, was placed on a corresponding footing. She died in childbirth in 1560. With his European fame, Titian is the last man one would suppose to have been under the necessity of writing letters for payment, especially when the defaulter addressed was lord of Spain and of the American Indies; yet he had constantly to complain that his pictures remained unpaid for and his pensions in arrear, and in the very year of his death (February) he recites the many pictures which he had sent within the preceding twenty years without receiving their price. In fact, there is ground for thinking that all his pensions and privileges, large as they were nominally, brought in but precarious returns. It has been pointed out that in the summer of 1566 (when he was elected into the Florentine Academy) he made an official declaration of his income, and put down the various items apparently below their value, not naming at all his salary or pensions. Possibly there was but too much reason for the omission.

In September 1565 Titian went to Cadore and designed the decorations for the church at Pieve, partly executed by his pupils. One of these is a Transfiguration, another an Annunciation (now

in S. Salvatore, Venice). He continued to accept commissions to the last. He had selected as the place for his burial the chapel of the Crucifix in the church of the Frari; and, in return for a grave, he offered the Franciscans a picture of the "Pietà." This work he nearly finished; but some differences arose regarding it, and he then settled to be interred in his native Pieve Titian was about ninety-nine years of age when the plague, which was then raging in Venice, carried him off on Aug. 27, 1576. He was buried in the church of the Frari, as at first intended, and his "Pietà" (now in the Venice Academy) was finished by Palma Giovane, who at that time was his assistant. He lies near his own famous painting, the "Madonna di Casa Pesaro." No memorial marked his grave, until by Austrian command Canova executed a monument. Immediately after Titian's own death, his son and assistant Orazio died of the same epidemic. His sumptuous mansion was plundered during the plague by thieves.

Titian's portrait of himself in the sixties is at Berlin, Madrid has his portrait as an old man of 80. He was highly distinguished, and a fine speaker, enjoying (as is said by Vasari, who saw him in the spring of 1566) health and prosperity unequalled. He was patronised by the Estes, the Gonzagas, the Medicis, the Farneses. He was favoured by Charles V. and by Philip II. He gave splendid entertainments; and it is related that, when Henry III. of France passed through Venice on his way from Poland to take the French throne, he called on Titian with a train of nobles, and the painter presented him as a gift with all the pictures of which he inquired the price. He was not a man of universal genius, like Leonardo da Vinci and Michelangelo; his one great and supreme endowment was that of painting. He carried to its acme the great colourist conception of the Venetian school.

Titian's pictures abound with memories of his home-country and of the region which led from the hill-summits of Cadore to the queen-city of the Adriatic. He was almost the first painter to exhibit an appreciation of mountains, mainly those of a turreted type, exemplified in the Dolomites. Indeed he gave to landscape generally a new and original vitality, expressing the quality of the objects of nature and their control over the sentiments and imagination with a force that had never before been approached. The earliest Italian picture, expressly designated as "landscape" was one which Titian sent in 1552 to Philip II. His productive faculty was immense, even when we allow for the abnormal length of his professional career.

The later pictures were painted loosely, telling well from a distant view. He himself avowed that after his visit to Rome in 1546 he had greatly improved in art; and in his very last days he said that he was then beginning to understand what painting meant. In his earlier pictures the gamut of colour rests mainly upon red and green, in the later ones upon deep yellow and blue. Palma Giovane records that Titian would set pictures aside for months, and afterwards, examining them with a stern countenance, as if they were his mortal enemies, would set to work upon them like a man possessed; also that he kept many pictures in progress at the same time, turning from one to the other, and that in his final operation on pictures of the last period he worked far more with finger than with brush. Michelangelo's verdict after inspecting the picture of "Danae in the Rain of Gold," during Titian's stay in Rome, "That man would have had no equal if art had done as much for him as nature," has often been quoted. He was thinking principally of draughtsmanship, for he added, "Pity that in Venice they don't learn how to draw well." However, as a draughtsman of the human figure Titian was competent and fine, and he is reported to have studied anatomy. His rendering of the nude was lifelike. He distanced all predecessors in the study of colour.

Titian's son, Orazio, born before 1525, who assisted Titian professionally, became a portrait-painter of mark. He executed a picture in the hall of the great council, destroyed by fire. Several other artists of the Vecelli family followed in the wake of Titian. Francesco Vecelli, his brother (d. 1560), was introduced to painting by Titian, and painted in the church of S. Vito in Cadore a picture of the titular saint armed. But he was diverted from painting to mercantile life. Marco Vecelli, called Marco di Tiziano (1545–1611), a distant relation, was constantly with the master, and learned his methods of work. He has left some able productions—in the ducal palace, the "Meeting of Charles V. and Clement VII in 1529"; in S. Giacomo di Rialto, an "Annunciation"; in SS. Giovani e Paolo, "Christ Fulminant." A son of Marco, named Tiziano (or Tizianello), painted early in the 17th century. There was another relative, Girolamo Dente, who, being a scholar and assistant of Titian, was called Girolamo di Tiziano. Various pictures of his were touched up by the master. Apart from members of his family, the scholars of Titian were not numerous. Paris Bordone and Bonifazio were the two of superior excellence. It is said that Titian engraved on copper and on wood, but this may well be questioned. He provided drawings for engravers. In 1508 according to Vasari appeared the series of woodcuts "Trionfi della Fede" designed by Titian (facsimile reproductions P. Kristeller, Berlin, 1906). A few bold and sketchy pen drawings are extant (Louvre, Uffizi).

We must now briefly advert to Titian's individual works, taking them in approximate order of time, and merely dividing portraits from other pictures. The earliest works which we proceed to mention may date towards 1505. In the chapel of S. Rocco, Venice, is his "Christ Carrying the Cross," now greatly dilapidated, it was an object of so much popular devotion as to produce offerings which formed the first funds for building the Scuola di S. Rocco in the scuola is his "Man of Sorrows." The "Tribute Money" ("Christ and the Pharisee"), now in the Dresden Gallery, dated towards 1508. In the church of S. Marcuola, Venice, is the "Christ Child between St. Andrew and St. Catherine", in S. Marziale the "Tobias and the Angel"; in the Capitoline Museum, Rome, "The Baptism of Christ"; in the Antwerp Museum, "Pope Alexander VII. presenting Jacopo Pesaro to St. Peter"; in the church of the Salute, Venice, St. Mark enthroned, along with SS. Sebastian, Roch, Cosmo and Damian. Somewhat later, painted before Giorgione's death in 1510 is the famous picture in the Villa Borghese, Rome, commonly named "The Sacred and Profane Love" (c. 1510–12). Towards 1512 was painted the "Three Ages," now in Bridgewater House—a woman guiding the fingers of a shepherd on a reed-pipe, two sleeping children, a cupid, an old man with two skulls, and a second shepherd in the distance—one of the most poetically impressive among all Titian's works, copies of which are in the Doria and Borghese galleries in Rome. Two of the pictures in the National Gallery, London—the "Holy Family With Adoring Shepherd" and the "Noli me tangere"—and the "Salome with the head of the Baptist" in the Doria Gallery, Rome, were going on at much the same time. The great Assumption in the Frari, Venice, painted in 1518, constitutes a landmark in Titian's work. Then followed three pictures painted for Duke Alphonso of Ferrara, the "Worship of Venus" showing the statue of Venus, two nymphs and many cupids, the "Bacchanal," with Ariadne dozing over her wine-cup, both now in Madrid, and the famous "Bacchus and Ariadne" in the National Gallery, completed in 1522. The "Resurrection of Christ" in S. Nazaro e Celso, Brescia, is dated 1522. The "Flora" of the Uffizi and the lovely "Venus Anadyomene" of the Bridgewater Gallery may date a year or so earlier. Another work of 1523 is the stupendous "Entombment of Christ" in the Louvre. The picture comes from the Gonzaga collection and from the gallery of Charles I. in Whitehall. In 1530 Titian completed the "St. Peter Martyr" for the church of SS. Giovanni e Paolo, for this work he bore off the prize in competition with Palma Vecchio and Pordenone. Of all his pictures this was the most daring in design of action. A fire destroyed it in 1867, the copy of it by Cardi da Cigoli has taken its place. To 1530 belongs also the "Madonna del Coniglio" (Louvre), painted for Gonzaga; to 1533 the "St. John the Almsgiver" for San Giovanni Elemosinario, Venice; to about 1538 belongs the "Venus" in the Uffizi, Florence; and the "Venus of Florence"; the portraits of the "Twelve Cæsars," for Gonzaga, no longer extant; the "Presentation of the Virgin in the Temple"—one of the conspicuous examples in the Venetian Academy, was finished in 1538. About 1540 were done the forcible paintings for S. Spirito, Venice, now in the church of the Salute —"Cain Killing Abel," the "Sacrifice of Abraham" and "David and Goliath", in 1543 the "Ecce Homo" of the Vienna Gallery,

where Aretino figures as Pilate The "Venus and Cupid" of Florence, the "Venus" of Madrid and the "Supper of Emmaus" in the Louvre were still in hand, or just completed, when Titian was summoned to Augsburg in 1547 Probably in the forties he also painted the "St John the Baptist" of the Academy at Venice, an impressive figure, classic in conception. In 1554 he sent to Philip II. in England a second "Danae" and a "Venus and Adonis." About the same time he sent to Charles V a "Trinity" (or, as Titian himself termed it, "Last Judgment"), which represented the emperor, with his family and others, all in shrouds, praying to the Godhead This was the object upon which Charles continued to keep his eyes fixed until the film of death closed on them A sketch of this picture ascribed to Titian has recently been acquired by the National Gallery, London Later pictures, from 1558 onwards, are the "Martyrdom of St. Lawrence," "Christ Crowned with Thorns" (Louvre), "Diana and Actaeon," "Diana and Callisto," "Jupiter and Antiope," the "Magdalene," "Christ in the Garden," and "Europa"—the last six for Philip II; the two Diana subjects are now in Bridgewater House, "The Europa" in the Gardner collection, Boston. The "Jupiter and Antiope," is commonly called "La Vénus del Pardo," having at first been in the Pardo Palace. It was presented to Charles I of England and is now in the Louvre In 1564 Titian offered to Philip II. his "Last Supper," which had been in hand for six years, it was cut down in the Escorial to suit a particular space. The "St. Jerome" of the Brera Gallery in Milan, a work of wonderful energy, spirit and force, was probably rather earlier than this The last "Madonna" painted by Titian is in the National Gallery (Mond Collection). It is enveloped in golden tone and loosely painted with utmost mastery of the brush. "The Christ Crowned with Thorns" in Munich and "The Entombment" in Madrid are powerful, emotional works of his last years Here as in his last work, "La Pietà," his work displays a mystic intensity which contrasts with the superb maternality of his middle period Two of the mosaics in St. Mark's church, Venice, namely, the Mark in pontificals and the sword sheathing angel on the right of the high altar, were said to have been worked out after Titian's designs

We now turn to the portraits—works great in style, stately, and simple in perception and feeling. Among the finest examples are Federigo Gonzaga of Mantua (Madrid), "The Lady at her Toilet," commonly called "Titian and his Mistress" or "Laura Dianti" (Louvre); Francis I. (Louvre), painted towards 1536, from a medal, for Titian never saw the French king; various likenesses of himself, one of about 1550, and another of 1562; Paul III (Naples)—done in about four weeks, was presented to the pontiff in May 1543 and cost two gold ducats; Pietro Aretino (Pitti); Titian's daughter Lavinia (Dresden); the Vendramin Family, until it left Alnwick Castle (1929) known as the Cornaro Family (Nat Gall); "L'Homme au Gant," an unknown youth (Louvre), Eleonora duchess of Urbino, Francesco duke of Urbino; Caterina Cornaro queen of Cyprus (Uffizi), Charles V on horseback after the battle of Mühlberg painted at Augsburg in 1548 (Madrid) and "Charles seated" executed at the same time (Munich); the portrait of a man called Alexander Medici (Hampton Court Palace), the physician Parma (Vienna) The female portraits done by Titian are few, usually of women of exalted rank. The beautiful Flora (Uffizi) and the Bella (Pitti) are among the master's most celebrated pictures. Of Ariosto the painter is said to have done three portraits. Much uncertainty, however, exists regarding these supposed portraits of Ariosto. One of the three appears as a wood-cut in an edition of the *Orlando furioso* A portrait from Cobham Hall in the National Gallery, London, was wrongly identified with Ariosto.

See Vasari, *Vite*, ed. Milanesi; L. Dolce, *L'Aretino, Dialogo della Pittura, Rime e Lettere* (Florence, 1910); J. A. Crowe and G. B. Cavalcaselle, *The Life and Times of Titian* (2 vols., 1877), Claude Phillips, *The Earlier Work of Titian* (1897, and ed. 1905), *The Later Work of Titian* (1898); G. Gronau, *Titian* (1900, Eng. trans. A. M. Todd, 1904); O. Fischel, *Tizian (Klassiker der Kunst* 1907); C. Ricketts, *Titian* (1910); C. Ridolfi, *Le Maraviglie dell' Arte* (ed. D. v. Hadeln, 1914); D. v. Hadeln, *Titian's Drawings* (1927).

(W. M. R.; I. A. R.)

TITLE GUARANTEE COMPANIES, the name given to companies which apply the principle of corporate indemnity to the protection of those interested in real estate titles, either as owners or lenders. They are of the class of indemnity companies in which technical skill and experience in investigation of risks are relied upon to protect the guarantor from loss. They are peculiar to countries where the title to real estate is a matter of public record, and where the complexity of the record and the variety of possible liens and encumbrances have made it difficult and expensive to determine whether the title is good. The only country where they have reached large proportions or achieved success as independent business enterprises is the United States. In Australia no investigation of a title to real estate is necessary, because before the land passed into individual ownership the government adopted a system of state registration and guarantee of title, so that its certificate of registered title was universally accepted. In certain other countries there is neither registration of title nor recording of deeds; the title-deeds are preserved and passed from owner to owner, and are accepted on the authority of the records and opinions of family solicitors. In the United States, however, there have been from the beginning acts providing that all deeds and mortgages be recorded, and the records, when properly made, constitute legal notice to all the world of their contents and claims At the same time, there are other records of wills, suits, judgments, taxes and mechanics' claims which may encumber the title In the great cities these various records became in course of time so voluminous that the proper investigation of them, and the determination of the validity of the title in view of them, required the best skill of an experienced lawyer and involved very heavy expenses. On a re-sale of the property the new buyer did not rely upon the lawyer who had made the examination for the seller, but felt called upon to employ and pay his own lawyer, who had to go over the same work again, and more, for with each new transaction the history was getting longer. The delay and expense involved were great, and yet the owner had little or no protection, for a lawyer is not held to guarantee the correctness of his opinion.

The first company actually to undertake the guarantee of real estate titles was formed in Philadelphia, Pennsylvania, in 1876. It differed from the Prussian Mortgage Insurance company (which guaranteed titles merely as an incident in its business as a dealer in, and custodian and guarantor of, mortgages) in that its main business was the issue of a policy of guarantee on a transfer of title to land. The advantages of its method were immediately recognized. Corporations to carry on the business were organized in New York, Washington, Baltimore and Boston, and subsequently in nearly every considerable city in the United States.

In order to be independent of the inaccurate and clumsy methods of the public record offices, title guarantee companies generally compile in their own office a copy or digest of all the real estate records of the locality in which they are established, maintaining for this purpose a staff of skilled clerks. To make the necessary examination of a title prior to the issuing of a guarantee, they require continually a body of experienced real estate lawyers. By these means a title can be examined and guaranteed in a week, whereas thirty or forty days was formerly required. This has done much to make real estate available capital, for individual and corporate lenders on mortgage accept the guarantee of the companies as the best evidence of title, and loans can be had without the delay that once prevailed

The expense of maintaining the staff of clerks and lawyers is great, amounting to half of the gross charges on titles guaranteed. Strictly speaking, the risks outstanding are also large, running up to $100,000,000 a year for a single company in New York city; but in well-managed companies the losses are very small, not exceeding 2% of the gross charges on titles guaranteed, so that the outstanding obligations should scarcely be called risks. In spite of the office expenses, the charges for first bringing a piece of land under the guarantee are no more than owners were in the habit of paying each time for examination and opinion by counsel, amounting to about one-half of 1% on the value of the property or on the amount of the mortgage; and when once the guarantee has been issued, it is re-issued on a subsequent **sale or mortgage on short**

notice and for a small fee. (C H K)

TITLE INSURANCE or **GUARANTEE OF TITLE,** a term used in the United States for a policy of insurance or a guarantee of indemnity (*see* TITLE GUARANTEE COMPANIES), giving protection and safeguard to an owner of real estate, or a lender of money upon it, against any loss or damage that he might sustain because of any defect in the title prior to the date of the policy, because of the unmarketability of the title or because of any unknown liens or encumbrances against the property, prior to the date of the policy

There are two kinds of property that people use and own—real and personal Real estate, land, constitutes the real property; stocks, bonds, monies and such movable and chattel holdings are the personal Personal property can be handled almost at will and in any manner of choice. Real estate is immobile. Real property rights and how one may use, own, possess—in fact, employ and enjoy the land he owns, have been safeguarded, restricted and defined in a very prescribed way by law, and custom has also exerted a considerable influence.

In many countries, the ownership of land is restricted to the few There is little incentive and almost no possibility for the general ownership, widespread buying and selling of land. In them, title to real estate is largely a matter of inheritance Ownership and the matters of title are ascertained from family records, files of title deeds of conveyance, wills and the tradition and general knowledge to be had about the title to the property. Family solicitors have usually handled such matters for generations, taken care of things as they appeared, and upon occasion, given the necessary details and furnished opinions about the title and rights of persons involved In America, however, probably more than in any other country, anyone can acquire land, and the buying, selling and using of real estate as security, are everyday matters.

It is absolutely necessary, however, in any real estate transaction, whether it be a sale, settlement of an estate where there is a division of real property, the lending of money with a real estate mortgage as security, and in fact, in all cases where real estate is involved, to know the condition of the title It should always be ascertained who owns the property and that there are no adverse claims or owners of interests other than those of the reputed owner; that all taxes are paid or discovered, because any due or unpaid taxes, whether general, State, county, township, or for special purposes such as parks, paving, public improvements, are liens upon the lands against which they are levied; that there are no suits pending, mechanics' liens, judgments rendered in any local court or liens filed by the Federal Government for fines in violation of some Federal statute or unpaid taxes due from the provisions of the Internal Revenue Act which are liens upon the real estate involved, and also that there are no matters in any probate or surrogate court affecting the title It is, therefore, the title to real estate that one acquires or lends money upon, and not the land itself. In order to keep a history or record of the titles to the lands, the United States has what is known as the public recording system All matters affecting the title to all parcels of land, including transfers, estates, taxes and suits, are entered and recorded in their proper offices and courts of records.

There are two principal kinds of policies, the owner's (or fee) and the mortgagee's policy The owner's policy guarantees the title to the property and the protection runs to the insured owner or purchaser. The mortgagee guarantees the title to be vested in the mortgagor at the time of making the mortgage; that the indebtedness secured by the mortgage or trust deed is a valid first lien on the property, and upon being transferable to an assignee, insures the validity and genuineness of the assignment of the lien. In case of loss, failure of title or attack it becomes the duty of the title company to indemnify its insured, take over the property or defend the action. The protection of title insurance covers all matters and questions that might be raised about all matters disclosed of record, and in addition things not disclosed or possible to ascertain. These last mentioned include forgeries, frauds, false representations, lost deeds and wills, deeds made by infants, deeds by lunatics, invalid and revoked powers of attorney, claims of undisclosed heirs, mistakes of law, jurisdictional questions, conflict of legal decisions and opinions and many others

Title insurance is peculiar to the United States because of the facts that the country has a public recording system, that it is not only necessary to ascertain all the minute facts and evidence about the title, but likewise arrive at and secure an opinion as to the sufficiency and legality of each step and matter Title insurance is a guarantee and protection as to all matters of record, as to the completeness and accuracy of the compiled evidence, as to things not disclosed or ascertainable and the opinion as to their legality and validity In order to do this, an abstract or history of title is first compiled This evidence of title is then examined and passed upon by authorities on title law and real estate title matters Physical examinations and surveys of the premises are also made and the policy then issued (R B. HA)

TITLES OF HONOUR, "those various names of greatness or eminency, which are the most distinguishing titles of civil dignity" (John Selden, *Titles of Honor*) This definition covers, if we understand "civil" in its proper and widest sense, all titles, whether official or honorary, civil or military, temporal or ecclesiastical In general, however, we now understand by titles of honour what Selden calls "honorary titles," *i.e*, distinctive designations implying rank and dignity, not office or vocation. *See* PEERAGE, FORMS OF ADDRESS; EMPEROR, KING, PRECEDENCE, etc

TITMOUSE (often abbreviated to "tit"), meaning a little mouse, the popular name of any of a number of birds of the genus *Parus*, family *Paridae*, of the order Passeres. The genus is usually non-migratory, and is widely spread throughout the world, being found everywhere except in South America and the Australian region east of Flores.

The great titmouse or ox-eye (*P. maior*) is found all over Europe and north Asia. It is conspicuous by its black head, white cheeks and yellow breast with a black band down the centre. Its love-note resembles the note made in sharpening a saw. Equally widely distributed and even more common is *P caeruleus*, the blue titmouse, with a plumage of blue and yellow. Not dissimilar are the coal-titmouse (*P. ater*), distinguished by its black cap and white cheek and nape, and the marsh-titmouse (*P palustris*), which is more soberly coloured The crested titmouse (*P cristatus*) inhabits the mountain pine-woods of Scotland and Europe generally. The most familiar American form is the chickadee (*q.v.*) or black-capped titmouse (*P. atricapillus*), but other species of the genus *Parus* and the allied genera *Psaltriparus* and *Auriparus* occur.

During most of the year, the various species associate in family parties, only breaking up into pairs to breed Composite bands of several species are often to be seen during the winter The nests are placed in hollow stumps, holes in walls or similar situations and have a thick lining of feathers and hair The eggs, often eight or nine in number, are white, freckled with rust colour Of a restless disposition, the birds feed largely on insects, but in winter will readily eat suet, coco-nuts and seeds, particularly those of the sunflower By their destruction of harmful grubs, these birds are of incalculable value to the gardener



BY COURTESY OF NATIONAL ASSOCIATION OF AUDUBON SOCIETIES
TUFTED TITMOUSE (P BAEOLOPHUS) OF THE UNITED STATES

The allied genus *Acredula* includes the long-tailed titmouse (*A. caudata*), which has a tail longer than itself and builds a beautiful oval nest of lichen, moss and wool lined with feathers. Over 2,000 feathers have been taken from one nest. When the female is brooding her tail is bent over her back and protrudes at the nest entrance.

The bearded titmouse, reedling or reed-pheasant (*Panurus biarmicus*) inhabits reed-beds. It belongs to a different family, the *Panuridae*

TITO (Josip Brozovich or Broz) (1892–), Yugoslav army officer and statesman, was born on May 25, 1892, near Zagreb, Croatia. He served in the Austro-Hungarian army in World War I, was captured by the Russians and in 1917 joined the Red army. Returning to Croatia after the war, he became a labour leader and Communist organizer, assuming the pseudonym Tito. After the Germans overran Yugoslavia in 1941, Tito organized a leftist guerrilla group which effectively harried the occupation forces. In 1945 Tito, who had appointed himself marshal, became prime minister and minister of national defense. He later was named president of the council of ministers. On June 28, 1948, the Cominform published a statement denouncing Tito, who thereupon left the camp of soviet satellites.

TITUS, like Timothy, in the New Testament, is known from allusions in the Acts of the Apostles and the Pauline epistles. He was a convert from paganism, and St. Paul refused to allow him to be circumcised (Galatians ii. 1 *seq.*) at Jerusalem, when the conservative party demanded this concession to religious feeling. He then appears in connection with the Corinthian church (*see* the Corinthian epistles), where he won the highest praise from the apostle for his upright and loyal services. He was specially entrusted with the business of organizing the collection for the poor Christians of Judaea, in the Achaian churches (2 Cor. viii. *seq.*), and evidently acted as a commissioner of the apostle Paul at Corinth during the dispute which followed. According to 2 Tim. iv. 10 he went off subsequently on a mission to Dalmatia, but the Epistle addressed to him implies a tradition that he superintended the work in the island of Crete, as a delegate of his chief. Later tradition made him bishop of Crete. Modern criticism has sometimes identified him with the author of the "We"-journal in Acts, and even thought that he was a brother of Luke (see *Expository Times*, xviii. 285, 335, 380). (J. Mor.)

TITUS, EPISTLE TO: *see* Pastoral Epistles.

TITUS, FLAVIUS SABINUS VESPASIANUS (A.D. 40 or 41–81), Roman Emperor 79–81, son of the emperor Vespasian, was born on Dec. 30, A.D. 40 (or 41). As a young man he served with credit in Germany and Britain, and had command of a legion under his father in the Jewish War. In 68 he was sent by his father to congratulate the newly proclaimed emperor Galba, but hearing of Galba's death he returned to Palestine. The next year Vespasian, having been proclaimed emperor, went to Italy, leaving Titus to carry on the siege of Jerusalem, which was captured on Sept. 8, 70. On his return to Rome he and his father celebrated a triumph, recorded by the "Arch of Titus." For the rest of Vespasian's reign he was associated with him in the government with the title of Caesar. During this time he was not popular, and he outraged public opinion by his connection with Berenice, sister of Herod Agrippa; both of them came and lived in the palace for a while, but Titus had to send her back. He succeeded his father in 79, and falsified the pessimistic prophecies of his detractors. He put an end to prosecutions for treason, banished the informers, and became *pontifex maximus* to avoid shedding blood. He was notably lenient to Domitian, who plotted against him. The Flavian amphitheatre (Colosseum) was finished in his reign, and he built new baths in Rome. He visited Pompeii when it was destroyed in 79, and contributed to its relief; during his absence there was a three days' fire in Rome, and he again gave his assistance. The empire was peaceful during his reign. The only fighting was in Britain, where Agricola conquered as far as the Tay. Titus died on Sept. 13, 81.

See Suetonius, *Titus*, Dio Cassius lxvi. 18–26; C. Beulé, *Titus et sa dynastie* (1870); L. Double, *L'Empereur Titus* (1877); Merivale, *Hist. of the Romans under the Empire* (ch. 60); H. Schiller, *Geschichte der römischen Kaiserzeit*, i. vol. 2.

TITUS TATIUS, in Roman legend, the Sabine king of Cures, who waged war upon the Romans to avenge the rape of the Sabine women (*see* Romulus). After various indecisive conflicts the latter, who had become Roman matrons, intervened and prevailed upon the combatants to cease fighting. A formal treaty was then arranged between the Romans and Sabines, whereby Romulus and Tatius were to be joint and equal rulers of the Roman people. Rome was to retain its name and each citizen was to be called a Roman, but as a community they were to be called Quirites (*q.v.*), the Sabines were to be incorporated in the state and admitted into the tribes and curies. After this arrangement had lasted for five years it came to an end by the death of Tatius, who was killed out of revenge by the inhabitants of Lavinium. According to Mommsen, the story of his death (for which *see* Plutarch) looks like a historical version of the abolition of blood-revenge. Tatius, who in some respects resembles Remus, is not an historical personage, but the eponymous hero of the religious college called *sodales Titii*. As to this body Tacitus expresses two different opinions, representing two different traditions, that it was introduced either by Tatius himself to preserve the Sabine cult in Rome, or by Romulus in honour of Tatius, at whose grave its members were bound to offer a yearly sacrifice. The *sodales* fell into abeyance at the end of the republic, but were revived by Augustus and existed to the end of the 2nd century A.D. Augustus and the emperor Claudius belonged to the college, and all its members were of senatorial rank.

See Livy i. 10–14; Tacitus, *Annals*, i. 54, *Hist.* ii. 95; Dion. Halic. ii. 36–52; Plutarch, *Romulus*, 19–24, Marquardt, *Römische Staatsverwaltung* (1885) iii. 446; Schwegler, *Romische Geschichte*, bk. ix. 3, 14, x. 5.

TITUSVILLE, a city of Crawford county, Pennsylvania, U.S.A., on Oil creek, 1,180 ft. above sea level, 42 mi. S.E. of Erie, served by the New York Central and the Pennsylvania railways. Pop. (1950) 8,921.

It is in the oil and gas region of northwestern Pennsylvania. Development of the field dates from Aug. 27, 1859, when the first artesian oil well in America was drilled just outside Titusville by Col. Edwin L. Drake (1819–80), in whose memory a monument was erected in Woodlawn cemetery by Henry H. Rogers in 1902. It was in the Titusville district that the natural gas resources of Pennsylvania were first developed (about 1872). On June 5, 1892, a cloudburst so flooded Oil creek that it wrecked many oil tanks along its banks. The oil caught fire (probably from lightning) and a mass of flames was carried down the creek, causing the loss of 60 lives and great damage to property. Titusville was founded in 1796 by Samuel Kerr and Jonathan Titus. It was incorporated as a borough in 1847 and chartered as a city in 1866. Drake Well Memorial park (a state park) is located at the site of the Drake well.

TIVERTON, a municipal borough of Devon, England, at the confluence of the Loman and Exe, 164 mi. W. by S. of London by the G.W. railway. Pop. (1938) 9,870. Area 28 sq. mi. St. Peter's church, originally consecrated as a chapel by Leofric, bishop of Exeter, in 1073, is Perpendicular. Of the original Norman fabric only a doorway remains. Of the castle, founded about 1105 by Richard de Redvers, the banqueting-hall, a tower, the chapel and a 14th-century gateway remain. Blundell's school, founded in 1604, has modern buildings outside the town in Tudor style.

After the decline of its woollen trade Tiverton became noted for the lace manufacture introduced by John Heathcoat (1783–1861), inventor of the bobbin net frame.

Tiverton is mentioned under the name of Tuyford in the will of King Alfred. In the Domesday survey it appears as a royal manor containing two mills, but it was bestowed by Henry I. on Richard de Redvers, and in 1245 appears as a mesne borough under Baldwin de Redvers. In 1615 the borough received its first charter of incorporation from James I. Fresh charters of incorporation were granted by James II. in 1689 and by George I. in 1724. It is in the Tiverton parliamentary division of Devon.

See *Victoria County History: Devonshire;* M. Dunsford, *Historical Memoirs of the Town and Parish of Tiverton* (Exeter, 1790), W. Harding, *History of Tiverton* (1845–47).

TIVOLI, (ancient *Tibur*), a town and episcopal see, province of Rome, 18 mi. E.N.E. of Rome by road and tramway, 24½ mi. by rail, 760 ft. above sea level. Population (1936), 16,886 (town), 20,875 (commune). Tivoli lies on the west of the Sabine mts., where the river Anio issues from them, upon a limestone rock above the river. The town on one side overlooks the Campagna di Roma and Rome itself, on the other the deep gorge of the Anio, with its lofty falls, and the environs are very beautiful.

Tivoli is in part built upon the extensive terraces of the temple of Hercules Victor, the chief deity of Tibur, of which some

remains exist A modern improvement is a channel, consisting of two parallel tunnels 290 and 330 yd long, which was made to the N E of the city in 1826–35, after a flood of the Amo led to a change in its course and threatened to carry away the town. On emerging from these tunnels, the river has a fall of 354 ft. Farther N W are smaller falls (the *cascatelle*) of that portion of the river which is carried through the town and serves for industrial purposes. Five miles W. are the sulphur baths of Acque Albule, with a temperature of 75.2° F They were known to the ancients and are still frequented. Tivoli has numerous remains, many of them dating from ancient Roman times. Tibur was a favourite place of resort for such Romans as Augustus, Maecenas, Hadrian Horace and Suetonius, all of whom had villas there, and Suetonius, as well as Catullus and Statius, made Tibur famous with their enthusiastic praise. The remains of villas in the district are numerous and important, particularly those of Hadrian's villa, which contained statues, marbles and fine mosaic pavements, some of the last being preserved *in situ* The Villa d'Este, begun in 1549 by Pirro Ligorio for Cardinal Ippolito d'Este the younger, has the finest example of a Renaissance garden in Italy The castle was built in 1460 by Pius II on the site of the amphitheatre and is now a prison. The town contains numerous old churches and houses, and there are some fine paintings of the later middle ages and early Renaissance in the cathedral.

Ancient Tibur.—Though on the edge of the Sabine mountains, Tibur was a member of the Latin league It allied itself with the Gauls in 361 B C, and in the war which followed the towns of Empulum and Saxula were destroyed and triumphs over Tibur were celebrated in 360 and 354 B C., and again in 338 when its forces were defeated with those of Praeneste. It became, however, an ally of Rome Its prosperity during the imperial period was mainly due to the favour in which it stood as a summer resort During the siege of Rome by Narses, Belisarius occupied Tibur; it was afterwards treacherously surrendered to Totila, whose troops plundered it, but who rebuilt it in A D 547 (T. A ; X.)

TJAP PRINTING, a kind of block printing executed by means of dipping blocks into heated wax and then impressing them upon the material—usually a cotton or silk fabric—after which it is dyed and the wax removed, leaving a permanent design These blocks are made by the natives of Java and the other islands of the East Indies by bending small strips of copper into the desired curves for sections of the pattern and inserting them into the end grain of the blocks of wood, allowing them to project a little less than one-eighth of an inch from the surface (*See* BATIK)

TLAXCALA, smallest state of Mexico Pop. (1950) 282,495; area, 1,554 sq mi , gives it the highest density (182 persons per square mile) among Mexican states It is surrounded on three sides by the state of Puebla and is bounded west and northwest by the states of Mexico and Hidalgo Lying on the great Mesa Central, it has a mean altitude of 7,000 ft. that provides it with a cool, healthful climate Railways and highways link it to the federal capital, Mexico City (66 m. W N W) and Puebla (14 m S). Almost exclusively agricultural, Tlaxcala grows cereals and has numerous handicrafts, notably weaving of serapes and woollen cloth It is the descendant of the Indian principality of Tlaxcala which refused to surrender to the Aztec confederation and joined Hernan Cortés as his principal Indian ally in the conquest of Mexico (1519–21). Continued loyalty to Spain brought the Tlaxcalans many subsequent privileges. Capital of the state is Tlaxcala (4,000), largest of numerous towns and villages.

(HD. C.)

TLAXCALA, a town of Mexico, capital of a state of the same name, on the Atoyac river, 7,500 ft. above the sea, 85 mi. E. of Mexico City by rail. Pop. (1950) 4,000. Historic interest attaches to the church of San Francisco, the first erected on the American continent, which still contains the vestments, pulpit, font and cedar ceiling brought from Spain in 1521.

TLEMÇEN, a town of Algeria, the capital of an arrondissement in the department of Oran, near the frontier of Morocco, 68 mi. by road and 102 by rail S.W. of Oran. Pop. (1948) of the town, 50,272; of the commune, 69,668, of which 12,899 were Europeans. It stands 2,500 ft. above the sea, on the north slope of the Lella Setta hills (4,000 ft.). The railway from Oran runs from Tlemçen to Ujda and thence to Rabat via Fez. Another line links Tlemçen to the port of Beni-saf.

The various quarters are grouped around the principal mosque —the Jewish to the southwest, the Moorish to the southeast, that of the merchants to the northeast, while the new town with the civic buildings lies to the northwest. Of the 64 mosques which existed at the period of the French conquest, several have disappeared. The great mosque (Jamaa-el-Kebir) has a brick minaret 112 ft. high, adorned with marble columns This mosque was built A D 1136 to replace a much older building. The mosque of Sidi Ahmed bel Hassan, usually called Abul Hassan, built A D. 1298, now transformed into a museum of antiquities, has two series of arches, which rest on alabaster pillars The courts are ornamented by sculptures of great beauty and richness, the delicately-carved cedar ceiling bears traces of polychromatic painting. The mosque of El-Halawi (the Sweetmeat Maker), dating from 1353, has eight magnificent columns of Algerian onyx The ceiling of cedar is richly carved, and there is a fine colonnade on each side of the court. The military authorities occupy the Meshuar or citadel, built in 1145, which separates the Jewish and Moorish quarters and was formerly the palace of the rulers of Tlemçen Only the minaret of the mosque, dating from the 14th century, and the battlemented wall, flanked by two towers, remain of its former magnificence. The vast basin (*sahrij*) under the old walls, now dry (720 ft in length, 490 in width and 20 in depth), was apparently made for naval exhibitions A covered market occupied the site of the *Kissaria*, the place of residence of European merchants from Pisa, Genoa, Catalonia and Provence Besides the large trade carried on there are native manufactories of cloth, carpets and leather articles A special manufacture is that of red shawls, used by Jewish women when in mourning In the immediate neighbourhood of the modern Tlemçen are numerous remains of the fortifications of Agadir (*vide infra*), and the minaret of the mosque, a beautiful tower dating from the 13th century, the lower part of which is built of large hewn stones from the Roman Pomaria. More noteworthy, however, are the ruins of Sidi Bu Medin and of Mansura. Sidi Bu Medin (more properly El Eubbad) is a little over a mile southeast of Tlemçen. It was founded A D. 1337 by Ali V, the first of the Beni-Marin (Marinide) sultans who ruled Tlemçen. The *kubba* or tomb of Sidi Bu Medin, near the palace, is held in great veneration by the Arabs. The adjacent mosque is a beautiful specimen of Moorish art.

Mansura, which is about 1½ mi west of Tlemçen, owes its foundation to the attempts of the Beni-Marin rulers of Morocco to extend their sovereignty. The Amir Abu Yakub Yusef besieged Tlemçen in the early years of the 14th century. The siege lasted eight years, and Yusef turned his camp into a walled city. The siege being raised, El Mansura (the victorious), as the new city was called, was abandoned It was reoccupied when (1335) Ali V renewed the siege, which this time proved successful. On the expulsion of the Marinides in 1359 Mansura was finally deserted

Besides the walls and towers, and the minaret of the mosque, little remains of Mansura, of which Ibn Khaldun has left a contemporary and graphic sketch. The minaret was one of the finest mosque towers in Algeria. It was 125 ft. high, and was built of hewn stone (X.; A BE)

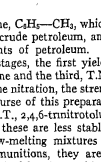
The Sultanate of Tlemçen.—In 1248 Tlemçen was captured by Abu Yahia Yarmorasen (C'hamarasan) who was chief of the Zenata tribe of Berbers and claimed descent from the Caliph Ali. Yarmorasen, who died in 1282, founded the dynasty of the Abd-el-Wahid, who ruled the greater part of what now constitutes Algeria. Under their sway Tlemçen flourished exceedingly. The presence of Jews and Christians was encouraged and the Christians possessed a church The bazaar of the Franks (*kissaria*) was a large walled enclosure, the gates of which were closed at sunset. As many as 5,000 Christians lived peaceably in Tlemçen, and the sultan included in his army a Christian bodyguard. In 1337 the power of the Abd-el-Wahid was temporarily extinguished by the Marinide sultans of Morocco They left fine monuments of the period of their ascendancy, which lasted 22 years. Once more, under the Abd-el-Wahid, now known as the Beni-Zeiyan,

from 1359 to 1553, Tlemçen enjoyed prosperity. It had a population reputed to number 125,000, an extensive trade, a brilliant court and a powerful army. The Spanish occupation of Oran (1509) struck a fatal blow at the European commerce of the town The Beni-Zeiyan, after the capture of Algiers in 1516 by the corsair Barbarossa (*q.v.*), gradually lost their territory to the Turks, while Tlemçen itself for 40 years became tributary to the Spanish governor of Oran In 1518 the town was held for a short time by Arouj Barbarossa, but Arouj was killed in a fight with the Spaniards In 1553 the Turks under Salah Rais, pasha of Algiers, captured Tlemçen and the Sultanate of Tagrart, as it was still frequently called, came to an end. Under the Turks the town ceased to be of any importance. When the French entered Algeria the sultans of Morocco were disputing the possession of Tlemçen with the Kuluglis, who fought first for themselves and afterward for France In 1835 Abd-el-Kader, on whose appearance the Moors retired, sought to re-establish the ancient empire of Tlemçen, but he retreated before Marshal Bertrand Clauzel in 1836. The treaty of the Tafna (1837) gave Tlemçen to Abd-el-Kader, but, war being renewed in 1842, Tlemçen was definitely occupied by the French.

BIBLIOGRAPHY.—W and G. Marçais, *Les Monuments arabes de Tlemçen* (1903). This accurate and finely-illustrated work, one of the publications of the *Service des monuments historiques de l'Algérie*, cites the principal works dealing with Tlemçen, and gives a critical estimate of their value. *See* also A. Bel, *Tlemçen et ses environs* (with bibliography) (1908), A Bel and P Ricard, *Le travail de la laine à Tlemçen* (Algiers, 1913) (F. R. C.; X)

TLINGIT, one of the tribes, or rather assemblages of tribes, of the North Pacific coast Indians, inhabiting the coastal strip of southeastern Alaska as far northwest as Controller bay. Their culture is that of the area, with dependence on fishing, canoe navigation, woodworking, totemic art, potlatch wealth distribution and slavery They are divided into Raven and Eagle (or Wolf) moieties, and subdivided into matrilineal clans. The language is superficially distinct, but may prove ultimately to relate with Haida and Athabascan (Na-Dene family). Population, at discovery (est.) 10,000; 1861, 8,600; 1910, 4,400. (A L. K)

T.N.T. (trnitrotoluene, $C_7H_5O_6N_3$, trotyl, triton, tolite, etc.) was discovered by J. Wilbrand in 1863, but its explosive properties became known only later when detonators (*q v.*) were adopted as the means of initiating high explosives. It was introduced into large-scale use during World War I and became the standard explosive in World War II, during which combined production of several warring nations ran into several thousand tons daily. Its structural formula is.



T N.T. is prepared by nitration of toluene, C_7H_8—CH_3, which is obtained by distillation of coal tar or of crude petroleum, and is made synthetically from other components of petroleum. This nitration is usually carried out in three stages, the first yielding mononitrotoluene, the second, dinitrotoluene and the third, T.N.T. Mixed nitric-sulphuric acids are used for the nitration, the strength increasing from stage to stage. In the course of this preparation isomers of the desired product—alpha T N.T., 2,4,6-trnitrotoluene —are formed in small quantities. Since these are less stable to heat and have the tendency to form low-melting mixtures and hence to cause exudation from loaded munitions, they are removed; this purification is best accomplished by the washing of crude T.N.T. with 5% sodium sulphite solution.

T N.T is a pale yellow crystalline powder, melting point 80.5° C., specific gravity 1.65. T.N T is only slightly soluble in water but is easily soluble in benzene, toluene and acetone. It is stable to heat and decomposes slowly only when heated above about 180° C.

Because of its low sensitivity to percussion, its low melting temperature (which permits it to be melted in steam-heated kettles) and its high explosive performance, T N T. became the most favoured of military explosives It is used singly and in mixtures with other explosives to load (by casting) all types of munitions. (*See* also BLASTING; EXPLOSIVES; NITROGLYCERIN.)

BIBLIOGRAPHY —A. Marshall, *Explosives*, 3 vol (1917–32); T. L. Davis, *The Chemistry of Powder and Explosives* (1941) (G. B. K)

TOAD, a name commonly applied, in contradistinction to "frog," to tailless amphibians of stout build, with warty skin. The true toads are the *Bufonidae* with dilated processes to the sacral vertebra and without any teeth in the jaws. The genus *Bufo* comprises about 100 species; smaller genera are *Nectophryne*, *Pseudobufo* and *Nectophrynoides* Some true toads are as smooth skinned as the typical frogs, while on the other hand some true frogs (*Rana*), adapted to burrowing habits, are superficially quite toad-like. The *Bufonidae* include terrestrial, burrowing, aquatic and arboreal types

The genus *Bufo* is represented in every part of the world except the Australian region and Madagascar. Two species are found in the British Isles: the common toad, *B. bufo*, and the more local natterjack, *B calamita*, which has a pale yellow line down its back and legs so short that it runs instead of hopping. The common species of eastern North America is *B. americanus*. The wide-spread "marine" toad of tropical America, *B. marinus*, has been introduced in the West Indies, Hawaii and in the Solomons. Toads lay their eggs in long strings, forming double files in jelly-like tubes They feed on worms and insects, and may make themselves useful in gardens. (*See* AMPHIBIA.)

(K. P S)



BY COURTESY OF IOWA GEOLOGICAL SURVEY
TOADFLAX OR BUTTER-AND-EGGS

TOADFLAX (*Linaria*), a genus of small plants of the family Scrophulariaceae (*q v.*), allied to the snapdragon (*q.v.*), but distinguished by the possession of a long spur at the base of the corolla. The common toadflax (*L vulgaris*), called also butter-and-eggs, has yellow flowers and creeping roots and is a wide-spread weed in grasslands

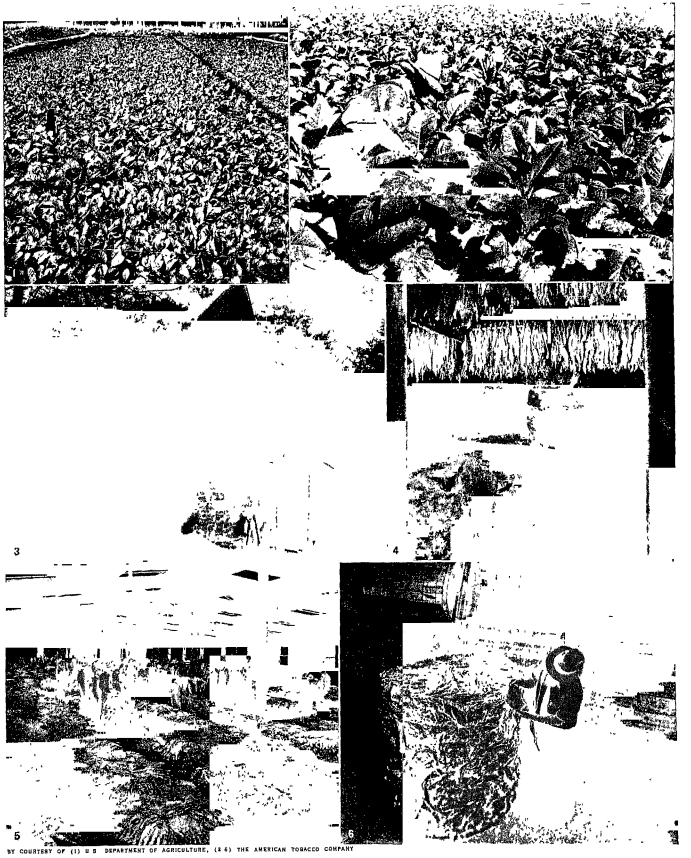
TOADSTOOL, the popular name for poisonous or inedible mushrooms, but entirely without diagnostic significance.

TOALA, a tribe of the south-west of the Celebes, probably of mixed pre-Dravidian stock.

TOBACCO. The name given to the plant and cured leaves of several species of *Nicotiana* which may be used immediately but, commonly, after aging and processing in various ways, by man for the purpose of smoking, chewing, snuffing and extraction of nicotine Nicotine and related alkaloids of tobacco furnish the habit-forming and narcotic effects which account for the general world-wide use.

Botany.—The tobacco of commerce is derived almost entirely from *Nicotiana tabacum*, native to South America, Mexico and the West Indies *N rustica* was the species cultivated by the aborigines of eastern North America and is cultivated in Asia Minor, the U S S.R., India and several European countries. These two species were known to Linnaeus and described by him in 1753. Certain other species, such as *N attenuata*, *N. trigonophylla* and *N. quadrivalvis* have been utilized for smoking by the Indians of western North America. There are numerous species of *Nicotiana* besides those mentioned, two of which are commonly used as ornamentals, namely, *N sylvestris* and *N alata*. The best evidence available indicates that all species of *Nicotiana* are native to America with the exception of *N. suaveolens* and the related native Australian species

Common tobacco, *N. tabacum* (fig 1), of which there are numerous varieties, usually reaches a height of 4 to 6 ft. when not



BY COURTESY OF (1) U S DEPARTMENT OF AGRICULTURE, (2 4) THE AMERICAN TOBACCO COMPANY

GROWING AND MARKETING OF TOBACCO

1. Tobacco seed bed, with plants of a suitable size for transplanting
2. Farmer "topping" tobacco plants so that they will spread out and grow larger leaves
3. Feeding the fires in a flue-cured tobacco barn. The flues from the exterior stoves run through the drying room inside
4. Interior of a flue-cured tobacco barn, showing the pipes (below) that transmit the heat
5. Auction floor in a tobacco warehouse
6. An open hogshead of tobacco

TOBACCO



BY COURTESY OF THE AMERICAN TOBACCO COMPANY

FURTHER STEPS IN THE PREPARATION OF TOBACCO

1. Tobacco entering a redrying machine
2. Machine which removes stems from the leaves
3. Shredding machine
4. Final mixing of blended tobaccos in a "merry-go-round." The tobacco is now ready for the manufacture of cigarettes

topped The flowers, borne in a panicle, normally self-fertile, are pink as a rule, although white and carmine red forms are known. The flower is tubular in shape with the corolla tube (figs 2B, 3) greatly exceeding the calyx in length. The lobes of the corolla are distinctly pointed and separated and are five in number. The leaves, varying in number with the variety, are arranged alternately, commonly sessile, that is, without petiole or stalk, and auricled or partly clasping the stem They vary greatly in size and shape depending upon the variety and growing conditions. The leaves of some of the larger-growing varieties may reach a length of 2 to 3 ft., with a width of about one-half the length, although some of the Turkish kinds, as grown commercially, are sometimes less than 3 in in length A plant may produce as many as 1,000,000 seeds, but under usual conditions produces around one-half ounce of seed (150,000 to 200,000 seeds). *N rustica* varies in height from 2 to 4 ft and commonly shows a decided development of suckers or axillary shoots The leaves tend to be thick, broadly ovate with a distinct naked petiole The corolla tube (fig. 2A) is short, with distinctly rounded lobes, and is pale yellow to greenish. The seeds are approximately 3 times the size of those of *N tabacum*. Both species have a definite epidermal covering made up of hairs, some of which are glandular and secrete a viscid gummy substance. Under favourable conditions both species may produce a high content of alkaloid; however, *N. rustica* tends to show a higher content.



COURTESY U S DEPARTMENT OF AGRICULTURE

FIG 1.—TOBACCO PLANT TOPPED AND SUCKERED (TYPICAL PLANT AS GROWN FOR COMMERCIAL PRODUCTION IN MOST AREAS)

History.—When Columbus and other early explorers discovered and explored America, they found the natives using tobacco much in the same manner as it is used today. The natives of America used tobacco in their ceremonials, as for example, smoking the pape of peace. It was generally supposed by the Indians to possess medicinal properties and this was the chief reason for its early use following introduction into Europe. The extension of tobacco culture to practically all parts of the world began with its introduction to Europe: France, 1556; Portugal, 1558; Spain, 1559; and England, 1565. Jean Nicot, the French ambassador at Lisbon, in whose honour the genus *Nicotiana* is named, is said to have sent seed of *N. tabacum* to the queen of France, Catherine de Medici

The common name, tobacco, was derived from the word applied both to the tube used by the aborigines for inhaling the smoke and to the cylinder of leaf prepared for smoking

The early beginnings of tobacco culture by white settlers in colonial America took place in the following areas on the dates indicated: Santo Domingo, 1531; Cuba, 1580; Brazil, 1600; Jamestown, Virginia, 1612 by John Rolfe; Maryland, 1631. The tobacco grown soon furnished the chief product in demand in Europe as a commodity of exchange for the manufactured articles required by the colonists.

The culture of tobacco has had many ups and downs, and overproduction from its very beginning was always an economic problem Following the American Revolution there was a tremendous expansion in culture from the colonial areas in Virginia and Maryland into Kentucky, Tennessee, North Carolina, Ohio [illegible] Georgia, [illegible]

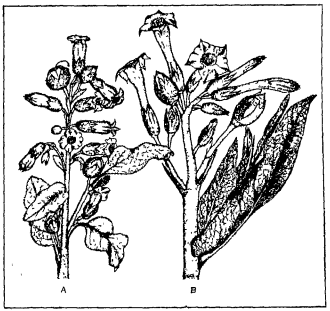
colouring. These plants when cured manifested a light yellowish red colour The leaf was porous and was found to have high absorptive capacity, which made it suitable for use in manufacturing chewing and smoking mixtures. This variety was improved by selection and became widely grown It is extensively used in cigarette blends.

Types of Tobacco.—The type of leaf tobacco is determined and frequently named on the basis of (1) variety, (2) methods of curing or handling, (3) the use to which the cured leaf is adapted, and (4) the section where grown. There are numerous types recognized by the trade which have been assigned numbers in the official United States department of agriculture type classification. fire-cured (21–24), dark air-cured (35–37), flue-cured (11–14), cigar wrapper (61 and 62), cigar binder (51–56), cigar filler (41–44), Burley (31), Maryland (32) and perique (72) All these types, as well as the Turkish or oriental, Sumatra cigar wrapper produced in the Netherlands Indies, and Cuban cigar leaf, are produced from *N tabacum* Most of these types are important tobaccos of world commerce The makhorka (sometimes mahorka) tobacco type is produced from *N. rustica* It is air-cured and is grown in the U.S.S.R. and Poland. More than one-half the acreage devoted to tobacco in the U.S.S.R. for 1933 was planted to the makhorka type The leaf is somewhat coarse in texture and high in nicotine content, and it is largely consumed locally.

The flue-cured type, sometimes designated as bright or Virginia, is by far the most popular tobacco type, largely because of its adaptability to the production of blended cigarettes

Culture.—The methods of culture vary somewhat in different parts of the world and with the various tobacco types, but the essential features remain much the same The plant is grown successfully under a wide range of climatic and soil conditions, however, the commercial value of the product depends largely upon the environment in which it is produced The variety of seed used, as well as the occurrence and control of insects and diseases, are factors of considerable importance in determining successful culture The methods described below relate primarily to culture in the United States

The seedlings are delicate and are produced in hotbeds or cold frames covered with glass in colder regions and in cold frames with cloth covers in warm regions The rate of seeding commonly employed is 1 oz of high quality seed to 200 sq yd. of seed-bed area Under favourable conditions this area can be expected to furnish 40,000 to 50,000 plants



COURTESY U.S. DEPARTMENT OF AGRICULTURE

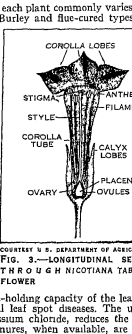
FIG. 2.—SEED PODS AND FLOWERS OF (A) NICOTIANA RUSTICA, AND (B) N TABACUM

for transplanting. The soil selected for the seed bed should be in a sheltered, sunny location and possess good drainage, tilth and high fertility. Sterilization of the soil by burning or steam to destroy insects, weed seeds and diseases is practised where possible It is customary to apply commercial fertilizer at the rate of ½ to 2 lb per square yard to the seed-bed area The seeds are usually mixed with some harmless bulky substance, preferably of a light colour such as

land plaster, so that a uniform distribution can be obtained Seeds are sown on a well pulverized, levelled area and covered very lightly by a roller or other suitable method of packing and forcing the seeds into the soil. The seedlings in 6 to 10 weeks after germination are 4 to 6 in. in height, at which time they are transplanted to the field, commonly by hand when the soil is wet or by machine during dry periods. Each plant must be watered unless the soil is wet The distance of planting varies widely according to the type of tobacco grown. The rows are 3 to 4 ft apart with plants spaced at a distance of 12 to 48 in. in the row. Cigar and Burley tobacco are commonly spaced 3 to 3½ ft. by 14 to 27 in., while fire-cured is planted in hills which may be as much as 4 ft. apart. Maryland tobacco is transplanted in hills 34 by 34 in. or closer, while flue-cured is spaced 2 by 4 ft. as a general rule. When the plant has attained the desired size, usually at or before flowering, it is disbudded or topped; that is, the terminal growth is removed

The number of leaves remaining on each plant commonly varies from 16 to 20 with the cigar, Maryland, Burley and flue-cured types, and 12 to 14 leaves with fire-cured and dark air-cured tobacco. Following topping, the suckers or lateral shoots are removed at more or less frequent intervals to increase leaf development

The choice of soil and its fertilization varies greatly with the kind of leaf grown. It is important that the soil be well drained Much of the tobacco grown in the United States, including Maryland, flue-cured, cigar binder and wrapper types, is produced on sandy and sandy-loam soils with a sandy or sandy-clay subsoil Cigar filler, Burley and fire-cured tobacco are produced on silt-loam and clay-loam soils, with clay subsoils Fertilization furnishes the basis for production of the desired type of leaf. The quantity of nitrogen is particularly important for the flue-cured types and to some extent for Maryland and Burley. A liberal supply of potash in the form of sulphate, carbonate or nitrate improves the fire-holding capacity of the leaf and reduces the susceptibility to bacterial leaf spot diseases. The use of chlorides in any form, such as potassium chloride, reduces the combustibility of cured leaf. Animal manures, when available, are often used. The most striking example of the wide variation in fertilizer practices is furnished in the production of cigar wrapper as contrasted with production of flue-cured cigarette leaf Both are grown on sandy loam soils of low natural fertility Where cigar leaf is grown, as much as 1 to 2 tons per acre of a fertilizer mixture containing 5% to 6% nitrogen, 5% phosphoric acid (P_2O_5) and 6% potash (K_2O) is applied broadcast to the soil prior to transplanting In contrast with this, flue-cured tobacco is fertilized commonly with 800 to 1,000 lb. per acre of 3-8-6, applied in the row prior to transplanting, with the remainder [illegible]



COURTESY U S. DEPARTMENT OF AGRICULTURE

FIG. 3.—LONGITUDINAL SECTION THROUGH NICOTIANA TABACUM FLOWER

[illegible] wrapper is limited to particular soils in regions of high rainfall, where special provisions for drainage are necessary, consisting of plantings on a mound with sufficient space for two rows of plants These mounds are separated by definite ditches to facilitate the runoff of water to prevent water logging. It is generally recognized that high quality leaf is produced for one or two years following the clearing from the jungle under conditions in the Netherlands Indies. Cuban leaf, much in demand as cigar filler, is produced from special varieties grown on certain soils in the Cuban climate; this type has not been duplicated anywhere else in the world.

The culture of Turkish or oriental tobacco is unique, in that spacing and topping practices differ radically from those for all other types of tobacco The plants are not commonly topped and may be spaced 9 by 18 in. or even closer The best quality Turkish is grown in Mediterranean climate on upland soils during periods of little or no rainfall. Turkish varieties are numerous and differ radically from all other known kinds

The choice of the variety of seed is dependent upon the type of leaf desired. Most strains and varieties are very local in their adaptation and are not suited to the production of widely divergent types of leaf The Orinoco group with its numerous strains is widely used for flue-curing, while the Pryor group, which was originally selected from Orinoco but later became quite distinct, is widely used in the production of dark air-cured and fire-cured tobacco The seedleaf strains, Havana Seed, Sumatra and Cuban, represent outstanding varieties used in the production of cigar leaf

Tobacco, like most crop plants, is subject to a number of diseases and insect pests, both in the seed bed and in the field, which are more or less world-wide in distribution. The more common diseases are mosaic, caused by a filtrable virus; black root rot, fusarium wilt, black shank and downy mildew or blue mould produced by specific fungi; and finally the leaf-spots and wilts which have bacteria as the causal organism. Control of these diseases may be accomplished in various ways sanitation, crop rotation, breeding of resistant strains of tobacco, and by the use of sprays and fumigants The more common insects are hornworms, flea beetles, cutworms, budworms which attack the growing plants, and the cigarette or tobacco beetle and tobacco moth which damage the stored leaf. The cigarette beetle sometimes damages the manufactured product. The insect pests are controlled on the growing crop by the use of dusts and sprays, with insecticides and fumigation and trapping for the stored product pests.

When the crop is mature, 70 to 120 days after transplanting, it is usually harvested by one of two methods. (1) the entire plant is cut and speared or hung across a lath or tobacco stick, (2) the leaves are removed at intervals as they mature. The leaves are strung by means of a needle as with cigar wrapper and Turkish, or looped as with flue-cured, using a string tied to a lath or stick which is finally hung in the curing shed or barn It is desirable to permit the leaf to wilt without sunburning to prevent breakage and bruising during the handling necessary in harvesting.

Curing.—There are four methods of curing commonly recognized, namely, sun-curing, air-curing, fire-curing and flue-curing The curing of tobacco is in no sense to be considered simply drying, for in all cases the process is regulated so as to develop the desired properties of the leaf. Curing is carried out in specially constructed buildings known as sheds in New England and barns in most other areas Sun-curing, formerly practised in parts of Virginia, is modified air-curing where the curing leaf is moved under cover when there is danger of rain. It is employed with the Turkish or oriental type Air-curing is accomplished customarily in buildings equipped with ventilators, making possible partial control of conditions Sometimes artificial heat is used. The time necessary for air-curing varies and may be from 1 to 3 months. Many tobaccos of the world are cured by this process, including the cigar, Maryland, Burley and dark air-cured types of the United States

The fire-curing process resembles air-curing except that open wood fires are kindled on the dirt floor of the barn after the tobacco has been hanging for 2 to 3 days, allowing the smoke to come in contact with the leaf, thereby imparting a characteristic aroma The firing process is intermittent and may continue until curing is complete The barns used for flue-curing are small and tightly constructed, provided with suitable ventilators and metal pipes or flues extending from wood-fired furnaces around the floor of the barn Oil heaters are also used, with no flues Heat is applied with due attention to gradual changes in the leaf, particularly colour and drying. The curing may be thought of as taking place in three stages, namely, yellowing, which takes place at 80° to 100° F; drying, beginning around 110° F, and gradually progressing to around 135° to 145° F; and killing and drying the stem, 160° to 200° F. The length of time required for flue-curing is 4 to 5 days

Grading, Marketing, Fermentation and Aging.—Following curing and during moist periods or in a moistening cellar when the leaf can be handled without breakage, it is removed from the stalks or sticks and graded according to colour, size, soundness and other recognizable elements of quality. It is tied into "hands" or bundles of 15 to 30 leaves by means of a tobacco leaf wrapped securely around the stem end of the leaves. After grading, the leaf is ready for market It may be sold directly to the purchaser who visits the farm, or packed in bales, boxes or hogsheads and shipped to a warehouse or other centre and sold on the basis of a carefully drawn sample by private sale or auction, or it may be carried directly to the auction ("loose leaf") warehouse, where it is displayed and auctioned to the highest bidder. It is a common procedure to recondition the tobacco, that is, to dry the product, and then return the proper amount of moisture by "redrying" after it has been marketed and before it is packed. The purpose is to avoid damage which occurs when the leaf is packed with an excessive moisture content, and to insure proper amount of moisture for aging. The aging period is from 1 to 3 years. This process is sometimes hastened by forced fermentation accomplished by adding moisture and placing in bulks before packing and storing.

Manufacture.—While some tobacco is consumed by the producer or sold directly for chewing and smoking, most of the leaf is aged and processed before consumption In most cases the stems or midribs are first removed from the leaf. The details of certain processes of manufacture are trade secrets, but in general commonly known procedures are followed. To produce an acceptable product and obtain uniformity through the years, blending of grades of different years and from different sections and types of leaf is a common practice

with most manufactured tobacco products. However, most types and grades of tobacco have rather specific uses For example, upper leaf grades on the plant are used for chewing and the lower leaves for smoking tobacco In the United States, cigarettes are commonly manufactured by blending flue-cured, Burley, Maryland and Turkish types Chewing tobacco is manufactured in several different forms, such as plug, twist, fine cut and scrap chewing. In most instances, flavouring, sweetening and conditioners are added in the manufacturing process Pipe smoking mixtures are made with considerable content of tobacco of the Burley type. The mixture commonly contains a conditioner (glycerine) and flavouring constituents Snuff is made from fire-cured leaf and stems which are fermented before and sometimes after grinding Salts and flavouring are frequently added in considerable amounts There are two forms of snuff, the light containing ground stems and the dark which is made from stemmed leaf.

Production and Consumption.—World production in 1938 (the last year before World War II in which complete statistics were available) in millions of pounds was as follows for the chief producing countries Algeria 42, Argentina 45, Belgium 11, Brazil 211, Bulgaria 57, Burma 94, Canada 101, China 985, Chosen 65, Cuba 55, France 73, Germany 73, Greece 106, Hungary 47, India 1,400, Indo-China 42, Italy 93, Japan 738, Mexico 42, Netherlands Indies 76, Philippine Islands 79, Poland 32, Puerto Rico 14, Rumania 27, Southern Rhodesia 23, Turkey 117, U S S R 596, United States 1,386 and Yugoslavia 35 In many of the principal producing countries the product in large part is consumed locally This is true for the most part of the heavy producers, China, India and the U S S R In international trade the Netherlands Indies furnish in large quantity an especially fine type of cigar wrapper leaf, while Cuba supplies cigar leaf which is not equalled in aroma anywhere else in the world. The Turkish or oriental tobaccos grown chiefly in Turkey and Greece are exported extensively and are used in the manufacture of cigarettes The Philippine Islands, Puerto Rico and Brazil also export important quantities of cigar leaf The preferential duty extended to empire tobacco by the British government greatly stimulated production in Northern Rhodesia, Southern Rhodesia, Nyasaland, British India and Canada The estimated world production in 1938 was 6,167,000,000 lb The United States is the largest producer, and about one-third of the crop is ordinarily exported. Production is localized in relatively few states The 1930–39 average production for these states is as follows, in thousands of pounds.

Massachusetts 8,366, Connecticut 22,753, New York 1,113, Pennsylvania 37,649, Ohio 32,019, Indiana 9,908, Wisconsin 29,213, Missouri 5,538, Maryland 26,601, Virginia 99,922, West Virginia 2,087, North Carolina 529,356, South Carolina 85,684, Georgia 68,500, Florida 10,919, Kentucky 316,383, Tennessee 110,125. The total average production for the United States for the period 1930–39 was 1,389,796,000 lb

Consumption in pounds per capita furnishes some interesting comparisons, and for European countries was in 1932 as follows Austria 3 51, Belgium 5 49, Bulgaria 2 22, Czechoslovakia 3 13, Denmark 4 43, Finland 1 66, France 2 90, Germany 3 24, Hungary 2 44, Italy 1 30, Netherlands 7 80, Norway 2 30, Poland 2 33, Rumania 1 37, Spain 2 37, Sweden 2 98, United Kingdom 3 32, Yugoslavia 1 22. The 1932 per capita consumption in the United States was 6 lb. but in 1939 had increased to 7 30 lb. This increase was largely due to increased cigarette consumption, while chewing tobacco showed a distinct decline. There was a considerable decline in cigar consumption after 1920. These trends appeared to be world-wide

Composition.—The compound which definitely characterizes tobacco is nicotine. It occurs in various proportions combined with organic acids (malic, citric, etc). Related alkaloids have been found in certain types, associated with the nicotine Nicotine can be used as a raw material for preparation of the antiseptic vitamin, nicotinic acid (niacin). Factors governing the nicotine content of tobacco are: (1) the species, variety and strain; (2) the environment in which the plant is grown, primarily the conditions of soil and climate; (3) cultural, curing and handling methods employed, e g , time of transplanting and harvesting, spacing of plants, topping and suckering operations The nicotine content of commercial types of tobacco varies considerably, but on the average the dark air-cured and fire-cured types contain 4% to 4 5%; cigar filler and Burley 2 5% to 4%; flue-cured 2 5% to 3%; Maryland 2%; and Turkish types 1% to 2% or more *N rustica* has been grown with as much as 10% nicotine in the leaf. Nicotine has long been used as an insecticide and as such is an important tobacco by-product

The ash content of tobacco is high and ranges from 15% to 25% of the leaf on a water-free basis The flue-cured type is notably rich in sugar with the cigarette grades showing 15% to 20% or more The Maryland cigarette leaf shows 90% of the total carbohydrates as cellulose, pectin and related compounds. Cigar tobaccos are especially high in nitrogenous compounds but are almost free of starch and sugars.

Among the changes in composition which take place during the fermentation or ageing process is a loss in nicotine and with cigar tobaccos which are commonly subjected to a heavy fermentation, one-half or more of the nicotine may disappear.

Revenue.—Tobacco has long been one of the chief sources of revenue in many countries of the world. This revenue is derived from taxes on the manufactured products, as in the United States, duties on imports as in the United Kingdom, or from profits from the operation of government monopolies which have been in effect in many European countries, Japan, and elsewhere. The income to the United States government in revenue from taxes collected on manufactured tobacco products greatly exceeds the sale value received by producers of the crop Besides the revenue collected by the federal government, many of the individual states of the union exact a tax which in the aggregate gives a tremendous total of revenue produced from taxation of tobacco and its products (*See* also CIGAR; CIGARETTE.)

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(J E Mv)

TOBACCO PIPE. The smoking of tobacco in pipes is a custom which has prevailed in America for a period of unknown duration. The most ancient pipes of which remains exist have been found in mounds or tumuli called pipe mounds, principally in Ohio, Indiana, Illinois and Iowa. These mound pipes, which are carved in porphyry and other hard stones, are very uniform in type, consisting of a slightly convex platform or base, generally from 3 to 4 in in length, and about an inch broad, with the bowl on the centre. A fine hole is pierced from one end of the platform to the bottom of the bowl, the opposite end being obviously for holding in the hand while the pipe is being smoked. In the commonest forms the bowl consists of a simple cylinder or urn, but in many cases remarkable artistic skill has been displayed in carving the bowls into miniature figures of birds, mammals, reptiles and human heads, often grotesque and fantastic, but always very vigorously expressed. These mound or platform pipes with carved human and animal forms are objects of the highest ethnographic interest and importance, being among the most characteristic remains of the ancient inhabitants of the Mississippi valley The wide area over which these, as well as remains of baked clay pipes, are found throughout the American continent testifies to the universal prevalence of smoking in the pre-Columbian era Many of the ancient clay pipes found in Mexico, etc., are elaborately moulded and ornamented, while others show considerable similarity to the early clay pipes of Europe. Among the North American Indian tribes the tobacco pipe occupies a position of peculiar symbolic significance in connection with the superstitious rites and usages of the race. The calumet, peace pipe or medicine pipe, is an object of the most profound veneration, entrusted to the care of a highly honoured official, and produced and smoked with much ceremony only on occasions of great importance and solemnity. It is remarkable that, while the most ancient American pipes had no separate stem, it is the stem only of the medicine pipe which is the object of veneration among the Indians, the bowl used being a matter of indifference. The favourite material for Indian pipe bowls is the famous red pipe stone (catlinite), a fine-grained, easily worked stone of a rich red colour from the Côteau des Prairies, west of the Big Stone lake in South Dakota.

Throughout Great Britain and Ireland small clay pipes are frequently dug up, in some instances associated with Roman relics. These are known among the people as elfin, fairy or Celtic pipes, and in some districts supernatural agencies have been called in to account for their existence The elfin pipes have commonly flat broad heels in place of the sharp spur now found on clay pipes, and on that flat space the mark or initials of the maker is occasionally found. There is no reason to believe that these pipes are older than the 17th century. The introduction of the tobacco pipe into Europe is generally ascribed to Ralph Lane, first governor of Virginia, who in 1586 brought an Indian pipe to Sir Walter Raleigh, and taught that courtier how to use it. The pipe-makers of London became an incorporated body in 1619.

By degrees pipes of special form and material have come to be definitely associated with particular peoples, *e.g.*, the elongated

painted porcelain bowls and pendulous stem of the German peasantry, the red clay bowl and long cherry wood stem of the Turk, and the very small metallic bowl and cane stem of the Japanese, etc Among other kinds of pipe which have been popular at various times are the "corn-cob," where the bowl is made of the cob of maize or Indian corn, and the "calabash" with the bowl of a small gourd The "churchwarden" is a clay pipe with a slender stem, about 16 to 20 in. long The most luxurious and elaborate form of pipe is the Persian *kalyún*, hookah or water tobacco pipe This consists of three pieces, the head or bowl, the water bottle or base, and the snake or long flexible tube ending in the mouthpiece The tobacco, which must be previously prepared by steeping in water, is placed in the head and lighted with live charcoal, a wooden stem passes from its bottom down into the water which fills the base, and the tube is fitted to a stem which ends in the bottle above the water Thus the smoke is cooled and washed before it reaches the smoker by passing through the water in the bottle, and by being drawn through the coil of tube frequently some yards in length The bottles are in many cases made of carved and otherwise ornamented coco-nut shells, whence the apparatus is called *nārgila*, from *nārgil*, a coco-nut.

TOBAGO, an island in the British West Indies, 20 mi. N E of Trinidad. Pop. (1950 est) 30,951. It is 26 mi. long and 7½ mi broad, with an area of 116 sq mi, of which more than half (42,000 ac) is under cultivation. Just off the northeast end of the island is Little Tobago, a 300 ac islet used as a sanctuary for birds of paradise brought there in 1908. Tobago consists of a single 18 mi long mountain mass of volcanic origin which rises to a height of 1 800 ft in the centre. Much of the island is clothed with a dense forest The higher lands are set apart as "rain preserve," and felling of timber there is forbidden The temperature averages 80° F., the annual rainfall is 60 in The rainy season lasts from June to December, with a short break in September The valleys are adapted to horse- and sheep-raising Cacao, copra, coconuts and limes are exported. Scarborough (pop. 1,100), formerly called Port Louis, is the capital, located on the south coast 8 mi. from the southwest point. There is daily air and semiweekly steamer service to Trinidad.

Tobago was discovered by Columbus, who called it Assumption (1498). It was first occupied by the Dutch (1632), who named it New Walcheren and held it precariously until 1662 Thereafter possession alternated between the French and English until 1814, when British title was confirmed by the treaty of Vienna It formed part of the Windward Islands colony until 1889, when it was joined to Trinidad, though legal and fiscal arrangements were kept distinct. In 1899 it became a ward of Trinidad, its revenue, expenditure and debt were then merged with those of the united colony (called Trinidad and Tobago), and Trinidad laws, with a few exceptions became binding in Tobago Daniel Defoe used Tobago as the setting for *Robinson Crusoe.* (L. W. Be.)

TOBIT, BOOK OF. This book of the Apocrypha is a religious novel which was for many centuries exceedingly popular both in Christian and Jewish circles in many lands This is shown by the multiplicity of versions and editions which have survived. Moreover, it was not without influence upon some of the writers whose work is contained in the Old Testament (*e.g.*, Daniel and some of the Psalms), Jewish pseudepigraphists (*e.g.*, the authors of the Book of Jubilees, the Testament of Job), some New Testament writers (*e.g.*, the Synoptists, especially in the description of the Resurrection and Ascension, St Paul, the author [?] of the Pastoral Epistles) and numerous post-apostolic Christian writers, many of whom, as did in particular Clement of Alexandria, regarded it as "Scripture" But in one respect it has achieved a distinction shared by no other Book of the Apocrypha, and by at most only one book (Jonah) of the Old Testament: it has made a remarkable appeal to the exponents of Christian Art, and its hero and his dog and certain dramatic incidents in his history became, in the Middle Ages, a favourite theme of the workers in ecclesiastic glass and mural decorations.

Date of the Work.—Hitzig's relegation of the date of writing to a time subsequent to the catastrophe of A.D. 70, Graetz's conviction that it belongs to the reign of Hadrian. Rosenthal's that it is a product of the School of Rabbi Akiba, and even W. R Smith's attempt to connect it with the Maccabean revolt, are no longer favoured Equally impossible is a date as early as 350 B.C, which was once favoured by writers influenced by Ewald. A date about 250 B.C seems to present least difficulties

The author wrote to inculcate respect for the dead, consanguineous marriages, and practical virtues such as almsgiving. He found the ultimate sanction for these ideals in the Old Testament, but when he set out to inculcate them in his tale he drew on earlier, and even contemporary pagan models. The Egyptian *Tractate of Khons* supplied him with the idea of a maiden possessed by a demon whom the god expelled It is also clear that the widely diffused "Fable of the Grateful Dead"—a dead man rewarding the burier of his corpse—was much in his mind when he set out to write his book; but in this case it may have been less a matter of consulting a literary model than of reproducing the general ideas of a class of fables known to him from boyhood Similarly there is no reason to posit any literary source, as J H Moulton formerly did, to account for the alleged *Median* and more specifically Magian elements in the book—*e g*, the dog, the demon Asmodeus (Aēšma daēvu), the seven angels, the saving heavenly visitor (Raphael) These are mostly not characteristics of the *later* Zoroastrian system, but belong equally to its earliest phases, and in great part even to pre-Zoroastrian Magianism, which, by 250 B.C, would be known wherever Persian traders and soldiers were to be found.

If, as is suggested, the author was an Egyptian Jew of 250 B.C., he may have written in Aramaic or in Greek. Numerous attempts, based on the theory of mistranslations in the extant Greek texts from an Aramaic original have been put forward, but on the whole the hypothesis that he was a Jew who "thought in" Hebrew or Aramaic, while writing in the Greek of his period, suffices to explain the "Semitisms" which are observable in his Book. Apart from the poem in ch. 13 there seems to be no reason for not regarding the book as a literary unity

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TOBOGGANING, the sport of sliding down snow-covered hills and artificial ice-shutes on the toboggan, a sled from 3ft to 8ft. long and 2ft. to 3ft. wide, formed of strips of wood from ¼in to ¾in. in width, fitted together and curved up at the front (Micmac Indian, *tobaakan*, sledge). The toboggan is not so well fitted for use on roads that are not steep or very smooth as is the sled provided with runners, but is generally used on open hills, or upon artificial courses (chutes), which are very popular in Canada. In Switzerland tobogganing on ths type of sled is called lugeing, and the sleds are known as luges; it is a popular sport with visitors to the Engadine, where both the sitting and *ventre-à-terre* position are practised. The run from the top of the Schatzalp at Davos is one of the best luge-runs in Switzerland.

On the big runs, of which the Cresta is the most famous, the steel skeleton type of toboggan is invariably used, and the runner is equipped with knee and arm pads and a felt-lined steel crash helmet to protect him in the event of accidents; specially constructed boots with steel spikes render steering and braking with the feet easy. The Cresta is built with several turns banked up with solid ice. (*See* also Coasting)

The United States.—With slight variations, tobogganing are constructed, in the United States, in the same manner and of the same materials as in other parts of the world. Tobogganing are best fitted for the soft fluffy snow of dry-cold climates, their flat bottoms and curled up fronts riding the surfaces with ease. They are often used for transportation purposes where other conveyances are of no use.

Tobogganing as a sport declined rapidly in popularity after 1932 when the enthusiasm for skiing became widespread. It is no longer an important attraction at such pioneer winter-sports centres as Hanover, N. H., and Lake Placid, in upper New York. At

the newer resorts created since 1935 in New England and the far west, toboggan chutes or runs are unknown.

TOBOLSK, a town in the Omsk region of the Russian S F S R., in 59° 22′ N., 68° 5′ E., on the Irtysh river, below the confluence of the Tobol Pop (23,500) Part of the town is low-lying and subject to floods, but the upper part is 200 ft. above the river and is crowned by an old fortress built in the reign of Peter the Great by Swedish prisoners, in imitation of the Kremlin at Moscow The river is usually frozen from Nov. 20 to May 14, and vessels from the Ob can reach the town in floodtime; the S S. "Louise" reached it from Hull in 1877 Twelve miles southeast are the ruins of the "fort of Kuchum" (Isker, Sibir), captured by Yermak in 1581 Tobolsk was founded by the Cossacks in 1587, and formerly had an active trade in fish and furs, but Omsk rapidly superseded it. The only industrial enterprise is a preserve factory using cranberries, rockcherry and honey.

The district is noted for *kustar* (peasant) industries, especially carpentering, the making of fishing nets, carving on mammoth ivory and the preparation of wool and skins The Tobolsk province was the earliest to be colonized, and also received the largest number of political exiles.

TOBRUK (anc. *Antipyrgos*), a fine natural harbour in Cyrenaica, Libya, on the N. coast of Africa at the intersection of 32° N. lat with 24° E long (Pop 1936, 2,579) The small and deep harbour, sheltered by high ground, is the only safe port easily accessible to large vessels for more than 1,000 mi , between Sfax in Tunisia and Alexandria. It is about 2½ mi. long by ¾ mi. wide.

Tobruk has long been the outlet for the trade of the oases which extend from Jarabub to Siwah It was almost destroyed in World War II, changing hands five times, being taken finally by the British, Nov. 13, 1942. (P W. I.)

TOCCATA, in music, a composition of indefinite form but of brilliant, fantasialike character, with a preponderance of running passages, calculated especially to display the execution of the performer. (It. *toccare*, to touch) Among the earlier masters, Johann Sebastian Bach (*q.v.*) left some magnificent examples, developing the highest possibilities of the form, while well-known modern examples are those of Robert Schumann and Claude Debussy.

TOC H, an interdenominational association for Christian social service, founded as a memorial to British youth who perished in World War I At Hooge, in the first German liquid-fire attack in July 1915, there fell a lad named Gilbert Talbot, lieutenant in the rifle brigade and son of the bishop of Winchester. In the following December in the Flemish town of Poperinghe a soldiers' club named "Talbot house" was opened in his memory.

In charge of this house was a Church of England chaplain, Rev. P. B Clayton, M C , who created there a centre of rest and recreation unique in its kind In 1920 Clayton established in London a new Talbot house, using, since this name was already appropriated, the signallers' method of pronouncing its initials; namely, "Toc H." The plan was to establish in the salient of London a house where men of all kinds would congregate and many of them live, dedicating a reasonable proportion of their leisure time to the service of their fellowmen and throwing its membership open to all men of good will

In 1922 it was incorporated by royal charter with the prince of Wales as patron. The king is the present patron Toc H stretches with its houses, or "marks" as they are called, and branches, throughout the British empire and beyond its confines. Capturing the imagination of youth by its call to service and sacrifice, developed on a wide yet deep interdenominational Christian basis, drawing together men of all classes and types often mutually antagonistic, it has become through the principles of service, fellowship, tolerance and honest thinking, to which its members are pledged, one of the greatest influences for good and for spiritual development and expression. Regular membership involves a probationary test, and the work of its members and branches is reviewed annually. Each branch is entrusted with a lamp of maintenance lighted with simple ceremony at every meeting in remembrance of lives lived and given in service and sacrifice and in rededication to the task they left unfinished—building "a new Jerusalem." (R. C. G.)

TOCHI VALLEY or DAWAR, one of the chief routes into Afghanistan in Pakistan It leads from the Bannu through tribal country, and is inhabited by the Dawari (*q.v.*). The valley is divided into two parts, known as Upper and Lower Dawar, by a narrow pass called the Taghrai Tangi, about three miles long Between Dawar and British territory is the low range of uninhabited hills which skirt the Bannu district. It was by this route that Mahmud of Ghazni effected several of his raids into India, and the remains of a road flanking the valley and of defensive positions are still to be traced After the Waziristan expedition of 1894 the Tochi was garrisoned by British troops, but when Lord Curzon reorganized the frontier in 1901, the British troops were withdrawn and their place supplied by tribal militia.

The chief posts are Sadgi, Idak, Miramshah, Datta Khel and Sheranni. The valley was the scene of action for the Tochi or Dawari expedition under Brigadier General Keyes in 1872, and the Tochi expedition under Gen Corrie Bird in 1897 After the disturbances following World War I a motor road was made up the valley

TOCQUEVILLE, ALEXIS CHARLES HENRI MAURICE CLEREL DE (1805–1859), was born at Verneuil on July 29, 1805 Alexis de Tocqueville became an assistant magistrate in 1830. A year later he obtained from the French government a mission to examine prisons and penitentiaries in the U S On his return he wrote *La Démocratie en Amérique* (1835, 3rd ed. 1868) It was at once caught up by influential members of the Liberal party in England, which country Tocqueville soon after visited, and where he married an Englishwoman Returning to France, he was elected a member of the Académie des Sciences Morales et Politiques (Jan 6, 1838). He sat in the chamber of deputies for several years both before and after the revolution of February, becoming in 1849 vice-president of the assembly and for a few months minister of foreign affairs He was a warm supporter of the Roman expedition, but an equally warm opponent of Louis Napoleon, he was arrested at the coup d'état, and retired from public life. Twenty years after his first book, he produced another, *L'Ancien régime et la révolution*, which almost equalled its success. His health was never very strong, and in 1858 he broke a blood vessel He was ordered to the south, and died at Cannes on April 16, 1859 His complete works, including much unpublished correspondence, were produced after his death in uniform shape by H G. de Beaumont (*Oeuvres complètes de Tocqueville*, 9 vol [1860–65]).

During the last 20 years of his life, and for perhaps half that time after his death, Tocqueville had an increasing European fame. He was the first writer to put the orthodox liberal ideas of 19th-century European politics into an orderly and attractive shape. He wrote the first reasoned political account of democratic government in the U.S. If not an entirely impartial writer, he was neither a devotee nor an opponent of democracy.

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TODA, a small pastoral tribe found on the Nilgiri hills in south India Like the Nayars (*q.v.*), they form an islet of tall, well-bearded, straight-nosed men with rich brown complexions in the midst of the darker Dravidian peoples. The women are lighter in colour, and wear a single garment arranged as a mantle. The men wear a similar one as a plaid. They practise adelphogamy, and have only three women to five men, but female infanticide probably survives only among the priesthood.

See W. H. R Rivers, *The Todas* (1906).

TODHUNTER, ISAAC (1820–1884), English mathematician, son of George Todhunter, a Nonconformist minister, was born at Rye on Nov. 23, 1820, and died at Cambridge on March 1,

1884 He was educated at University college, London, and at St John's college, Cambridge. He became a fellow of his college and college lecturer and private tutor Todhunter held many academic honours, and was a member of council of the Royal society. He became an assistant master at a school at Peckham, attending at the same time evening classes at the University college, London In 1842 he obtained a mathematical scholarship and graduated as B A at London university In 1844 he entered St. John's college, Cambridge, where he was senior wrangler in 1848, and gained the first Smith's prize and the Burney prize; and in 1849 he was elected to a fellowship, and began his life of college lecturer and private tutor. In 1862 he was made a fellow of the Royal Society, and in 1865 a member of the Mathematical Society of London In 1871 he gained the Adams prize and was elected to the council of the Royal Society. He died at Cambridge on the 1st of March 1884.

Works.—*Treatise on the Differential Calculus and the Elements of the Integral Calculus* (1852, 6th ed , 1873); *Treatise on Analytical Statics* (1853, 4th ed , 1874); *Treatise on the Integral Calculus* (1857, 4th ed., 1874); *Treatise on Algebra* (1858, 6th ed , 1871), *Treatise on Plane Coordinate Geometry* (1858, 3rd ed., 1861); *Plane Trigonometry* (1859, 4th ed , 1869); *Spherical Trigonometry* (1859), *History of the Calculus of Variations* (1861), *Theory of Equations* (1861, 2nd ed 1875), *Examples of Analytical Geometry of Three Dimensions* (1858, 3rd ed , 1873), *Mechanics* (1867), *History of the Mathematical Theory of Probability from the Time of Pascal to that of Lagrange* (1865); *Researches in the Calculus of Variations* (1871), *History of the Mathematical Theories of Attraction and Figure of the Earth from Newton to Laplace* (1873), *Elementary Treatise on Laplace's, Lamé's and Bessel's Functions* (1875); *Natural Philosophy for Beginners* (1877). An unfinished work, *The History of the Theory of Elasticity*, was edited and published posthumously in 1886 by Karl Pearson.

TODI (anc. *Tuder*), a town and episcopal see of the province of Perugia, Italy, 26 m S of Perugia by rail, on a steep hill above the east bank of the Tiber, 1,348 ft. above sea-level, and 866 ft. above the river. Pop. (1936), 3,820 (town), 20,459 (commune). Some portions of the ancient town walls—of two enceintes, an inner and an outer, the former attributed to the original Umbrian inhabitants, the latter to the Romans—are preserved, while the mediaeval walls are still more extensive, and also remains of baths, amphitheatre, theatre, and a substruction wall of massive masonry, with four niches Here was found the bronze statue of Mars, now in the Vatican, some fine bronze objects of the 5th cent c have been found in tombs Beneath the cathedral square, at the highest point of the town, is a large Roman reservoir The Romanesque cathedral has a simple façade (partly of the 11th, partly of the 14th century), with a fine portal and rose window In the same square are the massive Romanesque Gothic structures, Palazzo del Priori (1213), the Palazzo del Capitano del Popolo (*c.* 1290) and the Palazzo del Podesta (1293–1337). The Gothic church of S Fortunato, with its nave and aisles of the same height, has a splendid portal

Just outside the town on the west is the church of S Maria della Consolazione, one of the finest buildings of the Renaissance, and often wrongly attributed to Bramante. Contemporary documents prove that the interior was begun in 1508 by Cola di Matteuccio da Caprarola, and the exterior completed in 1516–1524 by Ambrogio da Milano and Francesco di Vito Lombardo; the slender dome was not added till 1607

See Pirro Priore Alvi, *Todi* (1910); G Bellucci, *La regione di Todi prima della storia*, Perugia, 1915; Bendinelli in *Monumenti dei Lincei*, xxiii., 609–684; xxiv., 841–914.

TODLEBEN (or TOTLEBEN), FRANZ EDUARD IVANOVICH, Count (1818–1884), Russian engineer general, was born at Mittau in Courland, on May 20, 1818. He entered the school of engineers at St. Petersburg, and passed into the army in 1836. In 1848 and the two following years he was employed, as captain of engineers, in the campaigns against Schamyl in the Caucasus. On the outbreak of war between Russia and Turkey in 1853, he served in the siege of Silistria, and after the siege was raised was transferred to the Crimea (*see* Crimean War). Sevastopol, while strongly fortified toward the sea, was almost unprotected on the land side. Todleben, though still a junior field officer, became the animating genius of the defence. By his advice the fleet was sunk, in order to blockade the mouth of the harbour, and the deficiency of fortifications on the land side was made good before the allies could take advantage of it The construction of earthworks and redoubts was carried on with extreme rapidity, and to these was transferred, in great part the artillery that had belonged to the fleet

It was in the ceaseless improvisation of defensive works and offensive counterworks to meet every changing phase of the enemy's attack that Todleben's peculiar power and originality showed itself He never commanded a large army in the open field, nor was he the creator of a great permanent system of defence like Vauban But he may justly be called the originator of the idea that a fortress is to be considered, not as a walled town but as an entrenched position, intimately connected with the offensive and defensive capacities of an army and as susceptible of alteration as the formation of troops in battle or manoeuvre Until June 20, 1855 he conducted the operations of defence at Sevastopol in person; he was then incapacitated by a wound

In 1860 Todleben was appointed assistant to the grand-duke Nicholas, and he became subsequently chief of the department of engineers with the full rank of general He was given no command when war with Turkey began in 1877. It was not until after the early reverses before Plevna (*q v.*) that the soldier of Sevastopol was called to the front Todleben saw that it would be necessary to draw works round Osman Pasha, and cut him off from communication with the other Turkish commanders In due time Plevna fell Todleben then undertook the siege of the Bulgarian fortresses After the conclusion of preliminaries of peace, he was placed in command of the whole Russian army. When the war was over he became governor of Odessa and hereditary count But his health was broken. For some time after 1880 he held the post of governor of Vilna. He died at Bad Soden near Frankfort-on-Main, on July 1, 1884

His great work on the defence of Sevastopol appeared in Russian, French and German (5 vols, 1864–72) Besides this, he wrote a letter to General Brialmont on the operations around Plevna, this was printed in the Russian engineer journal, and in German in the *Archiv fur preussische Artillerie-offiziere* (1878)

See Brialmont, *Le Général comte Todleben* (Brussels, 1884), *Life* by Schilder (in Russian, St. Petersburg, 1885–87); Krahmer, *General-Adjutant Graf Todleben* (Berlin, 1888).

TODMORDEN, a municipal borough and market town in the Sowerby parliamentary division of the West Riding of Yorkshire, England, 19 mi NNE. of Manchester, on the LMSR Pop (est 1938) 21,140. Area 20 59 sq mi. It is on both sides of the river Calder, at an altitude of about 500 ft., and is surrounded by high moorland.

Todmorden is a railway junction for trans-Pennine routes from Manchester, Preston and Burnley to the industrial West Riding, and the Calder and Rochdale canal connects it by water with Rochdale and with towns lower down the Calder valley.

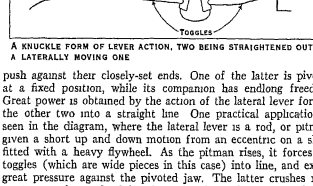
The staple industry is the spinning and weaving of cotton, and there are also foundries and machine-works. The municipal borough was incorporated in 1896

TODY, a bird (*Todus viridis*) inhabiting Jamaica, with allied species in Cuba, Haiti and Porto Rico. A stolid bird, the tody is brightly coloured in grass-green, with a crimson gorget. It feeds on insects and, like its allies the king-fishers, constructs burrows in which to lay its white eggs

TOGGENBURG, THE, an ancient county in the upper valley of the river Thur (Switzerland). On the death of the last count of Toggenburg (1436) Zürich and Schwyz, in the first intercantonal war, disputed its possession. Purchased by the abbot of St. Gall in 1468, it was an area of constant strife between the abbots and the inhabitants, many among whom embraced Protestantism. The Toggenburg war between the Roman Catholic cantons and Protestant supporters of the Toggenburgers resulted in a Catholic defeat (1712) and in the restoration of the ancient liberties. To-day it is a pleasant, highly prosperous part of the canton of St. Gall, inhabited by approximately equal numbers of Protestants and Catholics. Its exact limits are differently interpreted, but the entire upper valley of the Thur above the right-angled bend, near Wil, to the source near Wildhaus, is about 30 m. long, and runs mainly south-east to north-west, be-

tween steep fir-clad slopes. Near the valley head are the Churfirsten range (Hinterruck, 7,575 ft) southwards and the bold peaks of the Säntes (8,215 ft) northwards. The valley is well populated and has good through communications; a 20 m. railway runs from Wil, on the Winterthur-St Gall main line, to Nesslau, and public omnibuses make use of the excellent roads beyond, crossing the watershed near Wildhaus for Gams in the Rhine valley. The Toggenburg as a holiday area is still mainly confined to the Swiss themselves. The pastures throughout are unusually rich, but the predominant pastoral occupation of the upper half is replaced by manufactures, chiefly muslins, in the lower half. The old market centre of the valley was Lichtensteig, now surpassed in point of size and importance by several well built towns and villages, of which Wattwil (pop. 6,393), near the entrance of the Ricken tunnel, is the largest.

TOGGLE-LEVER, a combination of three levers, one being at right-angles to the other two, and arranged so as to



A KNUCKLE FORM OF LEVER ACTION, TWO BEING STRAIGHTENED OUT BY A LATERALLY MOVING ONE

push against their closely-set ends. One of the latter is pivoted at a fixed position, while its companion has endlong freedom. Great power is obtained by the action of the lateral lever forcing the other two into a straight line. One practical application is seen in the diagram, where the lateral lever is a rod, or pitman, given a short up and down motion from an eccentric on a shaft fitted with a heavy flywheel. As the pitman rises, it forces the toggles (which are wide pieces in this case) into line, and exerts great pressure against the pivoted jaw. The latter crushes rock or stone against a fixed jaw face. Another valued application of toggles is in power presses for drawing hollow sheet-metal articles, such as bowls, pans, etc., from the flat sheet. This operation necessitates holding the sheet firmly around the die during the drawing. The toggle mechanism does this and transfers the great stress direct to the frame of the machine, instead of throwing it on the crankshaft.

TOGO, HEIHACHIRO, COUNT (1847–1934), Japanese admiral, was born in Kagoshima, the son of a petty retainer. He joined the navy in 1863 and his first engagement was the "Kwaiten" five years later. He studied naval science and navigation in England from 1871 to 1878, and first became a prominent figure when, in 1894, as captain of the cruiser "Naniwa," he sunk the Chinese troopship "Kowshing" *en route* for Korea, thus precipitating war with China. When the Russo-Japanese conflict broke out in 1904, he was appointed to the command-in-chief of the Japanese fleet, and under his direction various brilliant operations took place, culminating in the battle of the Sea of Japan when the Russian fleet was annihilated. For these services he received (1907) the title of count. In 1906 he was made a member of the British Order of Merit. (*See* RUSSO-JAPANESE WAR.)

TOGOLAND, a country of West Africa (the French and German form is Togo). The maritime zone forms part of what was distinguished as the Slave Coast; it lies between the Gold Coast and Dahomey and extends from 1° 14′ E. to 2° 38′ E. Annexed to Germany in 1884, it was given a hinterland of nearly 35,000 sq. miles. Since 1919 it has been divided into British and French spheres (see *infra*).

Physical Features.—The coast is low and sandy and is formed by the detritus deposited by the sea current called Calema. It is perfectly straight, without harbours, and approached only through a dangerous bar. This coast strip, but 32 m. long, is nowhere more than 2 m. broad. It masks a series of lagoons, of which the largest, occupying a central position, is called the Togo, Avon or Haho lagoon. Behind the lagoons an undulating plain stretches some 50 miles. The Sio and Haho, the two largest rivers of the coast region, both flow into the Togo lagoon. These rivers rise on the eastern versant of a chain of mountains which traverse the country in a south-westerly to a north-easterly direction. It has no general name but in the south is called Agome. It is most elevated in its southern portion, Mt. Dabo having a height of 3,133 ft. and Mt. Atilakuse 3,248 feet. Its general elevation is between 2,000 and 2,500 ft., on the north-west side of the range the country is table-land, some 600 to 1,000 ft. high. Baumann Spitze (3,215 ft.) is an isolated peak in 6° 50′ N., 0° 46′ E., east of the main range. South and east of the range the country, apart from that watered by the coast streams, drains to the Mono river, which, in its lower course, forms the Togoland-Dahomey frontier. The greater part of the country lies west and north of the chain and belongs to the basin of the Volta. The chief river traversing it (north to south) is the Oti, a tributary of the Volta.

The climate on the coast is hot, humid and unhealthy. There are two wet seasons, the first lasting from March till June, the second from September to November. A marked feature of the climate is the prolonged period, December to April, in which the dry wind called *harmattan* prevails. The rainfall is thought to average 55 in. a year in the southern districts. On the tableland seasons of drought are not uncommon.

Coconut palms, introduced by the Portuguese, grow along the coast and for 80 m. or so inland. The lagoons are surrounded by dense belts of reeds, and the coast-land is covered with low, dense bush. There are forests of oil palms, rubber trees and vines, and timber and dyewood trees. There are rain-forests on the mountains and along the river valleys. On the hills the baobab and hyphaene palm are characteristic; on the plateau are stretches of open savanna and park-like country with clumps of silk cotton and shea-butter trees. The fauna resembles that of other parts of West Africa; it is poor on the coast.

Inhabitants.—In the south-west the inhabitants are negroes of the Twi-speaking clans, while on the coast and in the south-east they are members of the Ewe (Dahomey) tribes. Among the coast people there is a distinct infusion of Portuguese blood, and in all the ports are descendants of Brazilian negroes who returned to Africa during the 19th century. The northern tribes are distinct from the coast tribes, are of finer physique, and until recently went almost naked. Among these tribes the Mamprusi and Dagomba, the Kotokoli and Bassari may be noted. Though the Togoland natives number fewer than one million over 40 different languages are spoken. As is common in West Africa the people are divided into a large number of independent tribes, each under its own head chief, who is, however, subject to the authority of a council of sub-chiefs and leading officials. The use of poisoned arrows by the northern tribes still prevailed in 1928. In the coast lands the inhabitants are traders and agriculturists, in the interior they are largely pastoralists. The people are mostly pagans, but some thousands have embraced Christianity or Islam.

There are a number of ancient towns on the coast and lagoons. Togo is on the south-eastern shores of the Togo lagoon. On the narrow spit of land between the lagoons and the sea are Bagida and Porto Seguro—the last named one of the oldest towns on the Slave Coast and the port of Togo town—and, close to the eastern frontier, Little Popo, called by the Germans Anecho. On the Volta, a short distance above the Oti confluence, are the adjacent towns of Kete-Krachi; on an affluent of the Mono in 7° N. is Sagada. In the north are Yendi and Sansane Mangu, both on trade routes between Ashanti and the Niger countries. Lome, the chief port, is at the eastern end of the coast.

Economic Development Under the Germans.—In the 30 years the country was under German rule attention was paid chiefly to agriculture, trade and communications. A jetty was built at Lome and from it two railways started; one—opened in 1907—went north-north-west to Palime (72 m.), the other—opened in 1911—due north to Atakpame (105 miles). Along the coast a railway connected Lome with Anecho and several good

roads had been built Germans started plantations of coffee, cocoa, kola nuts, rubber and cotton, but the most valuable trade was in palm oil and kernels There was also a trade in maize, peanuts and shea butter. Several inland tribes raised cattle and sheep, and on the tableland horses and donkeys were raised. Strict labour regulations were enforced on the natives Direct steamship communication was maintained with Hamburg and Bremen, and most of the trade was with Germany In 1913, the last complete year of German rule, the total exports were valued at £457,000, the imports at £531,000. The European population (1912) was 368, of whom 327 were Germans

British Sphere.—The British sphere adjoins the Gold Coast It has an area of 13,042 sq mi. and a pop. (1948 census) of 378,660. The sphere is divided into two sections, the northern being administered as if it formed part of the Northern Territories of the Gold Coast, the southern as if it formed part of the Gold Coast colony The southern section is known as the Ho district and has about 100,000 inhabitants, who are more advanced in civilization than their northern neighbours The chief towns are Ho and Kpando In this district large areas are given over to cocoa and smaller areas to cotton. There is also an oil palm belt. The northern section is divided into districts, of which Kete-Krachi —in which there are cotton plantations—adjoins the Ho district This northern district contains the towns of Kete-Krachi and Yendi Trade in the north is chiefly in cattle and foodstuffs. The exports of the British sphere as a whole are mainly cocoa, cotton and palm kernels and palm oil, the chief imports are cotton piece goods, clothing, salt, tobacco and kerosene The administration built good roads in the British sphere and a motor ferry over the Volta at Senchi to connect the southern British section with the road system of the Gold Coast colony. In taking over the administration the Gold Coast authorities determined that the British sphere should have the same high standard in regard to public health, public works and education as the Gold Coast had. Consequently, expenditure for several years greatly exceeded revenue.

French Sphere.—The French sphere, which adjoins Dahomey on the east, has an area of 20,463 sq mi. and a pop. (1951 est) of 1,015,000. Administration of the sphere is carried out by a commissioner assisted by a privy council and an assembly of local representatives (elected) The products and trade are similar to those in the British sphere; *i.e.*, palm kernels, cocoa, cotton and coffee The area is rich in smelt iron, but mining is done only by the natives. At mid-20th century imports were valued yearly at about 1,600,000,000 fr. C F A and exports at 1,500,000,000 fr C. F. A. The major source of trade was with other members of the French union Lomé (pop, 1948 est., 30,100) is the capital and centre of external trade. The wharf at Lomé has a daily traffic capacity of 600 tons.

HISTORY

Foundation of a German Colony.—When Gustav Nachtigal was sent by the German government to West Africa in 1884 as imperial commissioner on an annexation errand, he had the fortune to find between the Gold Coast (British) and Dahomey (French) a small stretch of the Guinea coast sovereignty over which was not claimed by any European power. The king of Togo—the ruler of this little patch—was induced to sign a treaty (July 5 1884) placing his country under German suzerainty Thus Togoland was founded and by an agreement made with Great Britain and France a coast line of 32 mi. was obtained Before the coming of the Germans as rulers Portuguese, British, French and German firms had trading agencies along the lagoons behind the coast. In earlier days trade was chiefly in slaves (exported) and gin (imported); in later days the products of the oil palm had taken the place of slaves. The natives were in general dependent upon the rulers of Dahomey or Porto Novo, but the towns of Little Popo and Togo were capitals of small states which claimed freedom. With the development of French interests in Dahomey there was the prospect of these minute kingdoms being absorbed by France In Togo town, however Bremen merchants were influential and this fact helped Nachtigal to conclude his treaty.

Germany at once advanced claims to a large hinterland, and this caused a great deal of negotiation with Great Britain and France. It was not until 1899 that the inland frontiers of Togoland were fixed, Germany securing an area somewhat larger than Ireland Many of the tribes expressed preference for French or British rule, respectively, but the Germans had no great difficulty in making good their authority The people were fairly good agriculturists and the Germans steadily developed the resources of the country, they created a port—Lomé—and built railways. After 20 years' work Togoland was self-supporting; it was the only German colony in Africa to attain that position.

Later History.—In the first month of World War I (Aug. 1914) Togoland was surrendered by the Germans to a British force from the Gold Coast By the treaty of Versailles mandate for Togoland was given to the British and French The first division, made in an Anglo-French agreement of July 10, 1919, was unsatisfactory to the French colonies, as it left Lomé to Great Britain As a result, by a convention of Sept 30, 1920, Lomé and the whole seaboard went to France in exchange for an enlarged British area in the interior.

The mandate was approved by the League of Nations on July 20, 1922 The area received territorial status in 1946 under an agreement made by the United Nations Dec 14. At mid-20th century there was some agitation for a united Togoland based on the similar racial and cultural background of the Ewé peoples of both the British and French spheres. The two governments concerned, after taking a series of measures designed to remove difficulties between the Togolands and to find out the wishes and interests of all the peoples involved, became convinced that no solution altering the boundaries or political allegiance could command general assent As a practical solution, a joint council of representatives of the two Togolands was set up.

See H. Klose, *Togo unter deutscher Flagge* (1899), a comprehensive survey, with bibliography, *Togoland*, a British foreign office handbook (1920), and the annual reports published by the British and French governments on their respective spheres (F. R. C., X)

TOJO, HIDEKI (1884–1948), Japanese army officer and political leader, was born in Tokyo Dec. 30, 1884. He attended the Imperial Military academy in Tokyo and was commissioned a sublieutenant in the army upon graduation. In 1919 he served as military attaché to the Japanese embassy in Berlin. After returning to Japan he held various posts in the war office. In 1928 he was named commander of the 1st infantry regiment, which in 1936 participated in the mutiny of the Tokyo garrison He was named commander of the gendarmery headquarters in 1937 and shortly afterward became chief of staff of the Kwangtung army In July 1940 he was appointed minister of war in the cabinet of Premier Prince Fumimaro Konoye. Tojo succeeded Konoye as premier Oct 16, 1941, and pledged his government to a pro-axis policy as well as a "greater east Asia" program.

After the Japanese attack on Pearl Harbor, Dec. 7, 1941, Tojo officially declared war on the U.S. After prolonged Japanese military reverses in the Pacific, Tojo assumed virtual dictatorial powers, taking over the posts of minister of war and chief of the general staff. The successful U.S. invasion of the Mariana Islands so weakened his government that he was removed as chief of staff July 16, 1944. After Japan's formal surrender in 1945, Tojo shot himself in a suicide attempt, but was nursed back to health to face trial as a military criminal He was found guilty An appeal to the U.S. supreme court was denied, and he was hanged Dec. 23, 1948.

TOKAJ, a town in Hungary, at the confluence of the Bodrog and the Tisza and at the foot of the Hegyalja mountains which slope from a height of 2,700 ft. to a hilly plateau of 1,500 ft. near Tokaj. There lies the vineyard region of nearly 150 sq mi. on a volcanic soil. The vines are believed to have been introduced by Italian colonists in the 13th century. From their grapes is produced the famous wine Tokay, the trade in which is the principal occupation. Pop. 5,844.

TOKAT, a town in Turkey. Population (1950 census) 21,700 (town); 387,456 (vilayet). It is in the Sivas-Samsun *chaussée*, altitude 2,280 ft., at the mouth of a glen opening out to the

valley of the Tozanli Su, a tributary of the Yeshil Irmak It rose to importance under the Seljuks. The industries are the manufacture of copper utensils and yellow leather, and the stamping of colours on white Manchester cotton.

TOKELAU ISLANDS: *see* PACIFIC ISLANDS.

TOKUGAWA, YOSHINOBU, PRINCE (1837–1913), Japanese statesman, was born on Sept. 29, 1837 at Tōkyō. He was the last of the Tokugawa government, succeeding as shogun the 14th shogun, Iemochi, in 1866 Realizing after a year's time that the proper government of the country was impossible on the lines of feudalism, which was a bar to all progress and a source of continual internal strife, the shogun handed his resignation to the emperor on Oct 14, 1867. This act of sacrifice was the prelude to the enlightened Meiji era, which dates from the beginning of 1868 Tokugawa, having renounced his shogunate rights, went into a strict retirement from which he never emerged. He even renounced the succession to his title for his direct heir in favour of a collateral branch of the family, the first to inherit the title being Prince Iyesato Tokugawa, for many years president of the house of peers The emperor MEIJI accepted the renunciation, but he conferred on him another title of prince to be bequeathed to his son He died on Nov 21, 1913 at Tōkyō.

TOKUTOMI, IICHIRO (1863–), Japanese journalist and author, was born at Kumamoto, Jan. 25, 1863, and educated at the Doshisha, Kyoto. In 1887 he issued a monthly magazine, *Friend of the Nation*, and in 1890 started in Tōkyō the daily *Kokumin Shumbun* (Nation), of which he was proprietor and editor He also began to issue in the same year *Far East*, an English monthly. Tokutomi, who was appointed a crown member of the house of peers in 1911, published many important political and historical works including *The Future Japan* (1886) and *National History of Japan in Recent Age*.

In 1924 the Imperial Japanese academy awarded Tokutomi the emperor's medal in recognition of the merit of his works on Japanese history

TŌKYŌ, the capital of the empire of Japan, situated in 35° 41′ N. and 139° 45′ E., at the head of the bay of the same name on the southeast coast of the main island In old times the city was called Yedo The city stands on the banks of the river Sumida, which, although wide, is unnavigable by vessels of large tonnage owing to its shallowness. Yokohama, with which Tōkyō is connected by 18 mi of railway, is practically the port of the capital. The trains of the Tokai-do line, starting from the central station, run westward to Kobe, thence to Shimonoseki, at the western end of the main island, a distance of 700 mi. The Uyeno station is the starting point for trains to Aomori, a town 460 mi. away, at the northern extremity of the island. Topographically it may be divided into two parts, upland and lowland (Yamanote and Shitamachi) There are hills varying in height from 50 to 130 ft in the upland district, that is to say, the outskirts of the city from north to west. Lowland Tōkyō, that part of the city covering the flats on both sides of the river Sumida, is intersected by a system of canals The Nihonbashi (Bridge of Japan), in the district of the same name, is famous From this point all distances in Japan are measured. The largest bridges are those named Azuma, Umaya, Ryogoku, Shin-o and Eitai over the Sumida.

The municipality operates the electric tramways and the electric lighting system The underground electric railways, operated by private companies, are of recent development. They covered in 1939 about 10 mi The jinrikisha, drawn by one man or sometimes two men, which was formerly the chief means of passenger conveyance, became almost extinct after the introduction of modern means of transport

Tōkyō suffers frequently from earthquakes. The numerous residences of the daimyōs were the chief characteristics of the old town, especially in the Kojimachi-ku, but none of these remain Nearly in the centre of Kojimachi-ku, on an eminence surrounded by moats, stood the castle of Yedo, formerly the residence of the shoguns, which was burned down in 1873. The imperial palace was subsequently erected on this site The palace is half European and half Japanese in its style of architecture. The Nijū-bashi is the main entrance. Hibiya park is modelled on the European style, while retaining the special features of the Japanese gardeners' art. The largest and most beautiful parks are those in Shiba and Ueno, formerly the mausolea of the shoguns In Ueno, too, are the Imperial museum, the Imperial library and the Zoological gardens. The famous temple of Kwannon, the goddess of mercy, is in Asakusa park, in which a permanent fair is held

History.—No mention is made of Yedo or Tōkyō in Japanese history before the end of the 12th century It appears to have assumed no importance until about 1457, when Ota Dokwan, a general in the service of Uyesugi Sadamasa, governor of Kamakura, built a castle there About 30 years later the town fell into the hands of Hōjō of Odawara, and on his overthrow by Hideyoshi and Iyeyasu, the castle was granted to the latter, who was the founder of the shogun house of Tokugawa In 1590 Iyeyasu made his formal entry into the castle of Yedo, the extent of which he greatly enlarged From this date the real importance of Yedo began The family of the Tokugawas furnished the shoguns of Japan for nearly 300 years, and these resided during that period at Yedo At the restoration in 1868 the shōgunate was abolished, and the population of Yedo speedily decreased A fresh vitality was imparted by the transfer of the court from Kyoto, and the town then received its present name Tōkyō (eastern capital).

In Sept 1923 a disastrous earthquake followed by extensive fires razed several districts of Tōkyō to the ground An area of 25 sq mi was burned and numerous bridges were destroyed Reconstruction of a pure temporary nature was rapid, and a comprehensive scheme of permanent reconstruction was embarked upon with but little delay. The new plan, which provided for a number of wide streets to act as checks upon conflagrations, and for fireproof buildings in specified zones, was completed in 1930. Further building and other works had made good progress by 1937, when the outbreak of the China war put an end to new construction. With its moats, parks and gardens, its ancient temples and its fine modern buildings, Tōkyō bade fair at that date to become a handsome and imposing metropolis.

Administration.—Until 1932, for administrative purposes, Tōkyō was divided into 15 districts or *ku*, of which Kojimachi, Hongo, Koishikawa, Ushigome, Yotsuya, Akasaka, Azabu and Shiba are situated in the upland portion, while Kanda, Kyobashi, Nihonbashi, Shitaya, Asakusa, Honjo and Fukugawa are in the lowland area, much of which was originally swampy ground. Since then numerous suburban districts have been incorporated as *ku* in the city of Tōkyō (Tōkyō-shi), which has an area of 223 sq mi. This city, together with some yet unincorporated suburban areas, forms the urban prefecture of Tōkyō (Tōkyō-fu), under the general control of a prefectural governor Questions affecting the interests of the whole *fu* come before the *fu-kwai*, or prefectural assembly, of which the governor is president; while matters concerning the city alone are discussed by a *shikwai*, or municipal assembly, and administered by a municipal council, of which the *shichō* or mayor is president There is a regular water supply worked by the municipality Both police and fire brigade are under the command of a single *keishi-sōkan* (inspector-general). There are many schools for advanced students devoted to the various branches of science, mechanics and art. The imperial university of Tōkyō, which consists of the colleges of law, medicine, literature, science, engineering and agriculture, is the principal institution of learning in the empire, and there are numerous private universities of importance

There are several daily newspapers as well as weekly and monthly publications of all kinds In the lowland part of the city and in the suburbs there are many factories, their number having so much increased recently that Tōkyō may now be described as an industrial city.

Population.—There are no reliable data as to the population of Yedo during the feudal period. Owing to the influx caused by the periodical visits of the daimyōs (feudal lords) with their numerous attendants, it had by the early 18th century certainly reached 1,000,000, a population higher than that of any contemporary European city It probably exceeded 1,500,000 during the period 1800–50 In 1940 the population was 6,778,804

TOLAND, JOHN (christened JANUS JUNIUS) (1670–1722), English deist, was born on Nov 30, 1670, near Londonderry, Ireland. Brought up a Roman Catholic, in his sixteenth year he became a zealous Protestant. He studied at Glasgow, and then at Leiden under the famous scholar Friedrich Spanheim. He went in 1694 to Oxford, where he began the book which made him famous—his *Christianity not Mysterious* (1696, anonymous, 2nd ed. in the same year, with his name; 3rd ed., 1702, including an *Apology for Mr. Toland*). It gave great offense, and several replies were immediately published. The author was prosecuted by the grand jury of Middlesex; and when he attempted to settle in Dublin at the beginning of 1697, he was denounced from the pulpit and elsewhere. His book having been condemned by the Irish parliament (Sept. 9, 1697) and an order issued for his arrest, Toland fled to England. The resemblance, both in title and in principles, of his book to Locke's *Reasonableness of Christianity* led to a prompt disavowal by Locke of the supposed identity of opinions, and subsequently to the famous controversy between Stillingfleet and Locke. Toland's next work of importance was his *Life of Milton* (1698), in which a reference to "the numerous suppositious pieces under the name of Christ and His apostles and other great persons" provoked the charge that he had called in question the genuineness of the New Testament writings. Toland, replying in his *Amyntor, or a Defence of Milton's Life* (1699), opened up the question of the history of the scriptural canon. In 1701 Toland spent a few weeks at Hanover as secretary to the embassy of the earl of Macclesfield, and was received with favour by the electress Sophia in acknowledgment of his book *Anglia Libera*, a defense of the Hanoverian succession. On his return from the continent he published *Vindicius Liberius* (1702), in which he described *Christianity not Mysterious* as a youthful indiscretion. The next year he visited Hanover and Berlin and was again graciously received by the electress and her daughter Sophia Charlotte, queen of Prussia, the "Serena" of the *Letters* published on his return to England (1704). In two of these (*A Letter to a Gentleman in Holland* and *Motion Essential to Matter*), ostensibly an attack on Spinoza, he anticipated some of the speculations of modern materialism. The *Account of the Courts of Prussia and Hanover* (1705) was used by Carlyle in his *Life of Frederick the Great*. From 1707 to 1710 Toland lived in varying circumstances on the continent. In 1709 he published (at The Hague) *Adeissidaemon* and *Origines Judaicae*. The last of his theological works were *Nazarenus, or Jewish, Gentile and Mahometan Christianity* (1718), in which he maintained that the early Christians were Jewish Christians observing the Mosaic law and that their successors were the Nazarenes or Ebionites afterward regarded as heretics by the Church.

His last book, *Pantheisticon* (1720), gave great offense. He died on March 11, 1722, in London, as he had lived, in great poverty, with his pen in his hand. The term "free-thinker" was first applied to Toland, who indeed uses it himself.

See Mosheim's *Vindiciae antiquae christianorum disciplinae* (1722), containing the most exhaustive account of Toland's life and writings; a *Life of Toland* (1722), by "one of his most intimate friends"; "Memoirs of the Life and Writings of Mr. John Toland," by Des Maizeaux, prefixed to *The Miscellaneous Works of Mr John Toland* (London, 1747); and also G. Berthold, *John Toland und der Monismus der Gegenwart* (1876).

TOLEDO, a province of Spain, formed in 1833 from part of New Castile; bounded N. by Avila and Madrid, E. by Cuenca, S. by Ciudad Real and W. by Cáceres. Pop. (1930), 489,396; 1940 census 480,008; area 5,925 sq.mi. The surface is mountainous. Toward the centre there are extensive tablelands, but the whole of the south and east is occupied by the Montes de Toledo and the hills which separate the waters of the Tagus on the north from those of the Guadiana on the south. Toledo is well watered by the Tagus (*q.v.*) and its numerous affluents. Some gold, silver, lead, iron, quicksilver, copper, tin and other minerals are mined; there is not much trade in agricultural products. The principal manufactures are silk and woollen cloth, earthenware, soap, oil, chocolates, wine, rough spirit (*aguardiente*), guitar strings and arms. There is also a small trade in charcoal and timber. The province is traversed by three lines of railway connecting Madrid with the south, east and west. The province was contested by both armies during the entire civil war of 1936–39.

TOLEDO, the capital of the Spanish province of Toledo and formerly of the whole country, 47 mi. by rail S.S.W. of Madrid, on the river Tagus, 2,400 ft. above sea level. Pop. (1940) 27,427 (mun., 34,592). Toledo is of immemorial antiquity; it was a stronghold of the Carpetani and may have been a Carthaginian trading-station. Livy (xxv. 7) mentions *Toletum* as *urbs parva, sed loco munita*, which was captured by the Romans in 193 B.C. Under Roman rule it became a *colonia* and the capital of Carpetania. Its ecclesiastical importance is coeval with the introduction of Christianity into Spain, there were numerous church councils held here, notably in 396, 400 and 589, and here also was the chief battleground in the long political and religious struggle which ended (589) in the triumph of Spanish Catholicism over Arianism. From the reign of Athanagild (534–547) until the Moorish conquest in 712, Toletum was generally regarded as the capital of Visigothic Spain. The Moorish chroniclers grow eloquent over the treasures captured by Musa and his army in 712. *Tolaitola*, as the city was then called, prospered under the Moors, first as a provincial capital in the caliphate of Cordova, governed by an emir (712–1035), afterwards as an independent state (1035–85). Its rulers protected the large Jewish colony, founded extensive silk and woollen industries and made their city an important centre of Arab and Hebrew culture, one of the great names associated with it being that of Rabbi ben Ezra (1119–74). Spanish and Jewish inhabitants became "Mozarabs," adopting much of the Moorish culture. Toledo was captured by Alphonso of León and Castile, aided by the Cid, in 1085, and two years later he made it his capital. It declined after Philip II moved the capital to Madrid (1560). In one of the most famous sieges of the civil war of 1936–39, nationalists in the Toledo alcázar held out for 70 days and were relieved on Sept. 27, 1936.

Toledo occupies a rugged promontory of granite, washed on all sides except the north by the Tagus, which here flows swiftly through a deep and precipitous gorge. From a distance it has the aspect of a vast fortress, built of granite, defended by the river and by a double wall on the north, and dominated by the towers of its cathedral and alcázar. The absence of traffic in its maze of dark and winding alleys creates a silence uncommon in so large a town. The principal *plaza* is the arcaded Zocodover, described by Cervantes in the *Novelas ejemplares*. The houses, tall,



THE PUENTE DA ALCÁNTARA ACROSS THE TAGUS RIVER, A MOORISH BRIDGE REBUILT IN THE 13TH AND 17TH CENTURIES

massive and sombre, are entered by huge iron-studded doors, and most of their windows open on a sheltered inner court (*patio*). The alcázar and many other buildings of Toledo suffered great damage during the siege of 1936.

The Tagus is spanned by two fortified Moorish bridges, the Puente da Alcántara, on the northeast, which was rebuilt in the 13th and 17th centuries, and the Puente de San Martín, on the northwest, founded in 1212 and rebuilt in 1390. The Mudéjar Puerta del Sol is the finest of several ancient gateways, among which the Puerta Visagra (1550, restored 1575) and the Puerta

del Cambron (1102, restored 1576) are also interesting. The Puerta Visagra Antigua, a Moorish gateway of the 9th century, has been walled up, but its original form is preserved. The Alcázar, a huge square building with a tower at each corner and a fine arcaded patio, stands on the highest ground in Toledo, originally the site of a Roman fort, and now a military academy. Its fine façade designed by Juan de Herrera, a gateway by Alonso de Covarrubias and a staircase by Herrera and Francisco de Villalpando have been preserved The Ayuntamiento, or city hall, is a 15th-century building with 17th-century alterations by Domenico Theotocopuli (El Greco)

The cathedral occupies the site of a Visigothic church. St. Ferdinand founded the present cathedral in Aug. 1227. The completion of the main fabric was delayed until 1493, while many of the chapels and other subordinate buildings were added even later; thus Renaissance and baroque features have been introduced into a design which was originally Gothic of the 13th century. The interior is 395 ft. long by 178 ft. broad, and is divided by 84 pillars into five naves, with central lantern and choir, and a complete series of side chapels

Most of the chapels date from the 15th and 16th centuries, and are very magnificent in detail. The superb stained-glass windows, chiefly of Flemish work, belong to the same period and number 750 The choir stalls, placed in alabaster recesses divided by columns of red jasper and white marble, are among the finest extant examples of late mediaeval and Renaissance wood carving, though rivalled by the *retablo*, which rises behind the high altar to the roof. The treasury, reliquaries and library still contain many priceless manuscripts and works of art, including the silver monstrance executed by Enrique de Arfe in 1524, and paintings by Goya, El Greco, Titian and Rubens. In the Mozarabic chapel, mass is still performed daily according to the Mozarabic liturgy, which was also used in six of the parish churches until about 1850. (*See* MOZARAB.)

Apart from the cathedral, many of the other churches are of great interest and beauty. Several of them, notably Santo Tomé and San Vicente, contain masterpieces of El Greco (d 1614), many of whose pictures are collected in the Casa del Greco, founded by the Marqués de Vega-Inclán. The Franciscan convent and church of San Juan de los Reyes (florid Gothic) were founded in 1476 by Ferdinand and Isabella. El Cristo de la Luz was originally a mosque, built in 922 and incorporating some pillars from an older Visigothic church.

Santo Tomé, also a mosque, was reconstructed in the Gothic style during the 14th century. El Cristo de la Vega, formerly known as the Basilica de Santa Leocadia, occupies the site of a Visigothic church built in the 4th century to mark the burial place of the saint. The Mudéjar Santa María la Blanca became successively a synagogue (in the 13th and 14th centuries), a church (1405), an asylum for women (1550), barracks (1791–98) and again a church.

Toledo's characteristic industry is the manufacture of swords, carried on by private firms and especially in the royal factory (1788), which, like the railway station, is about 1 mi. from the city. Toledan blades have been famous for 2,000 years, the *cultor toletanus* being mentioned in the *Cynegetica* of Grattius (Faliscus), during the 1st century B.C. The industry throve under the Moors and especially during the 16th century; it is now practised on a smaller scale, but the blades produced are still remarkable for flexibility and strength.

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TOLEDO, a city of northwestern Ohio, U.S., a port of entry and the county seat of Lucas county; on Maumee bay (the southwestern tip of Lake Erie) at the mouth of the Maumee river.

It is on federal highways 20, 23, 24, 25, 68 and 223; and is served by the Ann Arbor, the Baltimore and Ohio, the Big Four, the Chesapeake and Ohio, the Michigan Central, the New York Central, the Nickel Plate, the Pennsylvania, the Wabash and the Wheeling and Lake Erie railways, by Capital, Chicago & Southern, Trans World and United air lines, and by lake steamers. Population, federal census (1950), 301,358; (1940) 282,349, (1930) 290,718.

The city has a land area of 43.11 sq mi.; lying on both sides of the curving river, but chiefly on the west, with seven connecting bridges It has tall hotels and business buildings, shaded residential streets; a zoological park with an open-air amphitheatre; a museum of natural science, and public buildings, notably the well-endowed Museum of Art, which houses a fine collection of Egyptian antiquities and glass and many canvasses of famous painters.

There are 535 mi. of paved streets, parks covering 2,240 ac., 50 mi. of boulevards, 300 churches, 11 hospitals, 54 public and 37 parochial schools and a public library with 10 branches. The University of Toledo (founded in 1872 as a private institution, and organized as a municipal university in 1884) has a campus of 160 ac. Private charitable organizations and welfare agencies are jointly financed through a community chest The city operates under a city-manager government, provided by the charter of 1936

The harbour has 35 mi. of shore and a depth of 25 ft., accommodating the largest lake vessels. Its traffic in 1948 amounted to 30,727,012 tons. In 1948 it handled 19,307,635 tons of coal, maintaining its position as the largest coal shipping port in the world. Foreign commerce in 1948 was represented by receipts of 211,454 tons of imports (mostly coffee, stone, sand, gravel and iron ore) In 1948 exports amounted to 5,379,712 tons (mostly coal, petroleum products and manufactured items). Domestic receipts amounted to 4,882,677 tons (largely iron ore, coal and petroleum products); domestic shipments reached 20,464,623 tons, mostly coal received by rail from Ohio, Kentucky and West Virginia fields. Glass, automobile parts, petroleum products, machinery and machine tools and automobiles are among the important products of Toledo's diversified manufacturing industries.

Toledo is one of the leading markets for hay and grain, coffee and spices and winter vegetables

The site of Toledo lies within an immense tract acquired by the United States from several Indian tribes in 1795 A stockade fort (Ft. Industry) was built there about 1800. In 1817 two companies bought from the government most of the land now occupied by the city, and laid out two towns, Port Lawrence in 1817 and Vistula in 1832. They were united in 1833 under the name of Toledo, and in 1837 the town was chartered as a city. The "Toledo War" was a dispute over the boundary line between Ohio and Michigan, both claiming a strip of rich agricultural land within which lay the site of Toledo, even then recognized as of great commercial importance.

In 1818 the Ohio legislature accepted the "Harris line" (surveyed in 1817 in accordance with the state constitution) and in 1835 the legislature, on the recommendation of Gov. Robert Lucas, passed an act providing for the organization of new townships in the territory thus added, and for the appointment of three commissioners to remark the northern state line. On the appointment of the commissioners Gov Stevens T. Mason of Michigan ordered out a division of the territorial militia, which late in March 1835, took possession of Toledo. A division of Ohio militia marched to Perrysburg, 10 mi. south of Toledo. Meanwhile Pres. Andrew Jackson had sent Richard Rush of Philadelphia and Benjamin C. Howard of Baltimore to Ohio as peace emissaries, and on their arrival at Toledo both forces disbanded. In June the Ohio legislature created Lucas county, mostly from the disputed territory, and made Toledo its judicial seat. In June 1836, congress decided the dispute in favour of Ohio, and in 1837 Michigan was admitted to the union on condition of relinquishing all claim to the strip in question, receiving the upper peninsula by way of compensation. In 1840, three years after its incorporation, Toledo had a population of 1,222. Toledo's city administration became famous under the mayoralty of Samuel Milton ("Golden Rule") Jones (1846–1904), a manufacturer who was first elected by the Republican party in 1897, and then re-elected on a nonpartisan ticket in 1899, 1901 and 1903

Jones introduced business methods into the city's affairs,

and won his nickname through his honesty and sincerity in both business and politics The independent movement started by him was carried on by Brand Whitlock (*q v*), mayor in 1906–13

TOLEDO, COUNCILS OF. From the 5th to the 16th century about 30 synods, variously counted, were held at Toledo in Spain. As nearly 100 early canons of Toledo found a place in the *Decretum Gratiani*, they exerted an important influence on the development of ecclesiastical law The last council of Toledo was that of 1582 and 1583

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TOLENTINO (anc. *Tolentinum Picenum*), a town of the Marches, Italy, in the province of Macerata, 21 mi by rail W by S. of that town Pop. (1936) 5,710 (town); 14,356 (commune). It is situated on the Chienti, 735 ft. above sea level, and was once a fortified town of great strength The church of S. Nicholas of Tolentino has a fine portal by the Florentine Giovanni Rosso (1435) At Tolentino in 1815 a battle was fought in which the French under Murat were defeated by the Austrians

TOLERANCE. Manufacturing on the interchangeable system, which originated in the production of firearms, requires that pieces to fit together shall not exceed a certain maximum dimension or fall below a certain minimum dimension The margin of error between the maximum and minimum dimensions is termed the tolerance. Exact sizes being a mechanical impossibility, the machines and tools which make the parts of an engine or machine are set and maintained to cut or grind such parts within certain limits. The finer the limits the more costly the manufacturing becomes, hence the tolerances or margins must be calculated according to the class of work produced, *e.g.*, it is not necessary to work so closely on the parts of a large engine or machine as it is on a small mechanism or tool. Grades of tolerance are therefore tabulated for various needs Tolerances usually range from the maximum amount of variation that the grade of work will permit to $\frac{1}{10\,000}$", thus the diameter of a shaft might have a tolerance of $\pm \frac{1}{1\,000}$" indicating that the shaft is permitted to be larger than standard by this amount or smaller by the same amount. In the unilateral system the tolerance is expressed in only one direction For example, $-\frac{1}{1000}$", and the diameter of the shaft might be basic size or $\frac{7}{8\,000}$" under basic size *Allowance*, a term distinct from tolerance, denotes the difference in the size of two mating pieces to make a particular quality of fit, either a tight force fit, an easy push fit or a running fit

TOLFA, a town of the province of Rome, Italy, 10 mi. E N E of Civitavecchia by road, 1,558 ft above sea level. Pop. (1936), 4,534 (town), 4,671 (commune). It is the chief place in the Tolfa mountains, an extinct volcanic group between Civitavecchia and the Lake of Bracciano. Vapours are emitted which deposit sulphur and alum, and alum mining is carried on The alum is treated both here and at Civitavecchia. Near Tolfa and Allumiere tombs of the early (pre-Benacci) Villanovan period, belonging to the 12th century B.C have been found.

See R. MacIver, *Villanovans and Early Etruscans* (Oxford, 1924).

TOLL, JOHAN KRISTOFFER, COUNT (1743–1817), Swedish statesman and soldier, was born at Mollerod in Scania, the son of one of Charles XII's warriors He served in the Seven Years' War. In the *coup d'état* of 1772 he ranged himself on the side of Sprengtporten and was told to capture the southern fortress of Kristianstad. By sheer bluff he won over the whole garrison on Aug 21, seven days later. Gustavus III's *coup d'état* at Stockholm completed the revolution. Toll was liberally rewarded. In 1783 he was placed at the head of the secret "commission of national defense," which ruled Sweden during the king's absence abroad. In 1786 he had risen to the rank of major-general and was Gustavus's principal adjutant.

After the death of Gustavus III, Toll was for a short time war minister and commander in chief in Scania, and was sent later as ambassador to Warsaw. Unjustly involved in the "Armfelt conspiracy," he was condemned to two years' imprisonment, but was reinstated in 1796 when Gustavus IV attained his majority At the riksdag of Norrkoping, 1800, he was elected marshal of the diet and was an able leader of the royalist party He carried on the negotiations with the powers concerning Sweden's participation in the war against Napoleon. In the Pomeranian campaign of 1807 he helped to defend Stralsund, and on its surrender to Marshal Brune on Aug. 20, he persuaded the latter (Sept 7) to make a convention by which the Swedish army was allowed to return unmolested to Sweden, and was rewarded by his marshal's baton. In 1814 Bernadotte created Toll a count

See R Nisbet Bain, *Gustavus III and his Contemporaries* (1895), K N. Liliekrona, *Faltmarskalken Grefve J. K. Toll* (Stockholm, 1849–50). (R N B)

TOLLER, ERNST (1893–1939), German poet, was born in Szamocin on Dec 1, 1893 On the outbreak of World War I he joined the army as a volunteer, but was invalided out A Socialist and friend of Kurt Eisner, Toller took a very prominent part in the Munich revolution of 1919, for which he was sentenced in July 1919 to five years' imprisonment in a fortress. He achieved celebrity with his revolutionary dramas *Die Wandlung* (1920); *Masse-Mensch* (1921, Eng. trans 1923); *Die Maschinensturmer* (1922; Eng trans 1923) and *Hinkemann* (1924); and with two volumes of lyrics, written in prison, *Gedichte der Gefangenen* and *Das Schwalbenbuch* (1924, also Eng trans). His *Masse-Mensch* ("Masses and Man") exemplified a new theatrical technique and had much influence on the Russian theatre In 1933 he was exiled from Germany.

See S. Grossmann, *Ernst Toller, Hochverrater und Dichter* (1919).

TOLSTOY, LEO (LYEV) NIKOLAYEVICH, COUNT (1828–1910), Russian novelist and moral philosopher, was born on Aug. 28, (Sept. 9,) 1828, at his parents' country place of Yasnaya Polyana, in the province of Tula. The Tolstoys are a family of Russian gentry dating back to the 16th century (*not* of German origin as is often affirmed, and as Tolstoy himself believed) Peter Andreyevich Tolstoy (*q v*) was created a count by Peter the Great. His descendant, Count Nicholas Ilyich, the novelist's father, married Princess Marie Volkonsky, who brought him a substantial fortune. They had five sons of whom Leo was the youngest but one. The surroundings in which he grew up were those of a family of the upper middle gentry of the last of the period of serfdom. This environment produced in him the "peer-and-peasant" view of life.

Early Years.—Tolstoy's mother and father died in 1831 and 1837, and he was brought up by elderly female relatives His education was in the hands of French tutors, a state of things that was already an anachronism So his intellectual and cultural groundwork was mainly 18th century French, and his contact [illegible] Russian [illegible]

ary review, who accepted it enthusiastically and had it published at once In 1854 Tolstoy received his commission, and was transferred (on his application) to the army that was operating against the Turks on the Danube, and a few months later to Sevastopol, where he remained till the end of the siege. After the fall of the fortress he was sent with dispatches to St. Petersburg, where he remained, frequenting society and literary circles, and much preferring the former to the latter. With the *littérateurs* he failed to get on Their plebeian arrogance shocked him, and he had no respect for their ideal of European progress. His resounding quarrel with Turgemev may be taken as typical of these relations In 1857 he retired from the army.

In the same year (and again in 1860) he travelled abroad, and (like Dostoyevsky a few years later) brought back nothing but disgust with the materialistic and plutocratic civilization of the west After his second journey abroad he settled at Yasnaya Polyana, and accepted an appointment to a magistracy introduced by the Emancipation act of 1861 for the settling of land disputes between the squires and their former serfs He also started a school for peasant children on new and original lines, based on his belief in the superior value of their natural lights to the artificial standards of civilization, and published a journal (*Yasnaya Polyana*) devoted to the advancement of his pedagogical ideas. But before long he gave up both magistracy and school. He was on the brink of an inner crisis.

The crisis, however, did not mature till 15 years later: it was postponed by his marriage He had been contemplating marrying for some time. His romance with Valeria Arsenev had ended in nothing. He was obsessed by grave misgivings and doubts before he proposed to Sophie Behrs, a young girl 16 years his junior, with whom he fell in love in 1861 He overcame them, however, and they were married in the following year.

Literary Works (1852–76). Tolstoy's literary work grew out of his diary. It was primarily an attempt to lay bare the *mechanism* of the inner life, and to give clear and verbal definition to the semi-articulate processes of the consciousness His first literary attempt, *The Story of Yesterday* (1851, first published 1926) sets out to give an exhaustive account of his feelings and reactions during a given space of twenty-four hours His first completed and published work, *Childhood* (1852), less exuberantly analytical and more conventional in form, reveals a greater command over the more intimate and elusive movements of the consciousness than had ever before been displayed in literature. In the stories that followed he further perfected his instruments of analysis, often to the detriment of the imaginative unity of the work At the same time a conflict which was to remain dominant throughout his life comes to the forefront—the conflict between spontaneous, unreflecting, natural Life and the claims of reason and moral law In *The Cossacks* (written 1854, published in what the author regarded as an unsatisfactory form in 1863) the victory rests with life: natural man, unconscious of good and evil, and consequently beyond the reach of ethical reason is glorified in the Cossacks who put to shame the reflecting and impotent hero, Olenin. The futility, meanness and vulgarity of civilized man is exposed again and again in *Two Hussars* (1856), *Lucerne* (1857), *Three Deaths* (1859) and in *Kholstomer* (1861), a very characteristic satire on the life of the upper classes, in which the rôle of the intelligent savage of 18th-century literature is played by a racehorse. All his early work is subjective, and the reflecting and introspective character, whether his name is Olenin or Nekhlyudov (as in *Boyhood*, 1854, and *Youth*, 1857) is always Tolstoy himself. The other men whose feelings are analyzed, are merely types of "man in general" —psychological mechanisms of cause and effect, devoid of personality. Such for instance are the officers of the *Sevastopol* stories (1855) in whom Tolstoy dissects the components of fear and courage.

After his marriage Tolstoy lived at Yasnaya Polyana, passing some part of the year at Moscow and on his estate beyond the Volga. His married life was happy and prosperous. His income was increased by successful farming and the sale of his books. His wife was entirely devoted to him and to her children of which she bore him nine. His inner conflict was lulled for many years by the triumph of spontaneous life over questioning reason. His philosophy in those years was "that one should live so as to have the best for oneself and one's family," and not try to be wiser than Life and Nature

This philosophy found its full expression in the first of his few great novels, *War and Peace*. It was commenced in 1864 and completed in 1866. After that he turned again for a time to pedagogical writings, and made several attempts at other historical novels, including one on Peter the Great, that remained unfinished, because of the invincible repulsion aroused in him by the proposed hero. In 1873 he began *Anna Karenina*, which appeared in instalments from 1875 to 1877 Towards the end of his work on this second of his great novels he entered on the prolonged and fateful crisis that resulted in his conversion Indications of its approach are clearly visible in the latter part of the novel.

War and Peace and *Anna Karenina* are Tolstoy's masterpieces. They mark, in a certain sense, the highest point reached in its development by the modern realistic novel. Literary realism attains in them its goal: an adequacy of the verbal pattern to the living reality which ultimately produces the feeling, familiar to readers of Tolstoy, that his characters are to be classified with people in flesh and blood, not with other characters in fiction This supreme achievement was largely prepared for by his previous apprenticeship, but *War and Peace* marks an enormous advance over all that had preceded it The countless characters that fill the stage are seen not from outside only, but from the inside The women in this respect are particularly remarkable, and among them most of all Natasha who is the centre of the novel, the embodiment of its philosophy, the quintessence of spontaneous, nature-wise mankind Nor does the author introduce himself so crudely as he does in his earlier work, but is transformed into the two distinct and objective characters of Prince André and of Pierre. With its world of characters, and against its vast background of Russian and European history the novel is a real piece of life, transformed by art The novel is markedly optimistic, and has not without propriety been described as an idyll of the Russian landed gentry. Not that the horrors of life are entirely absent but they are overcome by the beneficent influence of a benevolent Life-god presiding over the action. The idyllic atmosphere is preserved in the greater part of *Anna Karenina*, which as a whole marks no advance on *War and Peace*, though each of the individual characters (and again especially the women) come up to the same level, and even, perhaps, present a greater variety of persons entirely different from the author and seen from inside

His Conversion.—About 1876 Tolstoy began to feel uneasy about the unreflecting and prosperous life he was leading; the thought of approaching death grew into an invincible obsession; and the passionate craving for a religious justification of his life became the dominating force in him. At first he turned to the orthodox faith of the people, hoping that a religion that made so many millions happy in the midst of their misery would save him, but the proud rationalism of his mind could not accept its rites and fasts, he renounced the Church, and out of his own reading of the Gospels gradually evolved a new Christianity, from which all the metaphysical and non-ethical elements were eliminated The decisive stage in this conversion, he tells us, was the moment when he realized that the whole message of Christ was contained in the words (Matt. 5, 39) "that ye resist not evil." This doctrine of non-resistance became the foundation of the creed which soon became known as Tolstoyism (tolstovstvo)

It is necessary to distinguish two stages in this conversion: the initial pang of despair, and disgust with unjust and fleshly life, and the subsequent efforts to reduce this essentially mystical and incommunicable experience to a logical and consecutive doctrine. Tolstoy gave a complete account of his conversion in *A Confession* (written 1879, revised 1882, published 1884) It is a work of great imaginative sincerity and tremendous rhetorical power worthy to rank by the side of the *Confessions* of St Augustine. But the initial and more essential stage of despair is recorded with even greater power in a fragment, posthumously published, *The Memoirs of a Madman* (1884). The same experience is at the base of the two greatest imaginative works of his old age—*The Death*

of Ivan Ilyich (1884) and *Master and Man* (1895)

At first Tolstoy took no steps to propagate his new faith. It was not till after the revelation of social misery he had in a visit to the Moscow slums that his religion assumed a definitely social coloring, and not till his intimacy with V. G Chertkov that "Tolstoyism" became an organized sect, and began to acquire proselytes. This happened in 1884

Tolstoy's Teaching.—Tolstoy's religion expounded in *What I believe in*, and in *A Short Expositon of the Gospels*, is based on the natural light immanent in the human conscience which reveals to us the God that is the supreme Good and Reason. God is not personal, and there is no personal immortality Jesus was a great man, whose teaching is true not because he was the Son of God, but because it coincides with the light of the human conscience. The Buddha and other men were as great, and Jesus holds no monopoly of the truth. Tolstoy advanced no metaphysics and no image of the world order His religion is purely anthropocentric God and the Kingdom of God are "inside us" The aim of man is to achieve happiness, which can be done only by doing right, by loving all men, and by freeing oneself from the appetites of greed, lust and anger. All forms of violence are equally wicked. Not only war but all forms of compulsion inherent in the State are criminal. The true Christian must abstain from participating in them, he must refuse conscription; he must not accept any work under the State; he must not sit on a jury. Opposing the State with violence is also wicked and cannot lead to any better forms of life Revolutionary activity, though it may be based on the good feeling of love for the oppressed, is evil because it breeds hatred and violence. The social order can become better only when all men have learned to love each other Still there is a great difference in Tolstoy's attitude to the State and to the Revolutionaries; he disapproves of the latter, but all the force and bitterness of his invective is kept for the former. Property, as the gratification of greed and lust and the assertion of a single man's monopoly over things that belong to all, is wicked. It is the chief source of violence and so on. The rich have built up a corrupt and artificial civilization, and created for themselves fictitious values, which must be got rid of. The poor, however demoralized by servitude, have preserved their good nature in greater purity because they have not been corrupted by the artificial culture of the rich. Love and compassion must be extended to all living things, and abstention from the flesh of slaughtered animals is a characteristic tenet of Tolstoyism. So are abstinence from intoxicants and drugs (particularly tobacco), the artificial demand for which was created by a corrupt civilization, and which dim the natural conscience of man.

Tolstoy can hardly be called a social reformer for he advanced no practical proposal for the improvement of social conditions. He did not believe in the possibility of reform in the accepted sense of the word. The first duty of the true Christian being is to abstain from living by the work of others, and from taking part in the organized violence of the State. The only practical measure he advocated was the solution of the land question by means of the land tax of Henry George. His disapproval extended to the organized violence of Western capitalistic democracy as well as of Russian autocracy.

On the whole, the direct influence of Tolstoy's teaching in Russia was not great His disciples were never numerous (and seldom of a very high quality). He established relations with many dissenting Russian sects, but most of these (*e g*, the *Doukhobors*, *q.v.*) were essentially alien to him in spirit. His larger influence, however, was immense, and very soon crossed the frontier. In the last 15 or 20 years of his life he was probably the most venerated man in the world. His fame reached into China and India as well as Europe and America Visitors from all ends of the world made Yasnaya Polyana a new Mecca.

From the first, the Russian Government viewed Tolstoy's new activity with hostility. But it never attempted to do anything against him. Some of his more anti-Orthodox writings, as well as some of his bitterest attacks on the Romanoff dynasty had to appear abroad. But what appeared in Russia was quite sufficient for a complete acquaintance with his teaching. In 1901 the Synod of the Russian Church excommunicated him,—an act which has been much misinterpreted and which merely registered a fact he had himself proclaimed many years earlier, viz, that he had ceased to belong to the Church On the other hand many of Tolstoy's followers suffered imprisonment and banishment to Siberia chiefly for refusal of military service.

Tolstoy's conversion changed his attitude to his literary creation. He did not abandon it, nor did it deteriorate in quality, but it became different, so did his views of its social and moral function They are contained in *What is Art* (1896), one of the most remarkable books ever written on the subject. Art, according to Tolstoy, is a means of emotional communion, a means by which the artist "infects" other people with feelings he has himself experienced If this "infection" does not take place there is no art If it is limited to a small number of persons of the same class, time or nationality as the author, it is negligible and inferior art; if the appeal extends to mankind in general, but the feelings thus communicated are evil feelings it is genuine but evil art; if the feelings are good, it is good art and if they are the highest feelings possible, the religious feelings of love and compassion, it is the highest form of all, religious art The application of these standards led Tolstoy to reject or to minimize by far the greater part of modern art and literature, including his own early work, which had exalted the life of the rich and idle This change of attitude went hand in hand with a change in his literary taste. He rejected the "superfluous detail" of realism not only because it limited the appeal of literature to those familiar with the society described, but because it ceased to satisfy him aesthetically Already in 1873 he had written some stories for the people, in which everything that was not essential for the narrative development had been rigorously eliminated. From 1884 onwards he wrote a number of new stories of the same kind, masterpieces of chaste and classical narrative technique at the service of one unifying and crystallizing idea, the idea of ethical Christianity.

The same method, on a larger scale, is applied in *Father Sergius*, in *The False Coupon*, and in *Hadji-Murâd* (1896–1904) which was the favourite work of his old age and which he intended as an example of good art appealing to the sense of human brotherhood, though not to the highest religious feelings.

Apart from these works stands *Resurrection* (published in 1899–1900) in which he returned to his old "superfluous-detail" and which consequently failed to satisfy him. It contains beautiful passages in the idyllic style of *War and Peace*, and pages of powerful sature on the evil social order, but it falls short of being a masterpiece.

The most important imaginative work of his last period are the stories based on his inner experience—those connected with his conversion (*The Death of Ivan Ilyich*, *Master and Man*, *The Memoirs of a Madman*), and those in which he embodied his experience of sex, the *Kreutzer Sonata* (1889) and *The Devil* (1889, pub. 1911) The former group in particular stands in importance by the side of *War and Peace*. The atmosphere pervading them is totally different: they are as grimly tragical as the earlier novel is idyllic. They are on a level with the greatest religious writings of the world

Tolstoy's plays (with the exception of a comedy written in 1863 and published in 1926) all belong to the period after his conversion. They include *The Power of Darkness* (1889), a powerful drama of peasant life; *The Fruits of Enlightenment* (1st ed, 1891; 2nd ed, 1911), a light comedy satirizing the fads of "society," and *The Living Corpse* (pub. 1911), one of his last writings in which there is a mellowness of old age, and in which the character creator of *War and Peace* makes his last appearance.

Last Years.—Tolstoy's conversion led to his adopting a new mode of life—he dressed like a peasant, did much manual work, learned bootmaking and adopted a vegetarian diet. His wife and children (except his youngest daughter, Alexandra) remained hostile to his teaching and the Countess Tolstoy would not hear of his renouncing his worldly belongings which, she maintained, be held in trust for his children. So he made over all his property (including the copyright of his works written before 1880) to her. The paradoxical situation arose of the preacher of poverty and

abstention continuing to live in affluence surrounded by a family who disapproved of his views, but adored him. The first tension between him and his wife was followed by a rapprochement, cemented by the birth in 1886 of a sixth son. But the death of the little boy at the age of seven was followed by an increasing estrangement between husband and wife. She grew increasingly hysterical, embittered and tactless, and life at Yasnaya became a hell, a constant state of war between the family and followers of Tolstoy, between Countess Tolstoy and Chertkov. Tolstoy suffered deeply from the incongruity of his position at home. At last on Oct. 28, 1910, he left home secretly at night with his daughter Alexandra. He had no particular aim in view. His health broke down at Astapovo (gov. of Ryazan). He was laid up there in the station-master's room, and he died on Nov. 8 (21), 1910. He was interred at Yasnaya, without a Christian burial.

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(D. S. M.)

TOLSTOY, ALEXEI KONSTANTINOVICH, COUNT (1817–1875), Russian novelist, dramatist and poet, was a distant relation of Leo Tolstoy. Born at St. Petersburg on Sept. 5, 1817, and brought up on his uncle's estate at Tchernigoff, which he inherited in 1836, he was a playmate of the Emperor Alexander II. He studied at the university of Moscow, and was afterwards attached to the Russian Legation at Frankfurt and served in the Crimean War. He held various court appointments, and spent much time in western Europe. He died at his Tchernigoff estate, Krasni Rog, on Oct. 10, 1875. With his two cousins Zhemchuzhnikov, Tolstoy wrote between 1853 and 1863 much satirical nonsense-verse under the joint pseudonym of a fictitious civil servant, Kosma Prutkov. He also wrote some magnificent lyric poetry; one of his most famous pieces, a paraphrase of the lament for the dead in the Russian church service, is translated by Maurice Baring in the *Oxford Book of Russian Verse*. Outside Russia, however, Alexei Tolstoy is best known by his historical romance, *Prince Serebrany* (1863) (Eng. trans. by C. A. Manning, 1927), and his dramatic trilogy: *Death of Ivan the Terrible* (1866; Eng. trans. by A. Hayes, 1926); *Tsar Feodor Ioannovich* (1868; verse trans. A. Hayes, 1924), and *Tsar Boris* (1870). Some of his poems are translated in C. T. Wilson's *Russian Lyrics in English Verse* (1887); Anglo-Russian Literary Society, Nos. 21, 23, 25, and J. Pollen's *Rhymes from the Russian* (1891).

See A. Lirondelle, *Le Poète Alexis Tolstoï* (1912).

TOLSTOY, PETR ANDREYEVICH, COUNT (1645–1729), Russian statesman, was the son of Andrei Vasilevich Tolstoy, an *okolnichy* or courtier attached to the person of the tsar. He served in 1682 as chamberlain at the court of Theodore III. Miscalculating the strength of the tsarevna Sophia, he became one of her most energetic supporters, but contrived to join the other, and winning, side just before the final catastrophe. For a long time, Peter kept his latest recruit at arm's length, but when, in 1697, Tolstoy volunteered to go to Venice to learn Italian and shipbuilding, Peter could not resist the subtle flattery implied in such a proposal from a middle-aged Muscovite noble. In Nov 1701, Tolstoy was appointed the first regularly accredited Russian ambassador to the Porte, and more than justified the confidence of the most exacting of masters, though his peculiar expedients (such as the procuring of the strangulation of a grand vizier and the removal by poison of an inconvenient private secretary) savoured more of the Italian than of the Russian Renaissance.

Even before Poltava, Tolstoy had the greatest difficulty in preventing the Turks from aiding the Swedes, and when Charles XII took refuge on Turkish soil he instantly demanded his extradition. This was a diplomatic blunder, as it only irritated the already alarmed Turks; and on Oct 10, 1710, Tolstoy was thrown into the Seven Towers, a proceeding tantamount to a declaration of war against Russia. On his release from "this Turkish hell," in 1714, he returned to Russia, was created a senator, and closely associated himself with the omnipotent favourite, Menshikov. In 1717 his position during Peter's reign was secured once for all by his successful mission to Naples to bring back the unfortunate tsarevitch Alexius, whom he may be said to have literally hunted to death. For this he earned the undying hatred of the majority of the Russian people, but Peter naturally regarded it as an inestimable service and loaded Tolstoy with honours and riches, appointing him, moreover, the head of the secret chancellery, or official torture chamber.

Tolstoy materially assisted Menshikov to raise the empress consort to the throne on the decease of Peter (1725), and the new sovereign made him a count and one of the six members of the newly instituted supreme privy council. Tolstoy was well aware that the elevation of the grand duke Peter, son of the tsarevitch Alexius, would put an end to his own career and endanger his whole family. Thus, when Menshikov, during the last days of Catherine I, declared in favour of Peter II, Tolstoy endeavoured to form a party of his own whose object it was to promote the accession of Catherine's second daughter, the tsarevna Elizabeth. But Menshikov was too strong and too quick for his ancient colleague. On the very day of the empress' death (May 11, 1727), Tolstoy, now in his 82nd year, was banished to the Solovetsk monastery in the White sea, where he died two years later.

He was the author of a sketch of the impressions made upon him by western Europe during his tour in the years 1697–98 and also of a detailed description of the Black sea.

See N. A. Popov, "Count P. A. Tolstoy" (Russ.) in *Old and New Russia* (St. Petersburg, 1875); and "From the Life of P. A. Tolstoy" (Russ.) in *Russian Reporter* (St. Petersburg, 1860); R. N. Baun, *Pupils of Peter the Great* (London, 1897); and *The First Romanovs* (London, 1905).

(R. N. B.)

TOLTEC, a people frequently referred to in Aztec legend as formerly dominant in the region of the valley of Mexico, and associated with the ruins at Tollan (now Tula), that is, "Toltec places," but literally, place of tules or rushes. Their greatest preserved monuments, however, are at San Juan de Teotihuacan, 30 mi. northeast of Mexico city; and the terms Toltec and Teotihuacan are used by different archaeological schools as names of the same period.

Cholula, one of the large cities of Mexico in 1519, was associated with the Toltec traditionally; and in a measure Tezcoco. In Yucatan, Toltec influence is visible in ball courts, art style, etc, in the late Maya cities, especially Chichen Itzá. The legends or myths of the hero Quetzalcoatl (Kukulcan in Maya) associate him with the Toltec; and as he was the reputed institutor of higher culture, the Toltec were considered the first bearers of arts and knowledge, which is probably true for the region Tula-Mexico-Cholula. Brinton looked upon the Toltec as a mythical invention by the Aztec, a view significant only as a valid reaction against a former too credulous acceptance of the details of native tradition. The Toltec presumably were Nahua speaking; they may have been at their zenith about A.D. 900, and suffered decline about A.D. 1100.

TOLUCA, a city of Mexico and capital of the state of Méx-

ico, 45 mi W.S.W. of Mexico City on the highway to Guadalajara. Pop (est 1950), 46,000, at an altitude of 8,659 ft, which gives it a cool, healthful climate. Famous as a commercial centre for its fertile hinterlands, its Friday market day is one of the largest and most colourful in the republic It has a college, meteorological station and museum of popular arts Southwest of Toluca rises the extinct volcano, Nevado de Toluca (13,621 ft.) within which are two crater lakes. (HD C)

TOLUENE, or METHYLBENZENE, is an aromatic hydrocarbon (*see* CHEMISTRY · *Organic Chemistry*). It is a water-white liquid which has a boiling point of 110 56° C. at 760 mm. mercury pressure, a specific gravity of 0 8665 at 20° C. compared with water at 4° C, and an index of refraction of 1.4962 at 20° C. for the D-line of sodium It is insoluble in water but is soluble in all common organic solvents. Two commercial grades are produced: a nitration grade, the purer grade, and an industrial grade.

Toluene is one of the important constituents of coal-tar light oil (*see* COAL TAR), comprising 12%-20% by volume of the light oil; it is also present in petroleum, the toluene content usually being less than 0.5% Prior to 1917 toluene was produced almost exclusively from coal-tar light oils. During World War I toluene was in such great demand for the manufacture of the high explosive trinitrotoluene, T.N.T. (*q.v.*), that the production from coal-tar light oil was supplemented to a small extent by toluene isolated from petroleum. Between World Wars I and II, the processes for recovering toluene from petroleum were so improved that the petroleum industry became a major source of toluene. In the United States during World War II about 30,000,000 gal. of toluene were produced from coal-tar light oils and about 60,000,000 gal were obtained from petroleum sources.

Toluene is an important chemical raw material It is used in the manufacture of benzoic acid (*q.v.*), saccharin (*q.v.*), dyes (*see* DYES, SYNTHETIC), photographic chemicals, pharmaceuticals, etc. Its principal peacetime use is as a solvent. Because T N T has remained an important ingredient of explosives, and because toluene was an important constituent of high-octane aviation gasoline, toluene was one of the strategic materials of World War II.

Toluene should be used only in well-ventilated rooms since its vapours are poisonous. (F. E. CL)

TOMA, a small, light-complexioned, muscular folk, in French Guinea, who speak a language related to the Mande-Fu group.

See Gamory-Dubourdeau, "Notice sur les coutumes des Toma," *Bulletin, Comité Études—Hist. et Scient. d'Afrique Occidentale* (1925)

TOMAHAWK, the war hatchet of the North American Indians (Algonkin *otomahuk*, to knock down). The earliest tomahawks were of chipped stone, sharpened to a point at each end, something like a pickaxe, and passed through a hole bored in a stout wooden cudgel. In the more primitive types the stone head was simply tied to the handle by animal sinews, or a withe was doubled over the head and fastened below to form a handgrip. Sometimes deer antlers were used instead of stones. After the arrival of the white man, the heads were usually of iron. Where the stone head was sharpened only at one end, the blunt end was sometimes cut out into a pipe bowl, the handle, hollowed, serving as the stem. The weapon was at once symbolical of war and peace and was ceremoniously buried at the termination of hostilities, to be as formally exhumed when the feuds revived. Hence the colloquialism "to bury the hatchet"

TOMAR, a city of Portugal on the river Nabão, a tributary of the Zezere, 4 mi. from Paialvo railway station, which is 80 mi. N.E. of Lisbon by the main line to Oporto. Pop (1940) 7,952. Tomar contains examples of the best Portuguese architecture from the 12th century to the 17th The ruined castle of the Knights Templar, given to that order in 1159, is said to occupy the site of the ancient Nabantia. On the suppression of the Templars, King Dinis of Portugal founded the Order of Christ in 1314. The convent palace of the Knights of Christ includes a church and cloister dating from the 12th century, two cloisters and a chapter-house added in the 15th century by Prince Henry the Navigator and a very fine 16th century church built in the Manueline style by João de Castilho. Other interesting buildings are the churches of Santa Maria do Olival, rebuilt in the Gothic style in 1450 on the site of an older Templar foundation; São João Baptista, also Gothic, built in 1490, but with Manueline additions; Nossa Senhora da Conceição, Renaissance of 1579; and the ruined palace of Prince Henry the Navigator, restored in the 16th century by Queen Catherine, widow of John III. The city was formerly known as Thomar.

TOMASZÓW, an industrial town of Poland, in the province of Lodz. Pop. (1931), 38,065; (1946), 30,255. It has woollen mills, ironworks and steam flour mills and is the centre of the silk industry. Germany occupied it during World War II.

TOMATO (*Lycopersicon esculentum*) (family Solanaceae), a native of tropical America, now generally grown as a vegetable in tropical and temperate regions the world over. It was introduced into Europe early in the 16th century. With the exception of the very small currant tomato (*L. pimpinellifolium*), all cultivated forms consist of botanical varieties of *L. esculentum*, differing chiefly in fruit shape or plant habit. The tomato is a tender perennial that is cultivated as an annual. The plants are generally much branched, spreading 2-6 ft, and recumbent when in fruit, but a few forms are compact, upright. The leaves are more or less hairy, strongly odourous, pinnately compound, up to 1½ ft. long. The flowers are yellow, ¾ in. across, pendant, in clusters. Fruits vary in diameter from ¾-3 in. or more, are scarlet, scarlet-red or yellow; they vary in shape from oblate through spherical to oval, elongate or pear-shaped. The fruit is a soft, succulent berry containing two to many cells of small yellow seeds surrounded by jelly-like pulp. Botanically the edible portion is a fruit; it is generally considered as a vegetable because of the way it is used in the main part of the meal and is so classified in America for purposes of trade; however, by an old (1893) definition of a fruit, for purposes of trade, it could be considered as a fruit when eaten out of hand or as an appetizer. Although native to America, the tomato was eaten in Europe long before people in the United States first used it for food (about 1835). Until late in the 19th century many thought it was poisonous. It is an excellent source of vitamins A and C.

Since the tomato requires relatively warm weather it has been grown in Great Britain and northern Europe chiefly in hothouses, although a number of varieties are suitable for outdoor culture. It is grown under glass in America as a winter crop, but in very small volume compared to its field and home garden culture. In Italy it is grown to perfection and is manufactured into paste and other canned products. In the United States it is a major crop for use fresh, canned whole or as juice or made into a variety of sauces. One to two and a half million bushels have been imported annually (1930-40) into the United States, largely from Mexico and Cuba, during the winter, for use fresh. It is grown in winter in Florida and Texas and shipped all over the United States.

In Europe and most of the United States tomato seed is sown under glass or cloth protection about 6 weeks before the frost-free date, when the plants can be set in the open. For winter crops in the south, seed is sown in open beds in the fall. The seedlings are grown singly in pots and other containers or so spaced in boxes or beds of soil—from 2x2 to 4x4 in —that sturdy plants about 8 in tall may be produced for setting in the field. Often the seeds are sown only thinly in rows in the plant beds and not moved until set in the field Frequently in gardens, and in large fields in some areas, the tomato plants are pruned to a single stem and each tied to a stake to keep the fruits off the soil. In this system they are set 2-2½ ft apart in rows 3-4 ft. apart. Most of the crop in America is grown by allowing the plants to grow naturally upon the ground, spaced 3-5 ft. apart in rows 5-6 ft. apart, the spacing depending upon the variety and the plant size normally developed in the particular locality. The fruits are highly perishable when ripe and should be harvested every 3 or 4 days. For long distance shipment, the fruits are harvested when fully grown but still green in colour. They will ripen later if mature, but fruit harvested prematurely will not ripen. Green-harvested tomatoes never develop the high eating quality and high vitamin content characteristic of well-grown, vine-ripened fruit.

A large proportion of the tomato fields of the middle and north-



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DECORATIVE TOMBS

1. Exterior of the tomb of Perneb, of the V dynasty in Egypt (now in the Metropolitan Museum of Art, New York), as it appeared at the time of its excavation
2. So-called tomb of Absalom at Jerusalem; a rock cut monolith of typically Syrian Greco-Roman style. Probably 2nd century A D
3. The present state of the tomb of Hadrian in Rome, now the castle of San Angelo. Originally the circular wall was crowned by a cone of earth planted with trees
4. The tomb of Itimád-ud-daula at Agra, India, built in 1628, and showing the Mogul characteristic lavish use of pierced and inlaid marbles
5. The tomb of the Mongol conqueror Timur (Tamerlane) at Samarkand, 1405, typical of the Persian use of polychrome tile and the decorative dome form
6. The so-called Alexander sarcophagus, now in the museum at Constantinople, originally found at Sidon in Phoenicia. Its tinted reliefs of incidents from the life of Alexander the Great and the rich delicacy of its ornaments are characteristically Hellenistic
7. A small Muslim tomb at Cambay, India, showing mingled Jain and Mogul elements
8. The tomb of Giuliano de' Medici in the new sacristy of San Lorenzo at Florence, designed by Michelangelo, between 1520 and 1534, famous for its statues of "Day" and "Night"
9. The Scaligeri (della Scala) tombs at Verona, typical of Italian 14th century Gothic. In the foreground is the tomb of Martino II (d. 1351); behind, the much more lavish tomb of Can Signorio (d 1375)

ern part of the United States are set with plants grown in large "plant fields" in the southern states and shipped northward by fast motor truck or rail express at planting time. In 1943 about 7,500 ac. in the state of Georgia were devoted to growing tomato plants for this purpose. Seed is sown in March at 5 lb. per acre in rows 14-16 in. apart, about 15-20 seeds per foot of row. All land preparation, sowing, cultivating to control weeds and spraying to control pests is done by motorized equipment, but pulling the plants from the soil, counting, wrapping in wet moss and packaging for shipment must be done by hand. About 70,000-100,000 plants are usually obtained per acre. Most of the plants are shipped the middle of May for immediate transplanting upon arrival in the north.

In 1941–42 in the United States more than 200,000 ac of tomatoes were grown annually for fresh market and about 525,000 ac. for manufacturing. Production was more than 25,000,000 bu. for market and about 3,000,000 tons for processing Prior to 1929 tomato juice as a canned product was virtually unknown In that year 231,000 cases of juice were canned. Every succeeding year the pack increased rapidly, amounting to 23,000,000 cases in 1941. About 30,000,000 cases of canned tomatoes were packed annually in 1940–41. (V. R. B.)

TOMB, a broad term for any grave or funerary structure, especially one of relatively large size or with considerable decorative richness. Thus the tumuli or barrows used in many parts of northern and eastern Europe during the bronze and early iron age; the structures over a grave, common in Roman, mediaeval and modern times; structures containing a sarcophagus in which the body is placed; and those richly ornamented sarcophagi in niches or shrine-like constructions in the interiors of churches, all come under the general name of tomb. (*See* also BARROW; BURIAL; CAIRN; DEAD, DISPOSAL OF THE; MAUSOLEUM; SARCOPHAGUS; TUMULUS)

Since knowledge of the past is so largely gleaned from ancient burials, tombs play a most important part in all archaeological study. (*See* ARCHAEOLOGY)

Ancient.—Architecturally, tombs reach importance only with the development of Egyptian civilization, towards the end of the 4th millennium B.C. The early dynasty tombs are largely of the mastaba (*q.v.*) type, consisting of low, flat-roofed, masonry structures, with the tomb chamber itself sunk in the rock below; royal tombs of this period almost always took the form of pyramids (*q.v.*). During the middle kingdom, rock-cut tombs in cliff sides largely superseded the earlier types; they were usually fronted by a colonnaded porch. In the later empire, even this exterior embellishment disappeared, and tombs were merely chambers cut deep in the rock, at the ends of long tunnels, with inconspicuous entrances.

Many types of tomb are found in western Asia, both prior to and after the dominance of Hellenic Greek culture. Those of Lydia and Lycia are particularly remarkable. In Greece the most interesting type of pre-Hellenic tomb is the tholos or bee-hive type, roofed in corbelled masonry, and evidently imitating in shape a primitive house form. The so-called tholos of Atreus at Mycenae (*c.* 1200 B.C.) is typical. Other rectangular types are, however, found. On the Greek mainland, during the Hellenic period, tombs were largely superseded by simple graves or funerary urns; the gravestones, or stele, were of great beauty though small in size.

In Asia Minor, on the other hand, tombs were often large and lavish. The climax was reached in the mausoleum (*q v*) erected to enshrine the body of King Mausolos (353 B.C.). In the Roman world tombs of every type are found. The Italians early built elaborate tombs; especially famous are those at Cervetri and Volterra, and others at Vulci and near Perugia. These Etruscan tombs are sometimes of tholos type, sometimes tumuli, and sometimes represent the rectangular interiors of Italian houses, and are richly carved and painted. A similar variety is found in Roman tombs. There are pyramids (Gaius Cestius, Rome, probably prior to 12 B.C.); circular or tumulus types like that erected by Augustus for himself in Rome (28 B.C.) and the much larger and more monumental tomb of Hadrian, now the castle S. Angelo, and rectangular, shrine-like structures, like the so-called tomb of Absalom at Jerusalem (? 2nd century A.D.), or the tomb of Anna Regilla at Rome (end of the and century A.D.). The greater number of Roman burials were, however, in columbaria (*see* COLUMBARIUM).

Mediaeval.—In the mediaeval period, owing to the crowded conditions of churchyards, exterior tombs are rare, but tombs of privileged persons within churches common An exception is the group of arcaded tombs of the Scaliger family at Verona (14th century).

The interior tombs, particularly common in England, took the form of sarcophagi, bearing a recumbent effigy, like the crusaders' tombs in the Temple church in London, or of little shrines enclosing a sarcophagus, like Prior Rahere's tomb in the church of S. Bartholomew the Great, London (1400–05). Of the shrine tombs, the most interesting are the royal tombs in Westminster abbey, London.

Renaissance.—The early Renaissance period saw many tombs of great beauty constructed throughout Europe. In Italy, the most common type was a decorated niche containing a sarcophagus. An exquisite example is the Marsupini tomb in S. Croce, Florence (*c.* 1460), by da Settignano. The sarcophagus type is also found.

One of the first monuments in England showing Renaissance inspiration is the tomb of Henry VII in Westminster abbey, by Torrigiano; the same is true in France of the tomb of the children of Charles VIII in Tours cathedral (1506), by J. Juste and M. Colombe, and a similar rôle is played in Spain by the "Tomb of the Catholic Kings," in Granada, the tomb of Ferdinand and Isabella, by Fancelli (1517) and of Don Felipe and Donna Juana, by Ordóñez (1520). The most interesting groups of later Renaissance tombs are those of the Venetian churches, and the papal tombs in St. Peter's, Rome; the royal tombs in St. Denis, near Paris, and the later tombs in the aisles of the chapel of Henry VII, Westminster abbey. In the 18th century, throughout Europe, wall monuments in churches generally superseded tombs; there is, however, a new development of exterior tombs, usually taking the form of a richly decorated sarcophagus, sometimes known as table tombs, common both in England and her colonies.

Oriental.—In Mohammedan countries tombs were reserved for great personages or royal families. The richest and most monumental are the domed turbehs of the Turkish sultans in Constantinople; and the tombs built by the Muslim rulers of India, especially the great tomb of Mahmoud at Bijapur (1626–60) and the Taj Mahal (*q.v.*) at Agra (1632–47).

Chinese tombs vary according to the locality. Near Foochow there is a characteristic group in which a cylindrical stele is placed on a terrace in the middle of a crescent-shaped embankment. Farther north, near Hangchow, the cylindrical stelae are lower and topped with domes, and a semi-circular wall frequently takes the place of the embankment. The great imperial tombs are entirely different and resemble each other, whether at Nanking, in the western hills near Peking, or in Mukden. They all consist of a series of colonnaded halls crossing a great main axis, bordered with statues of beasts and men. The royal tombs at Tokyo, in Japan, resemble the Chinese tombs in having a series of great halls, and in being rather temples than simple tombs; the arrangement, however, is more informal, and a characteristic feature of the Japanese tombs is the hundreds of votive, stone lanterns which stand in the courts.

Modern.—The tomb of Napoleon in the church of the Invalides, Paris (1843–61) by Visconti, is a characteristic modern expression of a tomb which has become a national shrine. More recent tombs show a continuous development towards an increasing simplicity and the attempt to gain emotional effect by perfection and sincerity rather than by grandeur. (T. F. H.)

TOMBIGBEE, a river of the southeastern United States, in the states of Mississippi and Alabama. It flows from Prentiss county in the N.E. corner of Mississippi to the junction of Washington, Clarke and Mobile counties in Alabama, where it joins the Alabama river to form the Mobile river, which flows into

Mobile bay. Of the Tombigbee's several tributaries, the principal is the Black Warrior river.

The Tombigbee is about 450 mi. long and is navigable for approximately two-thirds of its length.

TOMLINE, SIR GEORGE PRETYMAN (1750–1827), bishop of Winchester, tutor and secretary to William Pitt the younger, was born at Bury St. Edmund's, Oct. 9, 1750, the son of George Pretyman. He took the name Tomline in 1803, in accordance with the terms of a will of which he was the beneficiary. He was graduated from Pembroke hall, Cambridge, in 1772, and was made fellow and tutor of the college the following year In 1774, when Pitt came to Pembroke, Tomline was appointed his tutor, an incident which marked the beginning of a lifelong friendship between the two men Tomline remained at Cambridge until 1782, serving as moderator of the university in 1781 He was made rector of Corwen, Merionethshire, in 1782 and in 1783, when Pitt became first lord of the treasury, he asked Tomline to become his secretary, a position the latter held until 1787. Concurrently, Tomline was for a short time rector of Sudbourn-cum-Offord, Suffolk (1785). In 1787, probably through the intercession of Pitt, he was appointed dean of St Paul's and bishop of Lincoln, and in 1820 he became bishop of Winchester, where he remained until his death. Pitt attempted at one time to have Tomline made archbishop of Canterbury, but without success

Tomline was much consulted by Pitt during the latter's lifetime, and had, perhaps, more influence on him than any other of his friends and advisers. He was with the prime minister only a few hours before his death and was made his literary executor. He was the author of a number of works, mostly on theological subjects, the most important of which were *Elements of Christian Theology* (1799) and *A Refutation of Calvinism* (1811), which was the subject of considerable ecclesiastical controversy. He also wrote a moderately valuable biography of Pitt (1821). He died Nov 14, 1827, at Wimborne, Dorsetshire.

TOMMASINI, VINCENZO (1880–1950), Italian composer, was born in Rome on Sept 17, 1880. He studied at the Liceo in Rome and later became assistant director of the Accademia di S. Cecilia His first work of importance was the string quartet of 1910; this was followed by the "Erotic Poem" for orchestra and the comic opera *Uguale fortuna* in 1911. The symphonic poem *Chiari de luna* was produced in 1916, and in 1917 he achieved his great triumph with *The Good-Humoured Ladies*, a ballet, founded on Carlo Goldoni's comedy. The original performance was in Rome, and it was later played in the principal music centres by Sergei Diaghilev's company with great success. Later works were: *Il beata regno* (1922); *Paesaggi Toscani* (1923); *Preludio, fanfara e fuga* (1928); *Il Carnevale di Venezia* (1929); and *Il Diavolo si Diverte* (*The Devil Has a Good Time*, New York city, Metropolitan Opera house, 1939). He died in Rome on Dec. 24, 1950.

TOMMASSEO, NICCOLÒ (1802–1874), Italian statesman and writer, was born in Sebenico, Dalmatia, Oct. 9, 1802. He studied law at Padua and then removed to Florence, where he joined the staff of the *Antologia*, a liberal periodical. One of his articles led to the suppression of the magazine in 1833 and to his own exile to Paris the following year. He returned to Italy in 1839, an amnesty having been granted, and settled in Venice. In Jan. 1848, he and Daniele Manin were arrested and imprisoned for making anti-Austrian speeches but they were set free by revolutionists in the uprising of March 17, 1848. Tommasseo was made minister of public instruction in Manin's provisional government. When Venice fell to the Austrians in Aug. 1849, Manin's terms of surrender included exile for the leaders of the revolutionary movement, in order that all the other revolutionists might be spared. Tommasseo therefore spent the years until 1854 on the island of Corfu, when he went to Turin, returning to Florence in 1861. During the last years of his life he lost his sight but continued with his writing until the year of his death. He died May 1, 1874, in Florence.

Of Tommasseo's numerous works, perhaps the best, and certainly the best known, are his several dictionaries of the Italian language—the *Dizionario dei sinonimi italiani* (1835), the *Dizionario estetico* (1840) and the *Dizionario universale della lingua italiana*, which he compiled in collaboration with B. Bellini and some of which was published after his death (1861–79). His *Supplusio d'un Italiano*, the story of his exile on Corfu, is also well thought of, and his *Canti Popolari Corsi, Toscani, Greci, e Illirici* is a valuable study. His other writings include treatises on moral and political philosophy, works of literary criticism, several volumes of poetry, a biography of Pasquale de' Paoli, a history of 16th century France and a historical novel.

TOMPA, MIHÁLY (MICHAEL) (1817–1868), Hungarian lyric poet, was born in 1817 at Rima-Szombat, in the county of Gomor, his father being village bootmaker. He studied law and theology in Sáros-Patak, and subsequently at Budapest. At the age of 30, after many vicissitudes, he accepted the post of Protestant minister in Beje, a small village in his native county, whence, in two years, he removed to Kelemér, and four years later to Hatvna, in the county of Borsod, where he remained until his death in 1868.

At the age of 24, Tompa published his first poems in the *Athenaeum*, which soon procured for him a high reputation. His first volume, *Népregék és Népmondák* (*Folk-Legends and Folk-Tales*), in 1846, met with great success, and the same may be said of the first volume of his *Poems* in 1847. In 1848 he took part in the War of Independence, acting as field chaplain to the volunteers of his county and seeing several battles, but the unfortunate close of that struggle silenced him as a poet for a considerable time and when in 1852 and 1853 he gave vent to his patriotic grief in some masterly allegories on the state of oppressed Hungary, he was twice arrested by the Austrian authorities After being released he published his *Virágregék* (*Legends of Flowers*), a collection of poems showing great imagination and love of nature. Soon after this he became oppressed with melancholy and abandoned this branch of poetry. He published three volumes of sermons in addition to his poetry. His collected poetical works were first published at Budapest in 1870.

TOMPION, THOMAS (1639?–1713), English clockmaker, known as "the father of English watchmaking," was born in Northhill, Bedfordshire. It is thought that he first worked as a blacksmith, although the supposition cannot be certainly verified. The first definite fact we have about him is the date of his apprenticeship to a clockmaker in London (1664). He was admitted to the Clockmakers' company, probably in 1671, and became master of that society in 1704.

In 1676 he was chosen clockmaker for the newly established royal observatory. He was responsible for a number of improvements in the construction of watches, most notably in his collaboration in the invention of the cylinder escapement with horizontal wheel, which made possible for the first time the construction of flat watches. He also made, with the aid of its inventor, Robert Hooke, one of the first watches with a balance spring to be produced in the country. Many of his clocks still exist, including several which were constructed to run for a year without being rewound. There is a barometer which Tompion made for William III at Hampton court, and other examples at Windsor castle and at Buckingham palace.

Tompion died Nov. 20, 1713, and was buried in Westminster abbey.

TOMPKINS, DANIEL D. (1774–1825), American politician, was born at Scarsdale, Westchester county, N.Y., on June 21, 1774. He graduated at Columbia college in 1795, and was admitted to the bar in 1797. In 1803 he was a member of the State assembly, and in 1804 he was elected to the national House of Representatives, but became a judge of the State supreme court, and served as such until 1807. He was governor of New York in 1807–17; and in 1817–25, during both terms of President James Monroe, was vice-president of the United States. In March, 1812, under the authority of the New York constitution of 1777, he prorogued the legislature—the only instance of the exercise of this power.

During the War of 1812 he was active in equipping and arming the New York militia. For this purpose he borrowed much money on his personal security, and sometimes neglected to secure

proper vouchers. Later the State comptroller announced a shortage of $120,000 in the military accounts, but Tompkins claimed that the State owed him $130,000. Later investigations disclosed that the State actually owed him more than $90,000. He died on Staten Island, N.Y., on June 11, 1825.

The *Military Papers of Daniel D. Tompkins, 1807–1817* (1898–1902) were published by the State. *See* D. S. Alexander, *Political History of New York*, vol. i. (1906).

TOMPKINS, SALLY LOUISA (1833–1916), U.S. hospital head and Confederate army captain, was born at Poplar Grove, the home of her grandfather, in Mathews, Va., Nov. 9, 1833. Before the Civil War she used her rather considerable fortune to assist worthy causes. In 1861, after the first battle of Bull Run, it became clear that the government was not maintaining enough hospitals to care for the sick and wounded, and Jefferson Davis asked that private homes be converted into hospitals. Miss Tompkins was able to obtain Judge John Robertson's Richmond home for the purpose, and with her own funds equipped and maintained it as a hospital until 1865.

Davis shortly ordered that all non-military hospitals be discontinued, but Miss Tompkins was loath to abandon her project and since Davis was anxious to retain her as head of the hospital, he commissioned her a cavalry captain (Sept. 9, 1861), a rank she retained until her death, although she would not accept the pay to which the commission entitled her. During the nearly four years her hospital existed, Miss Tompkins, who became known as "Captain Sally," cared for 1,333 patients, of whom only 73 died. The Robertson hospital was maintained until April 2, 1865, only a few days before the cessation of hostilities. Miss Tompkins died in Richmond July 25, 1916, and was buried with military honours.

Miss Tompkins was the only woman to hold a commission in the Confederate army.

TOMPKINSVILLE, a community on the northeastern shore of Richmond borough (Staten Island), New York city, N.Y., U.S.A. It is about 5½ mi. S.W. of the southern extremity of Manhattan Island. Tompkinsville was laid out in 1814–15 on a tract of about 700 ac., most of which was owned by Daniel D. Tompkins, governor of New York and vice-president of the U.S. It was chartered as a village in 1823, but because of legal flaws the charter was revoked soon after Tompkins' death (1825), and thereafter the village was gradually absorbed by New Brighton and Edgewater (both incorporated in 1866), although the locality continued to be called Tompkinsville. It was the watering place of early transatlantic sailing vessels.

TOMSK, a town of the Novosibirsk region of the Russian S.F.S.R., in 56° 30′ N., 85° 12′ E., on the right bank of the Tom river and on both sides of its tributary the Ushaika, at an altitude of 485 ft. Pop. (1939) 141,215. The river is frozen from Nov. 17 to May 13. A branch line links Tomsk with Taiga on the trans-Siberian railway.

The town was founded in 1604, but did not become important until 1824, when gold was found in the district and a gold smelting laboratory was later established in the town; the gold industry later declined rapidly. The town is an educational centre, with a university, library and museum.

TOMSKY, pseudonym of Michael Pavlovich Efremov (1880–1936), Russian politician, born on Oct. 19, 1880, in St. Petersburg (Leningrad), was the son of a workman, and became a factory hand at the age of 12. In 1904 he joined the Bolshevik party and was a member of the Reval council of workers' deputies during the revolution of 1905. Between 1906 and 1917 Tomsky suffered various terms of imprisonment and deportation, and was finally sentenced to five years' hard labour in the Moscow Butyrka prison, followed by deportation for life to Siberia. Released by the revolution of 1917, Tomsky took part in the Bolshevik July rising in St. Petersburg and the October revolution in Moscow. Afterwards he devoted himself particularly to trade union work, and edited *The Metal Workers' Review*. He was elected member of the Moscow trade union council, and in 1918 became president of the all-Russian central trade union council, with a short interval when he acted as representative of the Soviets in Turkestan. On the reorganization of the R.S.F.S.R. into the U.S.S.R. he became a member of the central executive committee of the U.S.S.R.

Tomsky was vice-president of the Soviet delegation to London in 1924, and a member of the delegation to Paris in 1926. He acted as general secretary of the provisional international council of the trade unions from its formation on Aug. 1, 1920, to May 1921.

On Aug. 22, 1936, Tomsky shot himself, rather than face a charge of treasonable complicity with Zinoviev.

His most important writings and addresses are included in the following volumes: *Die Neuen Aufgaben der russischen Gewerkschaften* (1922); *Der gegenwärtige Stand der Gewerkschaftsbewegung in Russland* (1923); *Getting Together: Speeches Delivered in Russia and England: 1924–25* (1925).

TOM-TOM, or TAM-TAM, a native Indian and Asiatic word, reduplicated and onomatopoeic in form, for a drum, hence often loosely applied to the various types of primitive drum used for purposes of religious excitement, war, signalling and the like, by savage tribes throughout the world. The term is applied strictly to the metal gongs of the far east, which are flat disks with a shallow rim.

TONALITE, in petrology, a rock of the diorite class, first described from Monte Adamello near Tonale in the Eastern Alps. It may be described as a quartz-diorite containing biotite and hornblende in nearly equal proportions. The principal felspar is plagioclase, but orthoclase occurs also, usually in small amount. With increase in silica, the tonalites pass into the granodiorites (*see* GRANITE).

The hornblende of the diorites is green, sometimes with a tinge of brown; the biotite is always brown and strongly pleochroic. Often these two minerals are clustered together irregularly or in parallel growths. They have generally a fairly strong tendency to idiomorphism, but may sometimes enclose plagioclase felspar in ophitic manner. Both of them decompose to chlorite, epidote and carbonates. The plagioclase felspar, which may form more than one-half of the rock, is andesine or oligoclase; simple crystals are rare, the majority being complex growths with centres of felspar rich in lime, while in the external zones the proportion of soda felspar increases greatly. The inner portions have often well-defined, but very irregular, boundaries, and are sometimes sponge-like, with the cavities filled up with a later, more acid, deposit. This seems to indicate that growth has taken place in stages, alternating with periods when the crystallized felspar was corroded or partly dissolved. The orthoclase sometimes forms irregular plates enclosing individuals of plagioclase. Quartz occurs both in irregular simple grains and as micropegmatite. Occasionally pale green pyroxene is visible in the centre of crystals of dark green hornblende. The accessory minerals apatite, magnetite and zircon are always present, and very common also are orthite in coffee-coloured zonal prisms practically always encircled by yellow epidote, and reddish-brown crystals of sphene, simple or twinned.

Externally tonalites are very like granites but are usually darker. Towards their margins the larger alpine masses of tonalite often assume banded or gneissic facies, due apparently to movement during intrusion. In the south of Scotland (Galloway district) they accompany hornblende- and biotite-granites, hornblende- and augite-diorites. The newer granites of the Highlands of Scotland in many places pass into tonalites, especially near their margins, and similar rocks occur in Ireland. Grano-diorites have been described from California, and rocks of similar character occur in the Andes, Patagonia and Lesser Antilles. Tonalites are also said to be frequent among the igneous rocks of Alaska.

(J. S. F.)

TONAWANDA, a city of Erie county, New York, U.S.A., on the Niagara river, 11 mi. N. of Buffalo, at the western terminus of the State Barge canal. It is served by the Erie, the Lehigh Valley, and New York Central railways and motorbuses. The population in 1950 was 14,610, in 1940 it was 13,008; in 1920, 10,068. Tonawanda and North Tonawanda (*q.v.*), on the opposite side of the canal, though separate municipalities, form practically one community. They have a fine harbour, electric power from Niagara Falls and many large manufacturing industries. Tona-

wanda was incorporated as a village in 1854 and as a city in 1903. The name is an Indian word, said to mean "swift water."

TONBRIDGE, a town and urban district of Kent, England, 27 mi. S.S.E. of London by the S. railway Pop. (est 1938) 17,670. Area, 7.2 sq mi. It stands above the River Medway There are remains of the ancient castle of the Clares, built in the time of Henry I and now town property. It was formerly defended by three moats, one of them formed by the Medway. Tonbridge school was founded by Sir Andrew Judd, lord mayor of London in the time of Edward VI, and was rebuilt in 1865

TONE, THEOBALD WOLFE (1763–1798), Irish rebel, the son of Peter Tone, a Dublin coachmaker, was born in Dublin on June 20, 1763. He entered Trinity college, at twenty-two he married Matilda Witherington, a girl of sixteen, took his degree in 1786 and went to London. He was entered at the Middle Temple, and afterwards read law in Dublin, being called to the Irish bar in 1789 Tone wrote two pamphlets in 1790, one of which, *A Review of the Conduct of Administration* attracted some notice from the Whigs.

Tone made the acquaintance of Thomas Russell (1767–1803), Napper Tandy (*q.v.*) and others, and the society of the "United Irishmen" was formed (1791) The original purpose of this society was simply the formation of a political union between Roman Catholics and Protestants, to secure parliamentary reform; it was only when that object appeared to be unattainable by constitutional methods that the majority of the members adopted the more uncompromising opinions which Wolfe Tone held from the first, and conspired to establish an Irish republic by armed rebellion. Tone desired to root out the popular respect for Charlemont and Grattan, and to transfer to more violent leaders the conduct of the national movement Grattan was a reformer and a patriot without a tincture of democratic ideas; Wolfe Tone was a revolutionary whose principles were drawn from the French Convention Grattan's political philosophy was allied to that of Edmund Burke; Tone was a disciple of Danton and Thomas Paine

In 1794 the United Irishmen, persuaded that their scheme of universal suffrage and equal electoral districts was not likely to be accepted by any party in the Irish parliament, began to found their hopes on a French invasion. An English clergyman named William Jackson, who had imbibed revolutionary opinions in France, came to Ireland to negotiate between the French committee of public safety and the United Irishmen For this emissary Tone drew up a memorandum on the state of Ireland, which he described as ripe for revolution; the paper was betrayed to the government, and in April 1794 Jackson was arrested on a charge of treason. Several of the leading United Irishmen, including Reynolds and Hamilton Rowan, immediately fled the country; the papers of the United Irishmen were seized; and for a time the organization was broken up. Tone, who had not attended meetings of the society since May 1793, remained in Ireland till after the trial and suicide of Jackson in April 1795. He was enabled to make terms with the government, stipulating only that he should not be called on to give evidence against Rowan and the others, and was permitted to emigrate to America, where he arrived in May 1795.

He went to Philadelphia where he met fellow exiles, and the French minister, Adet, who gave him letters of introduction to the Committee of Public Safety in Paris. In February 1796 he arrived in Paris and had interviews with De La Croix and L. N. M. Carnot, who were greatly impressed by his energy, sincerity and ability. A commission was given him as adjutant-general in the French army, which he hoped might protect him from the penalty of treason in the event of capture by the English. He drew up two memorials representing that the landing of a considerable French force in Ireland would be followed by a general rising of the people, and giving a detailed account of the condition of the country. The French directory, which possessed information from Lord Edward Fitzgerald (*q.v.*) and Arthur O'Connor confirming Tone, prepared to despatch an expedition under Hoche. On Dec. 15, 1796, the expedition, consisting of 43 sail and carrying about 15,000 men, sailed from Brest Tone, who accompanied it as "Adjutant-general Smith," had the greatest contempt for the seamanship of the French sailors, which was amply justified by the disastrous result of the invasion The ships were dispersed by a storm off the coast of Kerry

But the Dutch fleet was delayed by bad weather, and before it put to sea in October, only to be crushed by Duncan in the battle of Camperdown, Tone had returned to Paris; and Hoche, the chief hope of the United Irishmen, was dead Bonaparte, with whom Tone had several interviews about this time, was much less disposed than Hoche had been to undertake in earnest an Irish expedition, and when the rebellion broke out in Ireland in 1798 he had started for Egypt. When, therefore, Tone urged the directory to send effective assistance to the Irish rebels, all that could be promised was a number of small raids to descend simultaneously on different points of the Irish coast. One of these under Humbert succeeded in landing a force in Killala bay, and gained some success in Connaught before it was subdued by Lake and Cornwallis, Wolfe Tone's brother Matthew being captured, tried by court-martial, and hanged; a second, accompanied by Napper Tandy, came to disaster on the coast of Donegal, while Wolfe Tone took part in a third, under Admiral Bompard, with General Hardy in command of a force of about 3,000 men, which encountered an Englsh squadron near Lough Swilly on Oct. 12, 1798.

Tone, who was on board the "Hoche," refused Bompard's offer of escape in a frigate before the action, and was taken prisoner when the "Hoche" was forced to surrender At his trial by court-martial in Dublin, Tone made a manly straightforward speech, avowing his determined hostility to England and his design "by fair and open war to procure the separation of the two countries," and pleading in virtue of his status as a French officer to die by the musket instead of the rope He was, however, sentenced to be hanged on Nov. 12; but on the 11th he cut his throat with a penknife, and on Nov. 19, 1798, he died of the wound He was buried in Bodenstown churchyard

See *Autobiography of Theobald Wolfe Tone,* edited with introduction by R. Barry O'Brien (2 vols., 1893); R R. Madden, *Lives of the United Irishmen* (7 vols., 1842).

TONE POEM: *see* SYMPHONIC POEM

TONGA, the Tonga or Friendly Islands, an archipelago in the S. Pacific ocean, about midway between Fiji and Samoa. Pop. (1939) 34,130, area, 250 sq mi. The islands became a British protectorate in 1900.

Tonga is interesting to ethnologists because it is the western outpost of Polynesia and is within a few hundred miles of the eastern outpost of Melanesia, the Fiji archipelago There was a good deal of contact, in war and primitive trade, between Tonga and Fiji, with the result that both regions reveal some mixture of racial types and languages. As the trade winds in this part of the Pacific usually blow from the southeast, there was more movement from Tonga to Fiji than in the other direction. The expeditions that set out for Fiji to wage war and obtain the wood for the great canoes from the forests of Fiji (Tonga is almost devoid of trees) brought back larger and stouter canoes and a taste for war and cannibalism, along with some of the native arts of the Melanesians. Fragments of Fijian pottery have been found in the islands of the Tonga group.

The Tonga islands were discovered in 1616 by the navigators Jacob Lemaire and Willem Cornelis Schouten, who reached the island of Niuatobutabu and became involved in hostilities with the natives. Abel Tasman, who gave his name to Tasmania, arrived in Tongatabu in 1643 and avoided any such clash. The islands were visited by Samuel Wallis in 1767 and twice, in 1773 and 1777, by Captain Cook. The natives got into a state of turmoil and civil war in 1799, and this state of affairs dragged on intermittently until a strong king, whose native name was Taufaahau but who assumed the name of George Tubou I, became sovereign in 1845.

The first Methodist missionary arrived in 1822, and missionaries played a considerable part in subsequent developments. The king was converted to Christianity, and his example was followed by his subjects.

See Captain Cook's *Voyages* and other early narratives; G. Vason, *Four Years in Tongatabu* (1815); J. Martin, *Mariner's Account of the Tonga Islands* (1827), J. Macmillan Brown, *Peoples and Problems of the Pacific* (1927). For traditions and historical material, *see* the *Journals of the Polynesian Society* (New Zealand); P. S. A. Stewart, *Handbook of the Pacific Islands* (1922). (W. H. Cr.)

TONGHAK or **CHUNTOKYO**, a religious system of Korea, founded in 1864. The prime object was to preserve all national customs and ideals and oppose Christianity. Its forms are those of Confucianism but its spirit and voice are those of Buddhism and Taoism. The founder, Choi Jaiwoo (崔濟愚, 1824–64), was a great classical scholar with originality in ethical thought. At 16, having lost his father and being very poor, he wandered round the country from his birthplace, Kungchu, South Korea. He was struck by the chaotic conditions, the corrupt officialdom, the poverty and superstition of farmers, the unrest and misery of the towns, and the intellectual degeneracy of the nation. All this made him feel keenly the lack of a religion which could give the people a fresh vision and courage. Buddhism had been banished to mountain solitudes in the 15th century, Confucianism was for the upper classes only, so that there was no religion that could direct the destiny of the masses.

Choi Jaiwoo's belief was that *Chun* or *Tien* (天 god), the creator of all things, made heaven, earth and man; that man is the most intelligent and noble of all creations. Everything exists because there is man, who is as great as God provided he holds fast to God-given qualities. Man, in fact, is God (人 乃 天); they are one, not two. *To* or *tao*, an infinite being, existent before the creation of the world, is the way to heavenly doctrine. Thus his teaching, *Tonghak* (東學, Eastern Learning) was *called Chun tokyo* (天 道 敎, Heavenly Way Doctrine).

Since man is the highest of all God's creations, he must enjoy complete freedom and absolute equality. He must realize the self and develop it to be as noble as possible by emancipating body, mind and soul. Man is thus the core of the universe. The Kingdom of Heaven will exist on earth when all men develop intellectually, socially and spiritually, and for this goal man must pray and work. The founder was accused of heresy and executed on March 1, 1864, in Taiku, South Korea. Choi Sihyung (崔時亨, 1827–99) became his successor. He preached the doctrine of his predecessor adding the precept of abstention from flesh, and organized churches throughout Korea. He was hanged for heresy on June 2, 1899. His successor, Son Pyunghi (孫秉熙, 1861–1922) led a Tonghak rebellion. He sent many students abroad and took an active part in the Revolution of 1919; he was put in jail, where he died on May 19, 1922.

The Chuntoists support a number of schools and a college and teach the ideas of western civilization as well as oriental cultural elements. They preach any sacrifice in the cause of humanity and justice. Chuntoist activity in politics and the lack of a doctrine regarding the future life have given rise among Christians to the impression that Chuntoism is not a religious sect, but Confucianism, if judged by the two latter criteria, would also be considered non-religious. Chuntoism grew into one of the most potent forces of Korea. Its most prominent leaders were the educator, Choi Rin, and the philosopher, Paik Inho. (Y. K.)

TONGKING (TONKIN), northeastern part of French Indo-China, including densely populated deltas of the Red and Thai-Binh rivers. Borders Chinese provinces of Kwangtung, Kwangsi and Yunnan. Pop. (1936) 8,700,000, including 11,921 Europeans. Area 44,672 sq mi. The deltas are Indo-China's most densely populated areas, several districts averaging over 100 per sq.mi. in spite of absence of large cities. Middle Tongking, an undulating country, separates the delta from upper Tongking, a mountainous and forest-clad area to the north and west, deeply dissected by rivers flowing through deep valleys from the Yunnan plateau. The Red river, also called the Song-Koi, which, taking its rise in Yunnan at more than 2,000 metres above sea level, enters Tongking at Lao Kay, and flows thence in a south-easterly direction to the Gulf of Tongking. It was this river which mainly, in the first instance, attracted the French to Tongking, as it was believed that, forming the shortest route by water to Yunnan, it would prove to be the most convenient and expeditious means of transporting the tin, copper, silver and gold which are known to abound there. This belief has proved fallacious because the upper course of the stream is constantly impeded by rapids, the lowest being about thirty miles above Hung-Hoa. Beyond Lao Kay navigation is impracticable during the dry season, and at all other times of the year goods have to be there transferred into light junks. Near Son-Tay the Song-Koi receives the waters of the Song-Bo (Black river) and the Song-Ka (Clear river), and from that point divides into a network of waterways which empty themselves by countless outlets into the sea. The Song-Cau rises in north-eastern Tongking and below the town of Sept Pagodes, where it is joined by the Song-Thuong to form the Thai-Binh, divides into numerous branches, communicating with the Song-Koi by the Canal des Rapides and the Canal des Bambous.

The coast line of Tongking from Moncay on the Chinese frontier to Thanh-Hoa, near that of Annam, has a length of 375 mi. From Moncay as far as the estuary of the Song-Koi it is broken, rugged and fringed with islands and rocky islets. The bay of Tien-Hien, south of which lies the island of Ke-Bao, and the bay of Along, are the chief indentations. Beyond the island of Cac-Ba, south of the Bay of Along, the coast is low, flat and marshy. Tongking's climate is less trying to Europeans than that of most tropical lands. Most of the 60–100 in. of rain falls between May and the end of the year, there being both a south-west and a northeast monsoon, although winds are less regular and predictable than elsewhere in the monsoon region. Maximum temperature seldom exceeds 100° F., minimum lowland temperature being around 50°. Frost is encountered in the mountains. Typhoons occur in August and September. November to April is the best season. In the wooded regions of the mountains the tiger, elephant and panther are found, and wild buffalo, deer and monkeys are common. The delta is the home of many varieties of aquatic birds. Tea, cardamom and mulberry grow wild, and in general the flora approximate to that of southern China.

The people of Tongking are of Annamese stock, perhaps with a greater admixture of Chinese blood and with better physiques than most of the other Annamese. Savage tribes inhabit the northern districts—the Muongs the mountains bordering on Black river, the Thôs the regions bordering the Clear river and the Thai-Binh. The Muongs are bigger and stronger than the Annamese. They have square foreheads, large faces and prominent cheek-bones, and their eyes are often almost straight.

Rice is the only important crop in the fertile and densely populated deltas, where it often yields two crops per year. Production barely suffices for local consumption. Maize is cultivated in middle Tongking, tobacco along the coast, and small quantities of coffee, cotton, jute and sugar cane in various areas. About 200 tons of silk are produced. Small-scale farming prevails, nearly all proprietors cultivating their own land.

Mineral production for Indo-China is mostly in Tongking. More than 2,000,000 tons of coal are produced annually, with 100,000 tons of iron ore, 10,000 tons of zinc and smaller quantities of tin, tungsten, manganese and bauxite. The huge Lao Kay phosphate deposits were exploited by the Japanese in 1942, but American bombing stopped operations. A large part of Indo-China's industry is concentrated in a triangular area between Haiphong, Hanoi and Nam-Dinh. Haiphong is the outstanding industrial center, with cement, textiles and chemicals as chief products. Large distilleries are in other parts of the industrial area, while an electric grid covers the Tongking delta. Numerous handicraft industries produce artistic carvings, embroideries and other wares.

Haiphong (*q.v.*) is the chief port for Tongking and for Yunnan province, China, while Hongay is an important coal-exporting port. Haiphong's geographic position with regard to Yunnan makes Tongking a region of great interest to China. The railway from Haiphong to Kunming was destroyed in 1940 to forestall a Japanese invasion. A variety of boats traverses Tongking's waterways, while embankments often serve as roads. Commercial shipping extends up the Red river to beyond the Chinese border. Tongking has numerous modern highways, designed by French engineers.

The protectorate of Tongking approaches nearer to direct

administration than that of Annam, where the conditions of the protectorate are more closely observed. Till 1897 the emperor of Annam was represented in Tongking by a viceroy (*kinh-luoc*), but now the native officials are appointed by and are directly under the control of the resident-superior, who resides at Hanoi (*q.v.*) (pop. [1936] 149,000), presides over the protectorate council and is the chief territorial representative of France Tongking is divided into 27 provinces, in each of which there is a resident or a vice-resident. In each province there is a council of native "notables," elected by natives and occupied with the discussion of the provincial budget and public works There is also a deliberative council of natives for the whole of Tongking. The provincial administration, local government and educational system are analogous to those of Annam (*q.v.*). Two chambers of the court of appeal of Indo-China and a criminal court sit at Hanoi; there are tribunals of first instance and tribunals of commerce at Hanoi and Haiphong. When both parties to a suit are Annamese, it comes within the jurisdiction of the *An-Sat* or native judge of the province.

The local budget for 1936 balanced at 11,533,000 piastres. *See* also ANNAM and INDO-CHINA, FRENCH.

HISTORY

For the early history of Tongking, *see* ANNAM and INDO-CHINA, FRENCH. Tongking was loosely united to Annam until 1801, when Gia-long, king of Annam, brought it definitely under his sway Having, by the treaty of 1862 and the annexation of Cochin China, firmly established themselves in Annamese territory, the French began to turn their attention to Tongking, attracted by the reported richness of its mineral wealth. The invasion of northern Tongking by the disbanded followers of the Taiping rebels offered a pretext for action. Hostilities were checked for a time by the Franco-Prussian War (1870–71), but in 1873 Marie Joseph Garnier attacked Hanoi as a protest against the hindrances offered to Dupuis, a trader with military stores for Yunnan, and carried the citadel by assault. He then sent to Saigon for reinforcements and meanwhile attacked the five other important fortresses in the delta (Hung-Yen, Phu-Ly, Hai-Duong, Ninh-Binh and Nam-Dinh), and captured them all. This provoked the Tongkingese to call in the help of Lu-Vinh-Phuoc, the leader of the "Black Flags" (bands of Chinese rebels infesting the mountainous region of Tongking), who at once marched with a large force to the scene of action. Within a few days he had recaptured several villages near Hanoi, and so threatening did his attitude appear that Garnier, who had hurried back after capturing Nam-Dinh, made a sortie from the citadel, a move resulting in his death and that of his second in command.

Meanwhile the news of Garnier's hostilities had alarmed the governor of Saigon, who, wishing to avoid war, sent Philastre, an inspector of native affairs, to offer apologies to the king of Annam. When, however, Philastre heard of Garnier's death, he took command of the French forces, and at once ordered the evacuation of Nam-Dinh, Ninh-Binh and Hai-Duong—a measure which resulted in a general massacre of native converts in the area. In pursuance of the same policy Philastre made a convention with the authorities (March 1874) by which he bound his countrymen to withdraw from the occupation of the country, retaining only the right to trade on the Song-Koi at Hanoi and Haiphong. For a time affairs remained in *status quo*, but in 1882 Le Myre de Villers, the governor of Cochin-China, sent Henri Rivière with a small force to open up the route to Yunnan by the Song-Koi. With a curious similarity the events of Garnier's campaign were repeated. Finding the authorities intractable, Rivière stormed and carried the citadel of Hanoi, with very slight loss, recaptured Nam-Dinh, Hai-Duong and other towns in the delta, and then, like Garnier, fell a victim to his own impetuosity (May 1883).

In the meantime the Annamese court had been seeking to enlist the help of the Chinese in their contest with the French. The tie which bound the tributary nation to the sovereign state had never been entirely broken, and the present seemed an admirable opportunity for acknowledging the fact.

The king, therefore, despatched in 1880 a special embassy to Peking, loaded with unusually costly offerings and bearing a letter as from an acknowledged tributary which the emperor afterward ordered to be published in the *Peking Gazette* Rivière's death and the defeat of his troops left France in extreme difficulty, and Jules Ferry, who had become French premier in 1883, decided on a vigorous policy. Hanoi was still besieged by the "Black Flags" and the outlying garrisons had mostly to be withdrawn; reinforcements under Admiral André Courbet and Gen. Bouet could barely keep the native forces at bay, and only in the lower delta did the French make headway, seizing Hai-Duong and Phu-Binh almost without a casualty. Dr. Harmand, commissary-general, proceeded with Courbet and a naval force to the Hué river. After a feeble defence Hué city was taken and a treaty concluded with the king (Aug. 1883), in which the French protectorate was fully recognized, the king further binding himself to recall the Annamese troops serving in Tongking.

Though this treaty was exacted from Annam under pressure, the French lost no time in carrying out that part of it which gave them the authority to protect Tongking, and Bouet again advanced in the direction of Son-Tay. But again the resistance he met with compelled him to retreat, after capturing the fortified post of Palan. Meanwhile, on the determination to attack Son-Tay becoming known in Paris, the Chinese ambassador warned the ministry that, since Chinese troops formed part of the garrison, he should consider it as tantamount to a declaration of war. But his protest met with no consideration On the arrival of reinforcements an advance was again made, and on Dec. 16, 1883, after some desperate fighting, Son-Tay fell.

During 1884 the French made themselves masters of the lower delta. Throughout the campaign Chinese regulars fought against the French, who found themselves involved in war with China. In May 1884 François Fournier, the French consul at Tientsin, signed with Li Hung Chang, a memorandum by which the Chinese plenipotentiary agreed that the Chinese troops should immediately evacuate northern Tongking. A second treaty was signed at Hué confirming the French protectorate over Annam and Tongking, but hostilities did not cease. A misunderstanding over the date of the Chinese evacuation led to Col. Dugenne being despatched to occupy Lang-Son. The expedition was badly managed and 25 mi. from their objective the French entered an irregular engagement with the Chinese forces and were routed. An expedition, led by Colonel Donnier, against the Chinese garrison at Chu, about 10 mi. southeast from Lang-kep, was completely successful; and in a battle near Chu the Chinese were defeated.

In Jan. 1885 large reinforcements arrived and Brière de l'Isle, who had succeeded Millot as commander-in-chief, ordered an advance toward Lang-Son. The difficulties of transport greatly impeded his movements; still, the expedition was successful. On Feb. 6 three forts at Dong-Song, with large supplies of stores and ammunition, fell into the hands of the French. Three days' heavy fighting made them masters of a defile on the road, and on the 13th Lang-Son was taken, the garrison having evacuated the town just before the entrance of the conquerors. General Francois Négrier, who commanded a division under Brière de l'Isle, pressed on in pursuit to Ki-Hea, and even captured the frontier town of Cua-Ai. But Brière de l'Isle had to hurry back to the relief of Tuyen-Kwan, which was doggedly resisting the attacks of an overwhelming Chinese force, and Négrier was left in command at Lang-Son. The withdrawal of Brière de l'Isle's division gave the Chinese greater confidence, and, though for a time Négrier was able to hold his own, on March 24 and 25 he sustained a severe check between Lang-Son and That-Ke, which was finally converted into a complete rout. Brière de l'Isle reached Tuyen-Kwan, the garrison of which was commanded by Colonel Dominé, on March 3 and effected its relief. The disaster at Lang-Son caused the downfall of the Ferry ministry (March 30). Shortly afterward Sir Robert Hart succeeded in negotiating peace with China. By the terms agreed on at Tientsin (June 1885), it was stipulated that France was to take Tongking and Annam under its protection and to evacuate Formosa and the Pescadores. (For further history, *see* INDO-CHINA, FRENCH)

See J. Dupuis, *Le Tong-kin et l'intervention française* (1898); C. B.

Norman, *Tonkin, or France in the Far East* (1884); J. Ferry, *Le Tonkin et la mère-patrie* (1890), J. Chailley, *Paul Bert au Tonkin* (1887), H. Lyautey, *Lettres du Tonkin et de Madagascar*, 2 vols (1920), P. Gourou, *Les Paysans du delta tonkinois* (1936); T. E Ennis, *French Policy and Developments in Indochina* (1936); V. M. Thompson, *French Indo-China* (1937), also bibliography under INDO-CHINA, FRENCH

TONGUE. The tongue is a very mobile structure and becomes an important accessory organ in such motor functions as speech, chewing and swallowing. It aids in producing certain consonants, and in conjunction with the cheeks it is able to guide and maintain food between the upper and lower teeth until mastication is completed In individuals whose tongue has been excised, speech is defective. In a mammal, like the whale, that does not chew its food, the tongue is greatly reduced in size. Its mobility aids mammals in creating a negative pressure within the oral cavity, enabling them to suckle. In the horse this negative pressure is great enough to lift a column of water three feet, so that he can easily drink from a stream without raising his head.

The mucous membrane which covers the tongue is likewise concerned with seizing, holding and grinding food and with the reception of liquids. Its relief varies greatly In man it is not so highly differentiated as in other mammals because he has learned to use artificial means in procuring and preparing his food Especially important is the mucous membrane as a peripheral sense organ. It contains groups of specialized epithelial cells, known as taste buds, which are the special sense organs of taste, and many nerve fibres which carry stimuli from the oral cavity to the central nervous system. The tongue informs individuals of changes which occur within the oral cavity and at times aids in locating particles of food lodged between the teeth. The central nervous system is kept informed by this membrane as to the consistency and state of salivation of the food. Furthermore, the tongue's glands produce some of the saliva necessary for swallowing (deglutition). The general appearance of the mucous membrane has interested physicians for centuries, and the custom of having the patient protrude his tongue during an examination is not without meaning since certain changes in its appearance reflect disturbances in other organs and systems. A paralysis of one-half of the tongue would also show on examination for the tongue would deviate toward the affected side when protruded.

The mammalian tongue consists of a mass of interwoven, striated muscles covered with mucous membrane and interspaced with some glands and a variable amount of fat By its extrinsic muscles, the tongue is attached to the mandible, the hyoid bone, the skull, the soft palate and the pharynx. It is bound to the floor of the mouth and to the epiglottis by the reflections of its mucous membrane

The tongue presents on its upper surface a median groove, which traced posteriorly ends in a small pit, the *foramen caecum linguae*, which is the point of origin of the thyroid gland and forms the apex of a V-shaped groove, the *sulcus terminalis linguae*. The median groove and the terminal sulcus form an arrow, the tip of which is directed toward the oral pharynx. The terminal sulcus indicates the division of the tongue into two parts. The larger anterior part, or body, belongs to the floor of the mouth, while the smaller posterior, or root, forms the anterior wall of the oral pharynx

The superior surface of the body is called the dorsum. It is separated from the inferior surface by the lateral margins, which meet anteriorly at the tip. The dorsum exhibits a rough appearance because of numerous small projections, the lingual papillae, of which five kinds are recognized Filiform and conical papillae are slender, threadlike, cornified epithelial projections arranged in V-shaped rows, parallel with the terminal sulcus. They are numerous over the whole of the dorsum and contain an axial core of vascular fibrous tissue. Fungiform papillae are similar in structure but less numerous than the last and are easily distinguished by their larger size and reddish colour. Taste buds occur on most of the fungiform papillae. Circumvallate papillae, usually 7 to 11 in number, are found immediately in front of, and parallel to, the *sulcus terminalis linguae* Each papilla consists of a flat central mound, surrounded by a moat. On the sides of the moat are taste buds, and into the bottom of the fossa open ducts of the serous glands of Ebner. Foliate papillae, rudimentary in man, are represented by a few (three to eight) vertical folds on the lateral margin of the dorsum at its hinder part. Taste buds occur on the opposite sides of these papillae.

The inferior or under surface of the body is covered in its free portion by a thin, smooth mucous membrane. It presents a prominent median fold, the fraenulum linguae, which connects the tongue with the mandible and the floor of the mouth, on each side of this structure is an irregular, fringed fold, the *plica fimbriata*, extending from near the apex, backward approximately parallel with the lateral margin of the tongue. Between the fraenulum and the *plicae fimbriatae*, the lingual vein on each side shines through the mucosa.

The root of the tongue differs topographically, developmentally, structurally and functionally, in innervation and in appearance from the body. Topographically, the root belongs to the oral pharynx, and developmentally its mucous membrane arises primarily from the second branchial arches but receives additions from the third and fourth as well, while that of the body develops from the first and second (perhaps) branchial arches. Ultimately, the sensory portions of the trigeminal and facial cranial nerves (the nerves of the first and second branchial arches) innervate the epithelium of the body of the tongue, while the glossopharyngeal and vagus nerves (the nerves of the third and fourth arches) supply chiefly the root (*see* NERVE *Cranial*).

In appearance the mucous membrane of the root is warty because of the underlying nodules of lymphoid tissue, the lingual follicles, which collectively are designated as the lingual tonsil. The mucosa is not firmly adherent to the underlying structures, and a loose median fold of mucous membrane passes from the root to the epiglottis and separates the vallecular, or little valleys, where foreign bodies often become lodged. The lateral boundaries of the vallecular are two folds of mucous membrane, the pharyngoepiglottic, or lateral glossoepiglottic folds

The substance of the tongue is composed chiefly of interlacing striated muscle fibres arranged symmetrically on each side of a median fibrous septum They are derived from cervical myotomes and innervated by the hypoglossal nerve. The muscles which lie entirely within the tongue are the intrinsic muscles, four on each side—the superior and inferior longitudinal, the vertical and transverse muscles On contracting they change the length, width and breadth of the tongue and protrude it Moreover, when contracted on one side only, they effect a contralateral deviation of the tongue's tip. A special branch of the hypoglossal nerve, known as the end branch, innervates the intrinsic muscles Other muscles, the hyoglossus, chondroglossus, styloglossus and genioglossus, come from skeletal parts and insert into the substance of the tongue They are the extrinsic muscles, and there are four on each side. With the exception of the genioglossus muscle, they are retractors of the tongue The genioglossus muscle can protrude the tongue a small amount, but its main function is to build a fulcrum around which the intrinsic muscles function. The arteries of the tongue are derived mainly from the lingual branches of the external carotid arteries (*see* ARTERIES). The lingual veins return the blood from the tongue to the internal jugular veins (*see* VEINS).

Comparative Anatomy.—The tongue in fishes is rudimentary and practically immobile since it is composed mostly of thickened epithelium In some fishes, teeth are developed on the tongue. In the tailed forms of the Amphibia, the tongue resembles that of the fishes, but in most Anura it contains muscles and is quite movable In reptiles, the tongue is generally very movable though this is not true in the Crocodilia and Chelonia Many variations of its form are encountered in reptiles, and the forked tongues of snakes are familiar objects. In birds, the tongue possesses no intrinsic muscles, and its mobility varies. When it is very protrusible, as in the woodpecker, the movement is due to the hyoid bone moving forward In Mammalia, the tongue, except in Cetacea, is always movable and protrusible. In the lemurs an undertongue is found, which probably is represented by the *plica fimbriata* under the human tongue.

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TONGUE, DISEASES OF. Diseases arising primarily in the tongue are, in order of their severity cancer, leukoplakia, syphilis and actinomycosis Cancer of the tongue typically begins as a firmly walled-in ulcer Cancer, however, is so variable in appearance that inspection and observation alone do not permit a responsible distinction between serious and harmless states Presence or absence of pain bears no relationship to the nature of a lesion of the tongue Cancer of the tongue must be suspected whenever a lesion develops gradually and persists. Any such lesion requires medical investigation, microscopic examination of a small piece of tissue is the quickest and most reliable means for early detection or safe excision of cancer. In its early stage, cancer of the tongue can safely be removed by surgical treatment, possibly combined with radiation. The cause of cancer of the tongue is as unknown as that of cancer in other parts of the body, defective teeth have been suspected as one of the contributory causes, the use of tobacco seemed to account for the prevalence of tongue cancer in men until statistics proved its incidence among nonsmokers also to be twice as great in men as in women.

Leukoplakia consists in a thickening of the mucous membiane which covers the tongue and it appears as a sharply outlined uniformly whitish patch Although it may be produced by any number of irritants (tobacco, faulty teeth, ill-fitting dentures), syphilis should be suspected as the cause and cancer anticipated as its possible outcome. It therefore requires treatment even if it should remain painless or fail to spread Syphilitic leukoplakia often involves the entire surface of the tongue Leukoplakia is also observed in persons without any of the above-named causes.

Syphilis of the tongue appears either as a primary lesion (chancre) or as a tumour (gumma) associated with the tertiary stage; the latter can be extensive and greatly impair the function of the tongue Treatment is antisyphilitic or if necessary surgical.

Actinomycosis can produce a small nodule within the substance or an inflammation of part of the tongue; if preceded by complicated tooth extraction, the diagnosis is often missed because of the infrequency of this disease Treatment with antibiotics is usually very successful.

Secondary Changes.—The tongue as part of the digestive system often reflects gastrointestinal disturbances through changes in colour, evenness of surface or degree of moisture The well-known coating, however, provides no diagnostic clues since it also depends on diet habits and factors like breathing through the mouth or smoking. One of the earliest symptoms of systemic diseases may concern the tongue, *e g*, the fiery redness of pellagra, or the smoothness and burning in pernicious anaemia.

The appearance of the tongue is usually affected in febrile diseases. The various infections of the mouth often involve the tongue which may become predominantly painful because of the muscular efforts required for speaking, chewing and swallowing. The tongue may be abnormally small or large congenitally; largeness may result from a tumour spread diffusely through the substance of the tongue (lymphangioma) or from acromegaly. The tongue may deviate from its normal position; the tip of the outstretched tongue may point asymmetrically to either side instead of remaining in the midline. This deviation is found most often in persons who have suffered a stroke (apoplexy) but occurs occasionally in healthy persons as a result of uneven development or nerve supply of the musculature of the tongue

The normal tongue has an evenly coloured finely granular surface Two variations of this normal appearance may cause needless alarm. (1) the evenness of colour is disturbed by irregular grayish markings best described by the designation "geographic tongue"; (2) the surface shows deep irregular indentations and furrows (scrotal or beef tongue) The tongue can be the distressing site of allergic reactions, in some persons who are sensitive to certain drugs, the tongue can react with pain or burning or changes of appetrance.

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TONGUES, GIFT OF, a faculty of abnormal and inarticulate vocal utterance. under stress of religious excitement. which was widely developed in the early Christian circles, and has its parallels in other religions It is also called Glossolalia (Gr. γλῶσσα, tongue. λαλεῖν, speak) In the New Testament such experiences are recorded in Caesarea (Acts x 46), at Corinth (Acts xix 6, 1 Cor. xii, xiv), Thessalonica (1 Thess v. 19), Ephesus (Eph v 18), and universally (Mark xvi. 17) From the epistles of Paul, who thanked God that he spake with tongues more than all or any of his Corinthian converts, we can gather a just idea of how he regarded this gift and what it really was

Paul discriminates between the Spirit which during these paroxysms both talks and prays to God and the *nous* or understanding which informs a believer's psalm, teaching, revelation or prophesy, and renders them intelligible, edifying and profitable to the assembly Accordingly Paul lays down rules which he regarded as embodying the Lord's commandment A man "that speaketh in a tongue speaketh not unto men, but unto God, for no man understandeth", and therefore it is expedient that he keep this gift for his private chamber and there pour out the mysteries In church it is best that he should confine himself to prophesying, for that brings to others "edification and comfort and consolation" If, however, tongues must be heard in the public assembly, then let not more than three of the saints exhibit the gift, and they only in succession. Nor let them exhibit it at all, unless there is some one present who can interpret the tongues and tell the meeting what it all means If the whole congregation be talking with tongues all at once, and an unbeliever or one with no experience of pneumatic gifts come in, what will he think, asks Paul Surely that "you are mad." So at Pentecost on the occasion of the first outpouring of the Spirit the saints were by the bystanders accused of being drunk (Acts ii 15) In the church meeting, says Paul, "I had rather speak five words with my understanding, that I might instruct others also, than ten thousand words in a tongue"

Paul on the whole discouraged glossolaly. "Desire earnestly the greater gifts," he wrote to the Corinthians. The gift of tongues was suitable rather to children in the faith than to the mature Tongues were, he felt, to cease whenever the perfect should come, and the believer who spoke with the tongues of men and of angels, if he had not love, was no better than the sounding brass and clanging cymbal of the noisy heathen mysteries It was clearly a gift productive of much disturbance in the Church (1 Cor. xiv 23). He would not, however, entirely forbid and quench it (1 Thess v. 19), so long as decency was preserved

It is not then surprising that we hear little of it after the apostolic age. It faded away in the great Church, and probably Celsus was describing Montanist circles (though Origen assumed that they were ordinary believers) when he wrote (Origen, *Contra Celsum*, vii. 9) of the many Christians of no repute who at the least provocation, whether within or without their temples, threw themselves about like inspired persons; while others did the same in cities or among armies in order to collect alms

Tertullian in the 3rd century testifies that glossolaly still went on in the Montanist Church which he had joined; for we must so interpret the following passage in his *De anima*, cap. IX. "There is among us at the present time a sister who is endowed with the charismatic gift of revelations, which she suffers through ecstasy in the spirit during the Sunday service in church She converses with angels, sometimes even with the Lord, and both hears and sees mysteries." The magical papyri teem with strings of senseless and barbaric words which probably answer to what certain of the Fathers called the language of demons. It has been suggested that we here have recorded the utterances of glossolalists

The attitude of Paul toward glossolaly among his converts strikingly resembles Plato's opinion as expressed in the *Timaeus*, p 72, of the enthusiastic ecstasies of the ancient *μάντις* (soothsayer). The gift of tongues and of their interpretation was

not peculiar to the Christian Church, but was a repetition in it of a phase common in ancient religions The very phrase γλώσσαις λαλεῖν, "to speak with tongues," was not invented by the New Testament writers, but borrowed from ordinary speech.

Virgil (*Aen.* vi. 46, 98) draws a life-like picture of the ancient prophetess "speaking with tongues." He depicts her quick changes of colour, her dishevelled hair, her panting breast, her apparent increase of stature as the god draws nigh and fills her with his divine afflatus. Then her voice loses its mortal's ring: "nec mortale sonans." The same morbid and abnormal trance utterances recur in Christian revivals in every age, *e g.*, among the mendicant friars of the 13th century, among the Jansenists, the early Quakers, the converts of Wesley and Whitefield, the persecuted protestants of the Cevennes, the Irvingites, and the revivalists of Wales and America.

Oracular possession of the kind above described is also common among savages and people of lower culture; and Dr. Tylor, in his *Primitive Culture*, ii 14, gives examples of ecstatic utterance interpreted by the sane. Thus in the Sandwich Islands the god Oro gave his oracles through a priest who "ceased to act or speak as a voluntary agent, but with his limbs convulsed, his features distorted and terrific, his eyes wild and strained, he would roll on the ground foaming at the mouth, and reveal the will of the god in shrill cries and sounds violent and indistinct, which the attending priests duly interpreted to the people."

See E B. Tylor, *Primitive Culture;* H. Weinel, *Die Wirkungen des Geistes und der Geister* (Freiburg, 1899), Shaftesbury's *Letter on Enthusiasm;* Mrs Oliphant, *Life of Irving*, vol. ii., G B. Cutten, *Speaking with Tongues, Historically and Psychologically Considered* (1927) (the most complete existing survey of the subject). *See* also Thouless, *Introduction to the Psychology of Religion*, chap xi

TONIC SOL-FA. Tonic Sol-fa has as its leading principle the relationship of sounds The system is based on "mental effect," *i e.* the effect on the mind of any note, chord or progression in relation to a central Tonic or key-note. The prefix "tonic" was first used by John Curwen (1816–1880). He developed his method from that of Miss Sarah Ann Glover (1785–1867) of Norwich, to whom he always acknowledged his indebtedness, but, since her system could not become popular (it was out of print), he announced a number of modifications (twenty-one are tabulated in his *Teacher's Manual*), which established the "Tonic Sol-fa Method and Notation" as a national movement.

What, then, is Tonic Sol-fa? It is a letter-notation, as distinguished from a staff-notation. The initials of seven old syllables are used. They formed what was later called a "movable *do*" system, and Tonic Sol-fa follows this old practice. Guido d'Arezzo (995–1050) noticed that each line of a hymn to St. John began stepwise, forming his hexachord instead of the former Greek tetrachords, and he took the first syllable of each line of the hymn as a sound-name, thus ut, re, *mi*, fa, sol, la The last line of the hymn was Sancte Iohannes. The initial letters, *si*, were added in the 16th century to represent the seventh of the modern major scale. In the 17th century *do* (probably from Domnus) was substituted in most countries for *ut*. In the 19th century in England *si* was changed to *te* to avoid confusion with the initial of *sol*, and the spelling of all the syllables was adapted to the English language, with the advantage of having an open vowel sound for every note. The higher octave was shown by a small figure on the right above the note (d^1), and the lower octave syllables had a figure below the note (s_{1S}) at the right side as shown.

Besides the signs for tune already given, a notation of time was adopted, and varied spacing represented duration pictorially A vertical line (|) precedes the accent at the beginning of the bar (measure). A short perpendicular line (|) shows the middle or medium accent of common time (four-pulse measure). An accent mark if followed by an unfilled (un-syllabled) space indicates a rest. When a note follows the accent mark it occupies the time from that accent to the next. A long dash (—) after a note requires the sound to be continued through the next pulse or beat. A dot (full point) between two notes divides the pulse into equal parts (d r). A dot before a continuation mark (short dash) indicates that the previous note is to be continued through half of that pulse. A comma is the sign for a quarter-pulse (d,r). A dot and comma placed together show that the preceding note is of ¾-pulse length, and the following note ¼-pulse length (d ,r). An inverted comma is placed after a note of one-third pulse length (d,r). A line placed below two or more notes signifies that the notes are to be sung to the single syllable or word underneath the notes (d r). A brace binds each line of the score, and a double bar shows the end of the music A tune may be quoted which gives within one bar five signs for rhythm:

Key A { | m m . r | d l, — l, | d | ||
Oft m the stilly night, Ere

The question of key arises. At the beginning of the tune the pitch of it is indicated by the standard pitch-names (Key A, etc) Here comes the "enlightening fact" to a beginner. A tune in Tonic Sol-fa notation has the same appearance (apart from octave marks) whether pitched high or low; it is recognized as the same tune. In the song of Moore above, for example, the same syllables would be used whether sung at a pitch suitable to tenor or bass. The Tonic Sol-faist, having a movable doh method, has not to use a fresh set of syllables with every change of pitch, in the "fixed doh" way.

In modulation (called transition) to a new key in the course of a tune, the Tonic Sol-faist finds a new signature at the point of change, and is thus prepared. If a sharp key (passing from key F to key C is a remove sharp-wards) is imminent, the new tone (the sharp) is printed over the music (for example, A t) on the right of the key-name. If the tune passes flat-wards, the "distinguishing tone" is placed on the left of the key-name (fah in key F, for example, f F.) If the transition involved four removes to the right (sharp-ward progressions) the distinguishing tones would be t m l r. Four flat-ward removes would have as distinguishing tones at each remove, r s d f, read backwards. The latest practice is to name the number of new tones above three by a figure, as B $_4$, for example In the minor key (mode) the key-note is *lah*, thus in A minor "Lah is A."

Besides having changes of key defined by fresh signature (a practice which is growing in staff notation printing), the Tonic Sol-faist is given a new syllable, forming a bridge-tone or double-name, of which, with practice, he thinks the first and sings the second, or as a beginner he will glide from one to the other, as m'lah, or as a barrister addresses m'lor. In print, this is shown thus *mi*. Explanation of the treatment of minor keys cannot be pursued here, but the "minor mode" gives the Tonic Sol-faist no trouble.

A further detail is with regard to the inflected names adopted for "accidentals" (chromatics). Doh becomes, a semitone higher, de, and the long *e* sound also represents *re, fe, se, le* Depress *te* and it is named *taw*, printed *ta*. Similarly down "the modulator" may be found *la, ma, ra*. Characteristic of the minor mode are *ba* (pronounced bay) and *se*.

First lessons in Tonic Sol-fa are begun with the aid of a chart of tune: the modulator just named Its ladder-like appearance is a great aid to the beginner; it is the counterpart of the up-and-down picture of the staff notation. The mental image of the modulator remains; it is the answer to the objection that Tonic Sol-fa is a dead-level picture. Even before it is used, the learner hears "the sound before the sign " He learns the scale by "steps of the method," first *d*, *s* and *m*, second *r* and *t*, third *f* and *l*, fourth the whole scale and transition. Such simple tools enable the ordinary teacher of an elementary school to get from small children amazing results in sight-singing. Each scale tone when sung slowly is also found to have its own character or mental effect, and this is noticed in illustrating by familiar phrases of music, which, however, must not be pressed too far; *d* is firm, *s* martial, *m* mild, *r* prayerful (at high pitch, rousing), *t* leading upward, *f* leaning downward, *l* the mournful tone. The method applies other devices for teaching effect: French time-names for rhythm; hand-signs which, dispensing with printed notes, enable the teacher to give exercises rapidly. The ear is trained from the first lesson.

The value of it all is greatest in the higher stages: harmony is clarified by the tonic principle; transposition of music

is easy; rhythm is analyzed and simplified by the time names; and, in addition, Tonic Sol-fa is the best introduction to the staff notation. More and more, publishers find it worth while to print the Tonic Sol-fa notation along with the staff The facility and certainty of the Tonic Sol-faists have been admitted and praised by every conductor who has had experience of them. The story of the successful struggle to give this method a footing need not be told here. The danger now is when people in authority, or capable musicians who learned music easily, say that the notation is unnecessary, while passing compliments upon the method of teaching; and at the same time ignoring the need of giving children a good foundation in reading this notation (J. Grn.)

TÕNISSON, JAAN (1868– ?), Estonian statesman, was the son of a farmer in the Viljandi district of Livonia. After graduating in law at the University of Dorpat (Tartu) he was for some years in the judicial service of the Russian imperial government, but left that position in 1896 to become editor of *Postimees* (*The Postilion*), the oldest Estonian daily newspaper, in Tartu. Tonisson's initiative and influence ranged from agricultural shows to the founding of co-operative banks and from the temperance movement to schools and literary societies. In the revolution of 1905 he was at the head of the Estonian moderate constitutional movement, which he likewise represented in the Russian *duma*. With the other signatories to the Viborg Appeal, he was sentenced to a term of imprisonment. From 1917 onward Tonisson, as leader of the Estonian People's party, was a member of all the parliaments and other representative assemblies. He was expelled by the Bolsheviks in Nov 1917, but in Stockholm and in Copenhagen he carried out with the representatives of the Allied Powers the preliminaries of a *de facto* recognition of Estonia From 1919 to 1920 he was prime minister, and during his period of office peace was concluded with Russia. In the second *riigikogu* (parliament) he formed a new centre party by the amalgamation of his own party, the Christian People's party, and the National Liberals and became president of the chamber. He was *Riigivanem* (president) in 1927–28, and 1933 During the suspension of parliamentary activity (1934–37), Tonisson became professor of social sciences at Tartu, but later he was elected into the constituent assembly and into the parliament, where he was a prominent member of the opposition. In 1940 he was arrested and deported by the Soviet occupation forces, after which his fate was unknown.

TONK, a town and district of Rajasthan, Republic of India. The town (pop , 1941, 38,650), headquarters of the district, is 55 mi. S of Jaipur, near the right bank of the Banas river.

The former princely state of Tonk (pop , 1941, 353,687) was in the Rajputana agency (Harauti and Tonk subagency) till 1936, then Jaipur residency) prior to its accession to Rajasthan on March 25, 1948. It was divided into six isolated tracts around the following cities: Tonk; Aligarh, 25 mi S.E. of Tonk; Nimbahera, Pirawa and Chhabra (towns c 120–130 mi from Tonk in enclaves along the northwest fringe of Central India); and Sironj (180 mi. S.E. of Tonk and entirely within Central India); total area 2,543 sq.mi. The former *nawab* was of Afghan or Pathan descent. The founder of the family was the notorious Pindari leader Amir Khan, who submitted to the British in 1817.

TONKAWA, a tribe of south central Texas, usually considered as a distinct linguistic stock, belonged to the plains group of nomadic buffalo hunting Indians. The natives lived in skin tepees, planted little or not at all and bore a reputation, probably deserved, for cannibalism. They fought, at one time or another, most of their neighbours, from the Apache to the Caddo. The original population of perhaps 1,500 decreased to a few dozen.

TONKIN: *see* Tongking.

TONNAGE, SHIPPING: *see* Shipping: Tonnage Terms.

TONNAGE AND POUNDAGE. In England, customs duties anciently imposed upon exports and import the former being a duty upon all wines imported in addition to prisage and butlerage, the latter a duty imposed *ad valorem* at the r. of 1*s.* on the £ on all merchandise imported or exported. The duties were levied at first by agreement with merchants (poundage in 1302, tonnage in 1347), then granted by parliament in 1373, at first for a limited period only. They were considered to be imposed for the defense of the realm. From the reign of Henry VI until that of James I they were usually granted for life. They were not granted to Charles I, and in 1628 that king took the unconstitutional course of levying them on his own authority, a course denounced a few years later by 16 Car. I c. 18 (1640), when the long parliament granted them for two months After the Restoration they were granted to Charles II and his two successors for life. By acts of Anne and George I, the duties were made perpetual and mortgaged for the public debt. In 1787 they were finally abolished, and other modes of obtaining revenue substituted, by 27 Geo. III c. 13 (1787)

Poundage also signified a fee paid to an officer of a court for his services, *e.g.*, to a sheriff's officer, who is entitled by 29 Eliz. c. 4 (1586–87) to a poundage of 1*s.* in the £ on an execution up to £100, and sixpence in the £ above that sum.

TONNERRE, a town of north central France, in the department of Yonne, 52 mi. S.E. of Sens by rail. Pop. (1946) 3,937 Its ancient name of *Tornodorum* points to a Gallic or Gallo-Roman origin for Tonnerre. In the 6th century it became the capital of the region of Tonnerrois and in the 10th century of a countship.

It stands on a slope of the vine-clad hills on the left bank of the Armançon. At the foot of the hill rises the spring of Fosse-Dionne, enclosed in a circular basin 40 ft in diameter. The church of St. Pierre has a fine lateral portal of the Renaissance period to which the church, except the choir (1351), belongs. The church of Notre-Dame is mainly Gothic, but the fine façade is Renaissance The hospital itself was rebuilt in the 19th century. The Renaissance Hôtel d'Uzès was built in the 16th century.

TONQUA BEAN. The Tonqua, Tonka or Tonquin bean, also called the coumara nut, is the seed of *Dipteryx odorata,* a leguminous tree growing to a height of 80 ft , native of tropical South America. The drupelike pod contains a single seed possessed of a fine sweet "new-mown hay" odour, due to the presence of coumarin (*q.v.*). Tonqua beans are used in perfumery.

TONSBERG, a seaport of Norway, in Vestfold *fylke* (county), situated on a bay on the south coast, near the entrance to Oslo Fjord, 72 mi. S by W. of Oslo on the Skien railway. Pop. (1946), 11,354. It is one of the most ancient towns in Norway, declined in importance after the middle ages, but before World War II was a rapidly growing industrial town and the headquarters of a sealing and whaling fleet. It has refineries for preparing whale and seal oil and sawmills. The harbour is frozen in winter but a channel is kept open.

TONSILLITIS is either acute or chronic.

Acute Tonsillitis is an acute infectious inflammation of the pharynx (throat) and tonsils caused by invasion of the mucous membrane by micro-organisms. Since the tonsils contain deep folds of mucous membrane the inflammation with soreness, redness, swelling and often with white spots is greatest in the tonsils.

Acute tonsillitis is most often due to a haemolytic streptococcus, but it may be caused by a virus, a nonhaemolytic streptococcus or the bacterium of diphtheria. A certain type of haemolytic streptococcus causes a skin rash with the tonsillitis, called scarlet fever. Rheumatic fever and heart disease may follow haemolytic streptococcus tonsillitis and sore throat, therefore it is important that the diagnosis be made early by the increased white blood cell count and throat culture so that penicillin may be given to prevent rheumatic fever from developing. Acute tonsillitis caused by diphtheria comes on gradually and increases slowly, usually with a whitish-gray membrane on the tonsils. It is important that the diagnosis of diphtheria be made early by culture of the throat so that antitoxin may be given.

The symptoms of acute tonsillitis are sore throat with difficulty in swallowing, fever and, frequently, enlarged lymph glands on either side of the neck. Treatment includes, in addition to giving penicillin for haemolytic streptococcus or antitoxin for diphtheria, isolation to protect others from the infection, rest in bed as long as there is fever and hot throat irrigations or gargles of a teaspoonful of salt and a teaspoonful of baking soda in a pint of hot water.

Chronic Tonsillitis is a chronic inflammation of the tonsils

with redness and enlargement, caused by persisting infection following an acute tonsillitis In children there may be loss of appetite and weight, enlarged lymph glands in the neck and frequent or persistent sore throat. In adults chronic tonsillitis may also act as a focus for infection causing arthritis, neuritis or other distant inflammation.

The treatment of chronic tonsillitis is surgical removal. (*See* also LYMPHATIC SYSTEM). (G. E SH.)

TONSURE, a religious observance in the Roman Catholic and Orthodox Eastern Churches, consisting of the shaving or cutting of part of the hair of the head as a sign of dedication to special service. The reception of the tonsure in these churches is the initial ceremony which marks admission to orders and to clerical rights and privileges. It is administered by the bishop with an appropriate ritual. Candidates for the rite must have been confirmed, be adequately instructed in the elements of the Christian faith, and be able to read and write. Those who have received it are bound (unless in exceptional circumstances) to renew the mark, consisting of a bare circle on the crown of the head, at least once a month, otherwise they forfeit the privileges it carries The practice is not a primitive one, Tertullian simply advises Christians to avoid vanity in dressing their hair, and Jerome deprecates both long and closely cropped hair. According to Prudentius (*Περισ.* xiii 30) it was customary for the hair to be cut short at ordination. Paulinus of Nola (*c.* 490) alludes to the tonsure as in use among the (Western) monks; from them the practice quickly spread to the clergy For Gaul about the year 500 we have the testimony of Sidonius Apollinaris (iv. 13), who says that Germanicus the bishop had his hair cut "in rotae speciem."

The earliest instance of an ecclesiastical precept on the subject occurs in can. 41 of the Council of Toledo (A.D. 633): "omnes clerici, detonso superius capite toto, inferius solam circuli coronam relinquant" Can. 33 of the Quinisext council (692) requires even singers and readers to be tonsured. Since the 8th century three tonsures have been more or less in use, known respectively as the Roman, the Greek and the Celtic. The first two are sometimes distinguished as the tonsure of Peter and the tonsure of Paul. The Roman or St. Peter's tonsure prevailed in France, Spain and Italy. It consisted in shaving the whole head, leaving only a fringe of hair supposed to symbolize the crown of thorns. Late in the middle ages this tonsure was lessened for the clergy, but retained for monks and friars. In the Eastern or St. Paul's tonsure the whole head was shaven, but when now practised in the Eastern Church this tonsure is held to be adequately shown when the hair is shorn close. In the Celtic tonsure (tonsure of St. John, or, in contempt, tonsure of Simon Magus) all the hair in front of a line drawn over the top of the head from ear to ear was shaven (a fashion common among the Hindus) The question of the Roman or Celtic tonsure was one of the points in dispute in the early British Church, settled in favour of the Roman fashion at the Council of Whitby (664). The tonsure at first was never given separately, and even children when so dedicated were appointed readers, as no one could belong to the clerical state without at least a minor order. From the 7th century, however, children were tonsured without ordination, and later on adults anxious to escape secular jurisdiction were often tonsured without ordination. Till the 10th century the tonsure could be given by priests or even by laymen, but its bestowal was gradually restricted to bishops and abbots.

TOOKE, JOHN HORNE (1736–1812), English politician and philologist, third son of John Horne, a poulterer in Newport Market, London, was born on June 25, 1736. He was educated at Westminster school, Eton, and St John's college, Cambridge. He had been entered at the Inner Temple, but his father wished him to take orders and he was ordained to a curacy at New Brentford in 1760. He travelled in France in 1765–67, where he met John Wilkes (*q.v.*). In 1767 he returned and became Wilkes' most energetic and ingenious supporter. In 1771, however, he quarrelled violently with his leader, to the damage of their cause Horne's supporters took the name of the Constitutional Society

In 1773 he was placed beyond the reach of want by the gratitude of William Tooke, of Croydon, whose rights in an enclosure case he had protected by turning attention to his case

But Horne was now involved in serious trouble For signing the advertisement soliciting subscriptions for the relief of the relatives of the Americans "murdered by the king's troops at Lexington and Concord," he was tried at the Guildhall on July 4, 1777, before Lord Mansfield, found guilty, and committed to the King's Bench prison in St. George's Fields, from which he only emerged after a year's durance, and after a loss in fines and costs amounting to £1,200 Soon after his deliverance he applied to be called to the bar, but his application was negatived on the ground that his orders in the Church were indelible. Horne thereupon tried his fortune, but without success, on farming some land in Huntingdonshire He also published two influential reforming pamphlets: *Facts Addressed to Landholders,* etc. (1780), and *A Letter on Parliamentary Reform* (1782).

On his return from Huntingdonshire he became once more a frequent guest at Mr. Tooke's house at Purley, and in 1782 assumed the name of Horne Tooke. In 1786 Horne Tooke gave his philological treatise of *Ἔπεα πτερόεντα* (2 pts. 1786–1805), the sub-title of *The Diversions of Purley,* as a tribute to his friend.

Between 1782 and 1790 Tooke supported Pitt, and in the election for Westminster, in 1784, threw all his energies into opposition to Fox After the Westminster election of 1788 Tooke depicted the rival statesmen (Lord Chatham and Lord Holland, William Pitt and C. J. Fox) in his pamphlet of *Two Pair of Portraits* At the general election of 1790 he was a candidate for Westminster, in opposition to Fox and Lord Hood, but was defeated, and, at a second trial in 1796, he was again at the bottom of the poll. Meantime the excesses of the French revolution had provoked reaction in England, and the Tory ministry adopted a policy of repression. Horne Tooke was arrested early on the morning of May 16, 1794, and conveyed to the Tower. His trial for high treason lasted for six days (Nov. 17–22) and ended in his acquittal, the jury only taking eight minutes to settle their verdict Through the influence of the second Lord Camelford, he was returned to parliament in 1801 for the pocket borough of Old Sarum Efforts to secure his exclusion on the ground of his clerical orders failed, but an act was passed rendering all persons in holy orders ineligible, and he sat for that parliament only.

The last years of Tooke's life were spent in retirement in a house on the west side of Wimbledon Common, where he gave the Sunday parties, attended by Thurlow, Bentham, Coleridge, Paine and others, which became a legend. He died on March 18, 1812.

The *Life of Horne Tooke,* by Alexander Stephens, is written in an unattractive style and was the work of an admirer only admitted to his acquaintance at the close of his days The notice in the *Quarterly Review,* June 1812, of W Hamilton Reid's compilation, is by J. W. Ward, Lord Dudley. The main facts of his life are set out by Mr. J. E. Thorold Rogers, in his *Historical Gleanings,* and series. Many of Horne Tooke's wittiest sayings are preserved in the *Table Talk* of Samuel Rogers and S T. Coleridge.

TOOKE, THOMAS (1774–1858), English economist, was born at St Petersburg in February, 1774. Entering a large Russian house in London at an early age, he acquired sound practical experience of commercial matters and became a recognized authority on finance and banking. He was one of the earliest advocates of free trade and drew up the *Merchants' Petition* presented to the House of Commons by Alexander Baring, afterwards Lord Ashburton. He gave evidence before several parliamentary committees, notably the committee of 1821, on foreign trade, and those of 1832, 1840 and 1848 on the Bank Acts. He was elected F.R S. in 1821. He died in London on Feb 26, 1858.

Tooke is known for his *History of Prices and of the State of the Circulation during the Years 1793–1856* (6 vols., 1838–1857). In the first four volumes he treats (*a*) of the prices of corn, and the circumstances affecting prices, (*b*) the prices of produce other than corn, and (*c*) the state of the circulation. The two final volumes, written in conjunction with W. Newmarch, deal with railways, free trade, banking in Europe and the effects of new discoveries of gold

TOOL, an implement or apphance used by a worker in the treatment of the substances used in his handicraft, whether in

the preliminary operations of setting out and measuring the materials, in reducing his work to the required form by cutting or otherwise, in gauging it and testing its accuracy, or in duly securing it while thus being treated. (For the tools of prehistoric man *see* ARCHAEOLOGY; FLINTS; and EGYPT.)

In beginning a survey of tools it is necessary to draw the distinction between hand and machine tools. The former class includes any tool which is held and operated by the unaided hands, *e g*, a chisel, plane or saw. Attach one of these to some piece of operating mechanism, and it, with the environment of which it is the central essential object, becomes a machine tool. Simple examples are the common power-driven hack saw for metal, the small high-speed drill, and the wood-boring auger held in a frame and turned by a winch handle and bevel-gears. The difference between these and a big frame-saw cutting down a dozen boards simultaneously, or the immense machine boring the cylinders of an ocean liner, etc, is so vast that the relationship is hardly apparent. Often the tool itself is absolutely dwarfed by the machine, of which nevertheless it is the central object and around which the machine is designed and built A milling machine weighing several tons will often be seen rotating a tool of but two or three dozen pounds' weight. Yet the machine is fitted with elaborate slides, self-acting movements and provision for taking up wear, and is worth some hundreds of pounds sterling, while the tool may not be worth two pounds. Such apparent anomalies are in constant evidence This article is a survey of the principles that underlie the forms of tools. The subject of their embodiment in machine tools will be found and treated under MACHINE TOOLS, LATHE, PLANING-MACHINES, MILLING MACHINES, SAWING MACHINES, WOOD-WORKING MACHINERY, etc

An analysis of the essential methods of operation gives a broad grouping as follows:

I	The chisel group	Typified by the chisel of the woodworker.
II.	The shearing group	,, ,, scissors
III.	The scrapers	,, ,, cabinet-maker's scrape.
IV.	The percussive and detrusive group	,, ,, hammer and the punch.
V.	The moulding group	,, ,, trowel.

The first three are generally all regarded as cutting tools, notwithstanding that those in II and III do not operate as wedges, and therefore are not true chisels; but many occupy a border-

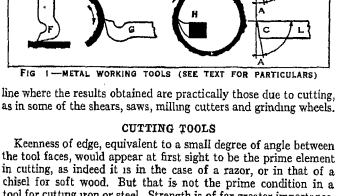


FIG 1—METAL WORKING TOOLS (SEE TEXT FOR PARTICULARS)

line where the results obtained are practically those due to cutting, as in some of the shears, saws, milling cutters and grinding wheels.

CUTTING TOOLS

Keenness of edge, equivalent to a small degree of angle between the tool faces, would appear at first sight to be the prime element in cutting, as indeed it is in the case of a razor, or in that of a chisel for soft wood. But that is not the prime condition in a tool for cutting iron or steel. Strength is of far greater importance, and to it some keenness of edge must be sacrificed. All cutting tools are wedges; but a razor or a chisel edge, included between angles of 15° or 20°, would be turned over at once if presented to iron or steel, for which angles of from 60° to 75° are required. Further, much greater rigidity is necessary in the latter, to resist spring and fracture A workman can operate a turning tool by hand, even on heavy pieces of metal-work. Formerly all turning, no matter how large, was done by hand-operated tools, and after great muscular exertion a few pounds of metal might be removed in an hour. With a similarly formed tool, in a rigid guide or rest, driven by the power of ten or twenty men, it becomes possible to remove say a hundredweight of chips in an hour; or with

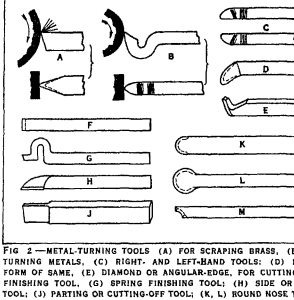


FIG 2—METAL-TURNING TOOLS (A) FOR SCRAPING BRASS, (B) FOR TURNING METALS, (C) RIGHT- AND LEFT-HAND TOOLS; (D) BETTER FORM OF SAME, (E) DIAMOND OR ANGULAR-EDGE, FOR CUTTING, (F) FINISHING TOOL, (G) SPRING FINISHING TOOL; (H) SIDE OR KNIFE TOOL; (J) PARTING OR CUTTING-OFF TOOL; (K, L) ROUND NOSE TOOLS; (M) RADIUS

a larger and more durable tool driven by the power of 40 or 60 horses, half a ton of chips may be removed in an hour.

All machine tools of which the chisel is the type operate by cutting, *i.e.*, they act on the same principle and by the same essential method as the knife, razor or chisel, and not by that of the grindstone A single tool, however, may act as a cutting instrument at one time and as a scrape at another.

Clearly, in order that a tool shall cut, it must possess an incisive form In fig. 1, *A* might be thrust over the surface of the plate of metal, but no cutting action could take place. It would simply grind and polish the surface. If it were formed like *B*, the grinding action would give place to scraping, by which some material would be removed. Many tools are formed thus, but there is still no incisive or knife-like action, and the tool is simply a scrape and not a cutting tool. But *C* is a cutting tool, possessing penetrative capacity. If now *B* were tilted backwards as at *D*, it would at once become a cutting tool. But its bevelled face would rub and grind on the surface of the work, producing friction and heat, and interfering with the penetrative action of the cutting edge. On the other hand, if *C* were tilted forwards as at *E* its action would approximate to that of a scrape for the time being But the high angle of the hinder bevelled face would not afford adequate support to the cutting edge, and the latter would therefore become worn off almost instantly, precisely as that of a razor or wood-working chisel would crumble away if operated on hard metal. It is obvious therefore that the correct form for a cutting tool must depend upon a due balance being maintained between the angle of the front and of the bottom faces—"front" or "top rake," and "bottom rake" or "clearance"—considered in regard to their *method of presentatson* to the work. Since, too, all tools used in machines are held rigidly in one position, differing in this respect from hand-operated tools, it follows that a constant angle should be given to instruments which are used for operating on a given kind of metal or alloy. It does not matter whether a tool is driven in a lathe, or a planing machine, or a sharper or a slotter; whether it is cutting on external or internal surfaces, it is always maintained in a direction perpendicularly to the point of application as in fig. 1, *F*, *G*, *H*, planing, turning and boring respectively. It is consistent with reason and with fact

that the softer and more fibrous the metal, the keener must be the formation of the tool, and that, conversely, the harder and more crystalline the metal the more obtuse must be the cutting angles, as in the extremes of the razor and the tools for cutting iron and steel already instanced The three figures *J*, *K*, *L* show tools suitably formed for wrought iron and mild steel, for cast iron and cast steel, and for brass respectively Cast iron and cast

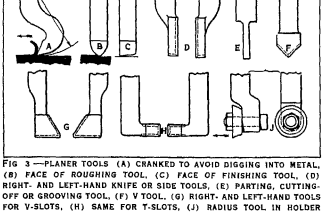


FIG 3.—PLANER TOOLS (A) CRANKED TO AVOID DIGGING INTO METAL, (B) FACE OF ROUGHING TOOL, (C) FACE OF FINISHING TOOL, (D) RIGHT- AND LEFT-HAND KNIFE OR SIDE TOOLS, (E) PARTING, CUTTING-OFF OR GROOVING TOOL, (F) V TOOL, (G) RIGHT- AND LEFT-HAND TOOLS FOR V-SLOTS, (H) SAME FOR T-SLOTS, (J) RADIUS TOOL IN HOLDER

steel could not be cut properly with the first, nor wrought iron and fibrous steel with the second, nor either with the third The angles given are those which accord best with general practice

The *angle of clearance*, or *relief a*, fig 1 J, K & L, is an important detail of a cutting tool. It is of greater importance than an exact angle of top rake; but, given some sufficient angle of clearance, its exact amount is not of much moment. Neither need it be uniform for a given cutting edge It may vary from say 3° to 10°, or even 20°, and under good conditions little or no practical differences will result. Actually it need never vary much from 5° to 7° The object in giving a clearance angle is simply to prevent friction between

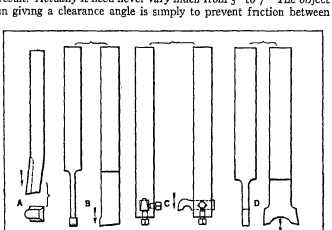


FIG. 4.—SLOTTER TOOLS (A) COMMON ROUGHING, (B) PARTING-OFF OR GROOVING; (C) ROUGHING OR FINISHING TOOL IN HOLDER, (D) DOUBLE-EDGED FOR CUTTING OPPOSITE SIDES OF SLOT

the non-cutting face immediately adjacent to the edge and the surface of the work. The limit to this clearance is that at which insufficient support is afforded to the cutting edge.

The *front*, or *top rake*, *b* in fig 1, is the angle or slope of the front, or top face, of the tool, it is varied mainly according as materials are crystalline or fibrous In the turnings and cuttings taken off the more crystalline metals and alloys, the broken appearance of the chips is distinguished from the shavings removed from the fibrous materials. It indicates too that extra work is put on the tool in breaking up the chips, following immediately on their severance, and when the comminutions are very small they indicate insufficient top rake. This is a result that turners try to avoid when possible, or at least to minimize. Now the greater the slope of the top rake the more easily will the cuttings come away, with the minimum of break in the crystalline materials and absolutely unbroken over lengths of many feet in the fibrous ones The breaking up or the continuity of the cuttings, therefore affords an indication of the suitability of the amount of top rake to its work However, compromise often has to be made between the ideal and the actual. The amount of top rake has to be limited in the harder metals and alloys in order

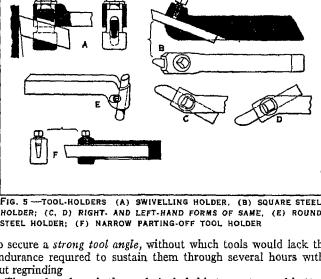
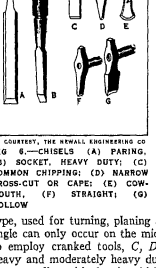


FIG. 5.—TOOL-HOLDERS (A) SWIVELLING HOLDER, (B) SQUARE STEEL HOLDER; (C, D) RIGHT- AND LEFT-HAND FORMS OF SAME, (E) ROUND STEEL HOLDER; (F) NARROW PARTING-OFF TOOL HOLDER

to secure a *strong tool angle*, without which tools would lack the endurance required to sustain them through several hours without regrinding

The *tool angle*, *c*, is the angle included between top and bottom faces, and its amount, or thickness expressed in degrees, is a measure of the strength and endurance of any tool. At extremes it varies from about 15° to 85°. It is traceable in all kinds of tools, having very diverse forms

Tools of the Chisel Type.—The grouped illustrations (figs. 2 to 6) show some of the types, but it will be understood that each is varied in dimensions, angles and outlines to suit all the varied kinds of metals and alloys and conditions of operation For, as every tool has to be gripped in a holder of some kind, as a slide-rest, tool-box, turret, tool-holder, box, cross-slide, etc, this often determines the choice of some one form in preference to another. A broad division is that into roughing and finishing tools Generally though not invariably the edge of the first is narrow, of the second broad, corresponding with the deep cutting and fine traverse of the first and the shallow cutting and broad traverse of the second. The following are some of the principal forms The round-nosed roughing tool (fig. 2) *B* is of straight-forward



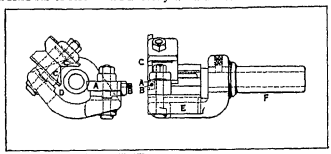
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FIG 6.—CHISELS (A) PARING, (B) SOCKET, HEAVY DUTY; (C) COMMON CHIPPING; (D) NARROW CROSS-CUT OR CAPE; (E) COW-MOUTH, (F) STRAIGHT; (G) HOLLOW

type, used for turning, planing and shaping. As the correct tool angle can only occur on the middle plane of the tool, it is usual to employ cranked tools, *C*, *D*, *E*, right- and left-handed, for heavy and moderately heavy duty, the direction of the cranking corresponding with that in which the tool is required to traverse Tools for boring are cranked and many for planing (fig 3). The slotting tools (fig. 4) embody the same principle, but their shanks are in line with the direction of cutting. Many roughing and

finishing tools are of knife type *H* Finishing tools have broad edges, *F*, *G*, *H*. They occur in straightforward and right- and left-hand types These as a rule remove less than $\frac{1}{16}$ in. in depth, while the roughing tools may cut an inch or more into the metal

Solid Tools v. Tool-holders.—It will be observed that the foregoing are solid tools; that is, the cutting portion is forged from a solid bar of steel This is costly when the best tool steel is used,



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FIG 7.—BOX TOOL FOR TURRET LATHE· (A) CUTTING TOOL; (B) SCREW FOR ADJUSTING RADIUS OF CUT; (C C) V-STEADIES; (D) DIAMETER OF WORK; (E) BODY OF HOLDER; (F) STEM

hence large numbers of tools comprise *points* only, which are gripped in permanent holders in which they interchange Tool steel usually ranges from about $\frac{1}{2}$ in. to 4 in square; most engineers' work is done with bars of from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. square It is in the smaller and medium sizes of tools that holders prove of most value. Solid tools, varying from $2\frac{1}{2}$ in to 4 in. square, are used for the heaviest cutting done in the planing machine. Tool-holders are not employed for very heavy work, because the heat generated would not get away fast enough from small tool points. There are scores of holders; perhaps a dozen good approved types are in common use. They are divisible into three great groups. those in which the top rake of the tool point is embodied in the holder, and is constant; those in which the clearance is similarly embodied; and those in which neither is provided for, but in which the tool point is ground to any angle. Charles Babbage designed the first tool-holder, and the essential type survives in several modern forms Fig. 5 includes two forms of tool holder. In one *E* the tool is a bit of round steel set at an angle which gives front rake, and having the top end ground to an angle of top rake. In

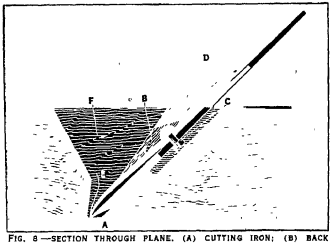


FIG. 8.—SECTION THROUGH PLANE. (A) CUTTING IRON; (B) BACK IRON; (C) CLAMPING SCREW. (D) WEDGE; (E) BROKEN SHAVING; (F) MOUTH

the other *A* the tool has the section of a truncated wedge, set for constant top rake, or cutting angle, and having bottom rake or clearance angle ground. This round tool is not applicable for all classes of work. It will turn plain work, and plane level faces, but will not turn or plane into corners or angles. Hence the invention of the tool of V section, and the swivel tool-holder. The round tool-holders are made right- and left-handed, the swivel tool-holder has a universal movement. The amount of projection of the round tool points is very limited, which impairs their utility when some overhanging of the tool is necessary. The V-tools can be slid out in their holders to operate on faces and edges situated well inward from the end of the tool-holder

Box Tools.—In one feature the box tools of the turret lathes resemble tool-holders The small pieces of steel used for tool

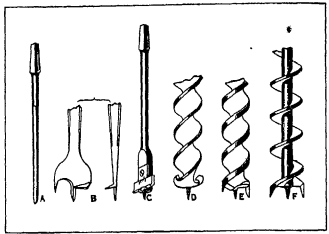


FIG. 9.—WOOD BORING BITS; (A) SPOON BIT; (B) CENTRE-BIT; (C) EXPANDING CENTRE-BIT. (D) GILPIN OR GEDGE AUGER. (E) JENNINGS AUGER; (F) IRWIN AUGER

points are gripped in the boxes, as in tool-holders, and all the advantages which are derived from this arrangement of separating the point from its holder are thus secured (fig. 7) But in all other respects the two are dissimilar Two or three tool-holders

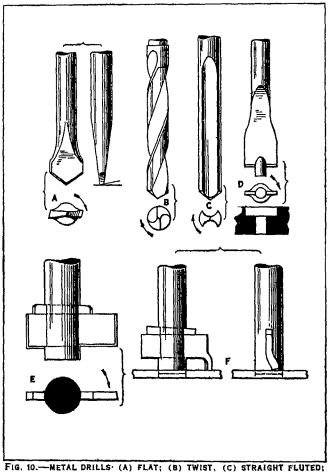


FIG. 10.—METAL DRILLS· (A) FLAT; (B) TWIST. (C) STRAIGHT FLUTED; (D) PIN. (E) ARBORING. (F) TOOL FOR BORING SHEET METAL

of different sizes take all the tool points used in a lathe, but a new box has to be devised in the case of almost every new job, with the exception of those the principal formation of which is the turning down of plain bars. The explanation is that, instead of a single point, several are commonly carried in a box. As com-

plexity increases with the number of tools, new designs and dimensions of boxes become necessary, even though there may be family resemblances in groups A result is that there is not, nor can there be, anything like finality in these designs. Turret work has become one of the most highly specialized departments of machine-shop practice, and the design of these boxes is already the work of specialists More and more of the work of the common lathe is being constantly appropriated by the semi- and full-automatic machines, a result to which the magazine feeds for

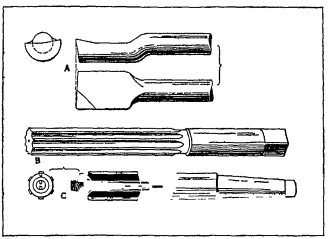


FIG 11—(A) D-BIT, (B) SOLID REAMER, (C) ADJUSTABLE REAMER

castings and forgings that cannot pass through a hollow spindle have contributed to a great extent. A great deal of the efficiency of the box tools is due to the support which is afforded to the cutting edges in opposition to the stress of cutting V-blocks are introduced in most cases as in fig 7. In many tools a shearing operation takes place, by which the stress of cutting is lessened

Planes.—Generally the tool angles of the chisel group lie between 15° and 25°. They include the chisels proper, and the gouges in numerous shapes and proportions, used by carpenters, cabinet-makers, turners, stone-masons, etc These are mostly thrust by hand to their work, without any mechanical control Other chisels are used percussively, as the stout mortise chisels, some of the gouges, the axes, adzes and stone-mason's tools.

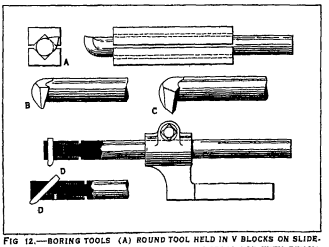


FIG 12.—BORING TOOLS (A) ROUND TOOL HELD IN V BLOCKS ON SLIDE-REST; (B, C) SQUARE AND V-POINTED, (D) BORING BAR WITH REMOVABLE CUTTERS

The large family of planes embody chisels coerced by the mechanical control of the wooden (fig. 8) or metal stock.

Drilling and Boring Tools.—Metal and timber are bored with equal facility; the tools (figs 9 and 10) embody similar differences to the cutting tools already instanced for wood and metal. All the wood-working bits are true cutting tools, and their angles, if analysed, will be found not to differ much from those of the razor and common chisel. The drills for metal furnish examples both of scrapers and cutting tools. The common drill is only a scraper, but all the twist drills cut with good incisive action. An advantage possessed by all drills is that the cutting forces are balanced on each side of the centre of rotation The same action is found in the best wood-boring bits—improved forms of the old centre-bit. But the balance is impaired if the lips are not absolutely symmetrical about the centre. This explains the

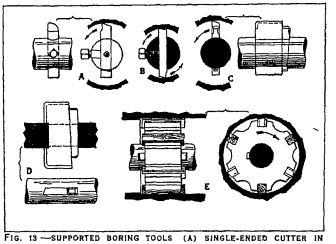


FIG. 13.—SUPPORTED BORING TOOLS (A) SINGLE-ENDED CUTTER IN BORING BAR, (B) SAME, DOUBLE-ENDED, (C) FLAT SINGLE-ENDED FINISHING CUTTER, (D) SAME, DOUBLE-ENDED, (E) BORING HEAD WITH THREE CUTTER AND THREE STEADY BLOCKS

necessity for the substitution of machine grinding for hand grinding of the lips, and great developments of twist drill grinding machines Allied to the drills are the D-bits, and the reamers (fig. 11). The first-named both initiate and finish a hole; the second are used only for smoothing and enlarging drilled holes, and for correcting holes which pass through adjacent castings or plates The reamers remove only a mere film, and their action is that of scraping. The foregoing are examples of tools operated from one end and unsupported at the other, except in so far as they receive support within the work. One of the objectionable features of tools operated in this way is that they tend to "follow the hole," and if this is cored, or rough-drilled out of truth, there is risk of the boring tools following it to some extent at least. With the one exception of the D-bit there is no tool which can be relied on to take out a long bore with more than an approximation to concentricity throughout. Boring tools (fig 12) held in the slide-rest will spring and bend and chatter, and unless the lathe is true, or careful compensation is made for its want of truth, they will bore bigger at one end than the other.

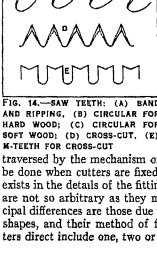


FIG. 14.—SAW TEETH: (A) BAND AND RIPPING, (B) CIRCULAR FOR HARD WOOD; (C) CIRCULAR FOR SOFT WOOD; (D) CROSS-CUT, (E) M-TEETH FOR CROSS-CUT

This brings us to the large class of boring tools which are supported at each end by being held in bars carried between centres. There are two main varieties: in one the cutters are fixed directly in the bar (fig 13, A to D), in the other in a head fitted on the bar (fig. 13, E), hence termed a "boring head" As lathe heads are fixed, the traverse cannot be imparted to the bars as in boring machines. The boring heads can be traversed, or the work can be traversed by the mechanism of the lathe saddle. The latter must be done when cutters are fixed in bars. A great deal of difference exists in the details of the fittings both of bars and heads, but they are not so arbitrary as they might seem at first sight. The principal differences are those due to the number of cutters used, their shapes, and their method of fastening. Bars receiving their cutters direct include one, two or four, cutting on opposite sides, and

therefore balanced. Four give better balance than two.

Saws.—The saws are a natural connecting link between the chisels and the milling cutters. Saws are used for wood, metal and stone. Slabs of steel several inches in thickness are sawn

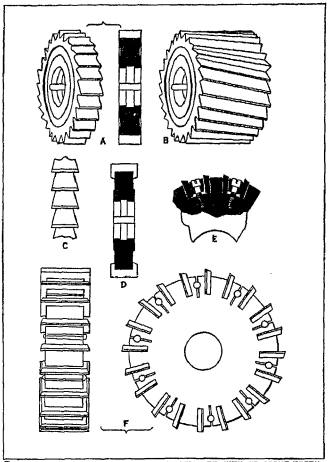


FIG. 15.—MILLING CUTTERS: (A) NARROW EDGE WITH STRAIGHT TEETH; (B) WIDE EDGE WITH SPIRAL TEETH. (C) TEETH ON FACE AND EDGES; (D) CUTTER WITH TEETH LIKE C. (E) FLAT TEETH; (F) INSERTED TOOTH

through as readily as, though more slowly than, umber planks. Circular and band saws are common in the smithy and the boiler and machine shops for cutting off bars, forgings and rolled sections. But the tooth shapes are not those used for timber, nor is the cutting speed the same. In the individual saw-teeth both cutting and scraping actions are illustrated (fig. 14). Saws which cut timber continuously with the grain, as rip, hand, band, circular, have incisive teeth, for though many are destitute of front rake, the method of sharpening a. an angle imparts a true shearing cut. But all cross-cutting teeth scrape only, the teeth being either of triangular or of M-form, variously modified. Teeth for metal cutting also act strictly by scraping. The pitching of the teeth is related to the nature of the material and the direction of cutting. It is coarser for timber than for metal, coarser for ripping or sawing with the grain than for cross cutting, coarser for soft than for hard woods. The *setting* of teeth, or the bending over to right and left, by which the clearance is provided for the blade of the saw, is subject to similar variations. It is greatest for soft woods and least for metals, where in fact the clearance is often secured without set, by thinning the blade backwards.

Milling Cutters.—Between a circular saw for cutting metal and a thin milling cutter there is no essential difference. Increase the thickness as if to produce a very wide saw, and the essential plain edge milling cutter for metal results. In its simplest form the milling cutter is a cylinder with teeth lying across its periphery, or parallel with its axis—the *edge mill* (fig. 15), or else a disk with teeth radiating on its face, or at right angles with its axis—the *end mill* (fig. 16). Each is used indifferently for producing flat faces and edges, and for cutting grooves which are rectangular in cross-section.

When more than about an inch in width, surfacing cylindrical cutters are formed with spiral teeth (fig. 15, B), a device which is

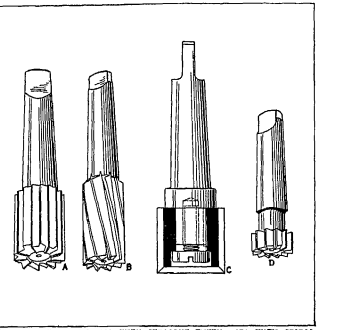


FIG. 16.—END MILLS: (A) WITH STRAIGHT TEETH; (B) WITH SPIRAL TEETH. (C) HOLDING SHELL CUTTER ON ARBOR WITH SCREW AND KEY; (D) T-SLOT CUTTER

essential to sweetness of operation, the action being that of shearing. These have their teeth cut on universal machines, using the dividing and spiral head and suitable change wheels, and after hardening they are sharpened on universal grinders. When cutters

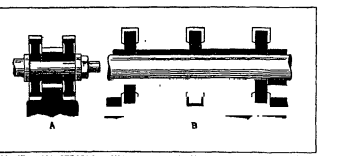


FIG. 17.—(A) STRADDLE MILL, (B) SET OF THREE MILLS FOR CUTTING GROOVES

exceed about 6 in. in length the difficulties of hardening and grinding render the "gang" arrangement more suitable. Thus, two, three or more similar edge mills are set end to end on an arbor, with the spiral teeth running in reverse directions, giving a broad face

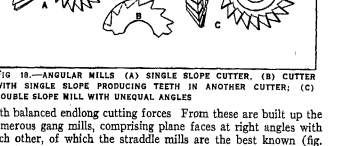


FIG. 18.—ANGULAR MILLS (A) SINGLE SLOPE CUTTER, (B) CUTTER WITH SINGLE SLOPE PRODUCING TEETH IN ANOTHER CUTTER; (C) DOUBLE SLOPE MILL WITH UNEQUAL ANGLES

with balanced endlong cutting forces. From these are built up the numerous gang mills, comprising plane faces at right angles with each other, of which the straddle mills are the best known (fig. 17, A). A common element in these combinations is the key seat

type B having teeth on the periphery and on both faces as in fig 15, C, D In a single cutter of the face type, but having teeth on back and edge also, T-slots are readily milled (fig. 16, D).

When angles, curves and profile sections are introduced, the capacity of the milling cutter is infinitely increased The making of the cutters is also more difficult Angular cutters (fig 18) are used for producing the teeth of the mills themselves, for shaping the teeth of ratchet wheels, and, in combination with straight cutters in gangs, for angular sections With curves, or angles and curves in combination, taps, reamers and drills can be fluted or grooved, the teeth of wheels shaped, and in fact any outlines imparted (fig 19).

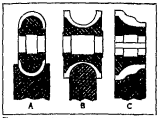
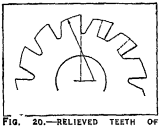


FIG 19.—CUTTERS (A) CONVEX, (B) CONCAVE, (C) PROFILE

One of the greatest advances in the practice of milling was that of making backed-off cutters The sectional shape behind the tooth face is continued identical in form with the profile of the edge, the outline being carried back as a curve equal in radius to that of the cutting edge (fig 20) The result is that the cutter may be sharpened on the front faces of the teeth without interfering with the shape which will be milled, because the periphery is always constant in outline After repeated sharpenings the teeth would assume the form indicated by the shaded portion on two of the teeth. The limit of grinding is reached when the tooth becomes too thin and weak to stand up to its work.


FIG. 20.—RELIEVED TEETH OF MILLING CUTTER

Scrapes and Files.—The tools which operate by scraping (fig. 21) include many of the broad finishing tools of the turner in wood and metal (*cf.* fig 2), and the scrape of the wood worker and the fitter The practice of scraping surfaces true, applied to surface plates, machine slides and similar objects, was due to Sir Joseph Whitworth. It superseded the older and less accurate practice of grinding to a mutual fit. Now, with machines of precision, the practice of grinding has to a large extent displaced the more costly scraping.

Files are classed with scrapes, for, although the points are keen, there is never any front rake. Collectively there is a shearing action because the rows of teeth are cut diagonally The sectional forms (fig. 22) and the longitudinal forms (fig 23) of the files are numerous, to adapt them to all classes of work In addition, the method of cutting, and the degrees of coarseness of the teeth, vary, being single, or float cut, or double cut (fig. 24). The rasps are another group Degrees of coarseness are designated as rough, muddle cut, bastard cut, second cut, smooth, double dead smooth, the first named is the coarsest, the last the finest. The terms are relative, since the larger a file is the coarser are its teeth, though of the same name as the teeth in a shorter file, which are finer.

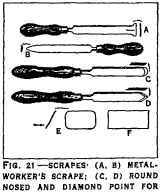


FIG. 21.—SCRAPES· (A, B) METALWORKER'S SCRAPE; (C, D) ROUND NOSED AND DIAMOND POINT FOR WOOD-TURNING; (E, F) CABINETMAKERS' SCRAPES

Shears and Punches.—These may be of cutting or non-cutting types Shears (fig. 25) have no front rake, but only a slight clearance. They generally give a slight shearing cut, because the blades do not lie parallel, but the cutting begins at one end and continues in detail to the other. But strictly the shears, like the punches, act by a severe detrusive effort; for the punch, with its bolster (fig. 26), forms a pair of cylindrical shears. The effect of shearing is practically identical with that of punching, and likewise planing and annealing shorn edges has substantially the same influence as reamering punched holes. *See* also SCREW.

HAMMERS AND MOULDING TOOLS

Hammers.—These form an immense group, termed percussive, from the manner of their use (fig 27). Every trade has its own peculiar shapes, the total of which number many scores, each with its own appropriate name, and ranging in size from the minute

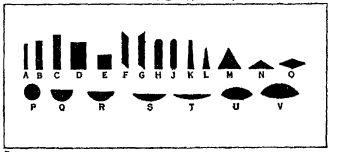


FIG 22.—CROSS-SECTIONAL SHAPES OF FILES (A) WARDING, (B) JILL, (C) FLAT, (D) PILLAR; (E) SQUARE, (F, G) SWAGED REAPERS, (H) MILL, (J) TOPPING, (K) REAPER, (L) KNIFE, (M) THREE-SQUARE; (N) CANT, (O) SLITTING OR FEATHER EDGE; (P) ROUND, (Q) PIT-SAW OR FRAME-SAW, (R) HALF-ROUND; (S, T) CABINET, (U) TUMBLER; (V) CROSSING

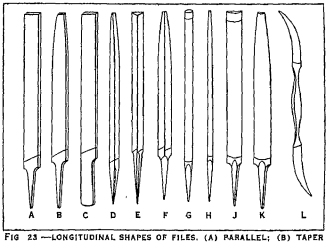


FIG 23.—LONGITUDINAL SHAPES OF FILES. (A) PARALLEL; (B) TAPER BELLIED, (C) KNIFE REAPER, (D) TAPERED SQUARE, (E) PARALLEL TRIANGULAR, (F) TAPERED TRIANGULAR, (G) PARALLEL ROUND, (H) TAPER, (J) PARALLEL HALF-ROUND; (K) TAPERED HALF-ROUND, (L) RIFFLER

forms of the jeweler to the sledges of the smith and boiler maker and the planishing hammers of the coppersmith. Wooden hammers are termed mallets, their purpose being to avoid bruising tools or the surfaces of work Most trades use mallets of some form or another Hammer handles are rigid in all cases except certain percussive tools of the smithy, which are handled with withy rods, or iron rods flexibly attached to the tools, so that when struck by the sledge they shall not jar the hands The fullering tools, and flatters, and setts, though not hammers strictly, are actuated by percussion. The dies of the die forgers are actuated percussively, being closed by powerful hammers. The action of caulking tools is percussive, and so is that of moulders' rammers.

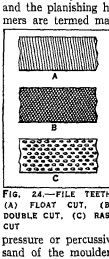


FIG. 24.—FILE TEETH: (A) FLOAT CUT, (B) DOUBLE CUT, (C) RASP CUT

Moulding Tools.—This is a group of tools which, actuated either by simple pressure or percussively, mould, shape and model forms in the sand of the moulder, in the metal of the smith, and in press work. All the tools of the moulder (fig. 28) with the exception of the rammers and vent wires act by moulding the sand into shapes by pressure. They are made in iron and brass. The fullers, swages and flatters of the smith, and the dies used with hammer and presses, all mould by percussion or by pressure, the

work taking the counterpart of the dies, or of some portion of them. The practice of die forging consists of moulding processes

For a discussion of Toot Steel see the article under that heading.

MEASUREMENT

An advance of the greatest importance made in mechanical engineering is that of measurement. Since the beginning of the 19th century steady movement has been going on in this direction. Methods of measurement adopted in woodworking have but little application in high-class engineers' work They are adopted, however, to a considerable extent in the metal trades which are allied to engineering, as sheet metal working, girder work, etc. When a carpenter or joiner sets about constructing a door, window sash, roof or box he takes a two-foot rule, a marker and possibly compasses. Whether the tool used be saw, chisel, gouge or plane, the woodworker estimates by sight alone whether or not the lines marked are worked by.

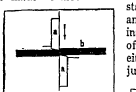


FIG. 25.—SHEAR BLADES (a, a) BLADES; (b) PLATES BEING SHEARED

The broad difference between his method and that of the engineer's machinist lies in this, that while the first tests his work by the eye, the second judges of its accuracy or otherwise by the sense of touch. It may seem that there cannot be very much difference in these two methods, but there is. To the first, the sixty-fourth part of an inch is a fine dimension, to the second one-thousandth of an inch is rather coarse In what are called "limit gauges" the plugs and rings are made of slightly different dimensions If a plug is made a thousandth of an inch less than its ring, it will slip through it easily with very perceptible slop. The common rule is therefore scarcely seen in modern machine shops, while the common calipers fill but a secondary place, their function having been invaded by the gauges. A minute dimension cannot be tested by lines of division on a rule, neither can a dimension which should be fixed be tested with high precision with a movable caliper of ordinary type Yet it must not be supposed that the adoption of the system of gauging instead of the older methods of rule measurement relieves men of responsibility. The instruments of precision require delicate handling. Rough forcing of gauges will not yield correct results. Without correctness of measurement mechanical constructions would be impossible, and the older device of mutual fitting of parts is of lessening value in face of the growth of the interchangeable system, of international standards, and of automatic machine tools.

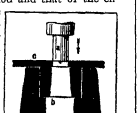


FIG. 26.—PUNCHING (a) PUNCH; (b) BOLSTER; (c) PLATE BEING PUNCHED

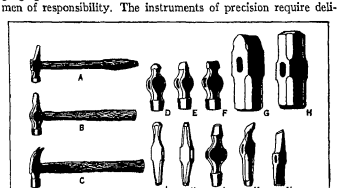


FIG. 27.—HAMMERS (A) EXETER, (B) JOINER'S, (C) CANTERBURY CLAW, (D, E, F) ENGINEER'S (BALL, CROSS AND STRAIGHT PANE [PEEN]), (G, H) SLEDGE HAMMER, STRAIGHT PANE (PEEN) AND DOUBLE FACED; (J, K, L, M) BOILER MAKERS'; (N) SEALING

The two broad divisions of measurement by sight and by contact are represented in a vast number of instruments. To the first named belong the numerous rules in wood and metal and with English and metric divisions, and the scales which are used for setting out dimensions on drawings smaller than those of the real objects, but strictly proportional thereto The second include all the gauges These are either fixed or movable, an important subdivision. The first embrace two groups—one for daily workshop service, the other for testing and correcting the wear of these, hence termed "reference gauges" They are either made to exact standard sizes, or they embody "limits of tolerance," *i.e.*, allowances for certain classes of fits, and for the minute degrees of inaccuracy which are permissible in an interchangeable system of manufacture The movable group includes a movable portion, either corresponding with one leg of a caliper or having an adjustable rod, with provision for precise measurement in the form

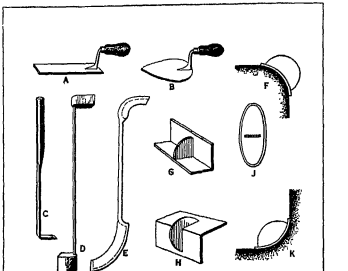


FIG. 28.—MOULDING TOOLS. (A) SQUARE TROWEL, (B) HEART TROWEL; (C, D) CLEANERS; (E) FLANGE BEAD; (F) HOLLOW BEAD; (G, H) SQUARE CORNER SLEEKER; (J) BUTTON SLEEKER; (K) PIPE SMOOTHER

of a vernier or of a screw thread divided micrometrically. These may be of general character for testing internal or external diameters, or for special functions as screw threads. Subtitles indicate some particular aspect or design of the gauges, as "plug and ring," "caliper," "horseshoe," "depth," "rod," "end measure," etc. So severe are the requirements demanded of instruments of measurement that the manufacture of the finer kinds remains a speciality in the hands of a very few firms. The cost and experience necessary are so great that prices rule high.

Rules and Scales.—The rules are used for marking off distances and dimensions in conjunction with other instruments, as scribers, compasses, dividers, squares; and for testing and checking dimensions when marked, and work in course of reduction or erection, directly or from calipers. They are made in boxwood and in steel, the latter being either rigid or flexible, as when required to go round curves. Rules are fitted in combination with other instruments, as sliding calipers, squares, depth gauges, etc. The scales are of boxwood, or ivory, the value of which is discounted by its shrinkage, and of paper They are fully divided, or open divided; in the first case each division is alike subdivided, in the second only the end ones are thus treated.

The Gauges. *Fixed Gauges.*—These now embrace several kinds, the typical forms being represented by the cylindrical or plug and ring gauges and by the caliper form or snap gauges. The principle in each is that a definite dimension being embodied in the gauge, the workman has not to refer to the rule, either directly or through the medium of a caliper. This distinction, though slight, is of immense importance in modern manufacturing. Broadly it corresponds with the difference between the older heterogeneous and the present interchangeable systems.

Plug and Ring Gauges.—The principal ones and the originals

of all the rest, termed Whitworth gauges after the inventor, are the plug and ring gauges (fig 29, *A* and *B*). The principle on which they depend is that if the two gauges are made to fit with perfect accuracy, without tightness on the one hand or slop on the other, then any work which is measured or turned and bored or ground by them will also fit with equal accuracy. Bored holes are tested by the plug gauge, and spindles are tested by the ring gauge, and such spindles and holes make a close fit if the work is done carefully Of course, in practice, there is very much variation in the character of the work done, and the finest gauges are too fine for a large proportion of engineers' work. It is possible to make these gauges within $\frac{1}{50\,000}$ of an inch But they are seldom required so fine as that for shop use; $\frac{1}{5\,000}$ is generally fine enough. For general shop work the gauges are made to within about $\frac{1}{1\,000}$ of an inch. Standard gauges in which the plug and ring are of the same diameter will only fit by the application of a thin film of oil and by keeping the plug in slight movement within the ring Without these precautions the two would "seize" so hard that they could not safely be separated.

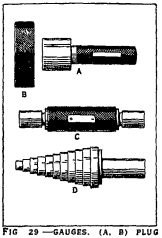


FIG 29 —GAUGES. (A, B) PLUG AND RING. (C) DIFFERENCE, (D) STEPPED REFERENCE

Plug and Ring v. *Horseshoe Gauges.*—The horseshoe, snap or caliper gauges (fig 30) are often used in preference to the plug and ring types.

Limit Gauges.—Some fits have to be what is termed in the shops "driving fits," that is, so tight that they have to be effected by driving with a hammer or a press, while others have to be "working fits," suitable, say, for the revolution of a loose pulley on its shaft or of an axle in its bearings. The "limit" or "difference gauges" (figs. 29 and 30) are designed for producing these working fits; that is, the plug and ring gauges differ in dimensions so that the work bored will drive tightly, or slide freely over the work turned These are variously sub-classified. The system

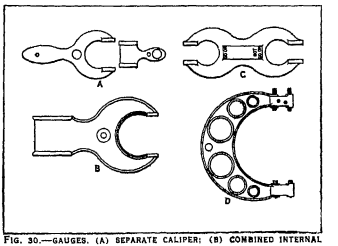


FIG. 30.—GAUGES. (A) SEPARATE CALIPER; (B) COMBINED INTERNAL AND EXTERNAL; (C) DIFFERENCE. (D) NEWALL ADJUSTABLE LIMIT GAUGE

which is generally accepted embraces *force fits*, which require the application of a screw or hydraulic press; *driving fits*, that require less power, as that of a hammer; *push fits*, in which a spindle can be thrust into its hole by hand; and *running fits*, such as that of shafts in bearings. Fixed gauges are made for each of these, but as this involves a heavy outlay there are also adjustable limit gauges (fig. 30, *D*) for external dimensions, the standard plug being used for holes. The setting is done by screwed plugs or anvils adjusted by reference bars. In all these gauges the "go on" and "not go on" ends respectively are stamped on the gauge.

Reference Discs and End Measuring Rods.—Shop working gauges become in time so damaged by service that they fail to measure so accurately as when new. To correct these errors

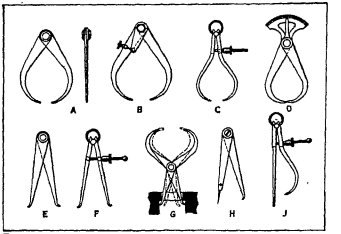


FIG. 31.—CALIPERS: (A) EXTERNAL; (B) TYPE ADJUSTED BY SCREW IN AUXILIARY LEG; (C) SCREW. (D) SELF-REGISTERING; (E) COMMON INTERNAL; (F) SCREW TYPE WITH SPRING; (G) COMBINED INTERNAL AND EXTERNAL; (H) COMPASS; (J) KEYHOLE

reference gauges are provided. These are never used in the shops for actual measurement of work, but are only kept for checking the truth of the working gauges. They include disc,

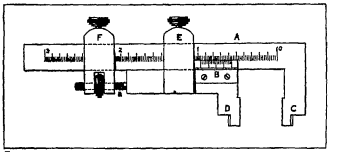


FIG. 32.—VERNIER CALIPER (A) BEAM; (B) VERNIER; (C) FIXED JAW; (D) MOVABLE JAW; (E) CLAMPING HEAD; (F) ABUTMENT HEAD WITH ADJUSTING SCREW, a, FOR ADJUSTMENT OF D

stepped and end measurement gauges. The disc and the stepped are used for testing the ring gauges, the stepped kind comprising essentially a collection of discs in one piece (fig. 29, *D*) The end

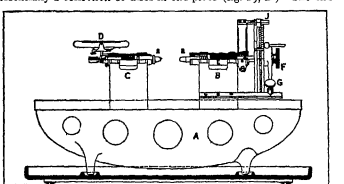
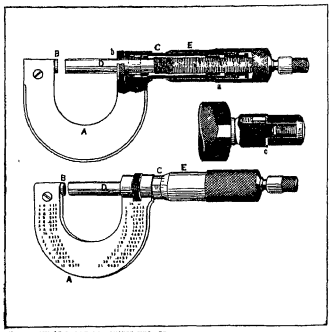


FIG. 33.—MEASURING MACHINE. (A) HOLLOW BASE; (B) MEASURING HEADSTOCK; (C) MOVABLE HEAD. (D) SPIRIT-LEVEL; (E) MEASURING SCREW. (F) NUT FOR ADJUSTMENT OF E; (G) KNOB FOR SLOW MOVEMENT OF E; (J) VERNIER; a, a POINTS BETWEEN WHICH CONTACT IS MADE

measure pieces test the external gauges. Some end measure standard lengths are so accurate that any sizes taken at random in any numbers from $\frac{1}{4}$ in. to 4 in , varying by sixteenths of an inch, will, when placed end to end, make up an exact length.

Movable Gauges.—This extensive group may be regarded as compounded of the common caliper and the Whitworth measuring machine. They are required when precise dimensions have

to be ascertained in whole numbers and minute fractional parts. They combine the sense of touch by contact, as in the calipers, with the exact dimensions obtained by inspection of graduated scales, either the vernier or the micrometer screw If gauges must not vary by more than $\frac{1}{10,000}$ of an inch, which is the limit



BY COURTESY OF BROWN AND SHARPE MFG. CO.

FIG. 34.—MICROMETER CALIPERS (A) FRAMES, (B) ANVIL: (C) HUB, (D) SPINDLE WITH MICROMETER SCREW, (E) THIMBLE, a, ADJUSTING NUTS, b, CLAMPING NUT, c, RATCHET STOP

imposed by modern shop ideals, then instruments must be capable of measuring to finer dimensions than this. Hence, while the coarser classes of micrometers read directly to $\frac{1}{1,000}$ part of an inch, the finest measure up to $\frac{1}{100,000}$ of an inch, about 200 times as fine as the diameter of a human hair.

Calipers.—Common calipers (fig. 31) are adjusted over or within work, and the dimensions are taken therefrom by a rule or a gauge.

Vernier Calipers.—The vernier fitting, so named after its inventor, Pierre Vernier, in 1631, is fitted to numerous calipers and caliper rules. It is applied to calipers for engineers' use to read to $\frac{1}{1,000}$ of an inch without requiring a magnifier. The beam of the caliper is divided into inches and tenths of the inch, and each tenth into fourths and the vernier into twenty-five parts, or the beam is divided into fiftieths of an inch (fig. 32) and the vernier has 20 divisions to 19 on the rule.

Micrometer Calipers are the direct offspring of the Whitworth measuring machine. In the original form of this machine a screw of 20 threads to the inch, turned by a worm-wheel of 200 teeth and single-threaded worm, had a wheel on the axis of the worm with 250 divisions on its circumference, so that an adjustment of $\frac{1}{1,000,000}$ of an inch was possible. The costly measuring machines made to-day have a dividing wheel on the screw, but they combine modifications to ensure freedom from error, the fruits of prolonged experience. Such machines (fig. 33) are used for testing purposes; but there are immense numbers of small Instruments, the micrometer calipers (fig. 34), made for general shop use, measuring directly to $\frac{1}{1,000}$ of an inch, and in the hands of careful men easily to half and quarter thousandths. In these the subdivision of the turns of the screw is effected by circular graduations. Usually the screw pitch is 40 to the inch, and the circular divisions number 25, so that a movement of one division indicates that the screw has been advanced $\frac{1}{40}$ of $\frac{1}{25}$ or $\frac{1}{1,000}$ of an inch. Provision for correcting or taking up the effects of wear is included in these designs (*e.g.*, at *a* in fig 34), and varies with different manufacturers A vernier is sometimes fitted in addition, in very high class instruments, to the circular divisions, so that readings of ten thousandths of an inch can be taken. Beam micrometer calipers (fig 35) take several inches in length, the micrometer being reserved for fractional parts of the inch only

Depth and Rod Gauges.—It is often necessary to measure the depth of one portion of a piece of work below another part, or the height of one portion relatively to a lower one To hold a rule perpendicularly and take a sight is not an accurate method, because the same objections apply to this as to rule measurement

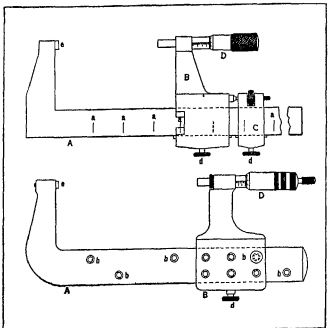


FIG 35.—BEAM MICROMETER CALIPERS (A) BEAM, (B) HEAD, ADJUSTABLE BY EQUAL INCH DIVISIONS, BY LINES a, a, OR HOLES b, b, AND PLUG HOLES; (C) ABUTMENT BLOCK WITH SCREW c FOR FINE ADJUSTMENT, d, CLAMPING SCREWS, (D) MICROMETER, e, ANVIL

in general There are many depth gauges made with rule divisions simply. These have the marked advantage of a shouldered face which rests upon the upper portion of the work, from which the rule measurement is taken (fig 36) These generally have

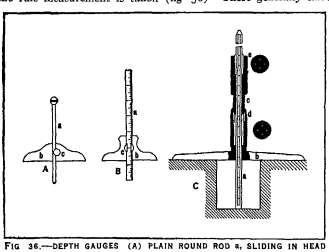


FIG 36.—DEPTH GAUGES (A) PLAIN ROUND ROD a, SLIDING IN HEAD b, AND PINCHED WITH SCREW c; (B) GRADUATED RULE a, SLIDING ON HEAD b, IN GROOVED HEAD OF CLAMPING SCREW c; (C) SLOCOMB DEPTH GAUGE, FITTED WITH MICROMETER, a ROD, SLIDING IN HEAD, b, c HUB, d THIMBLE CORRESPONDING WITH SIMILAR DIVIDED PARTS IN MICROMETER CALIPERS, e CLAMPING SCREW

a clamping arrangement. For very accurate work either the vernier or the micrometer fitting is applied For larger diameters are the rod gauges (fig. 37) to which the micrometer is fitted

Screw Thread Gauges.—The taking of linear dimensions, though provided for so admirably by the systems of gauging just discussed, does not cover the important section of screw measurement This is a department of the highest importance. In most English shops the only test to-day of the size of a screw or nut

Is the use of a standard screw or a standard nut. This method may suffice in many classes of work, but it is utterly unsuited to an interchangeable system; and when there is a fair amount of the latter firms sometimes make thread gauges of their own, in general form like the plug and ring gauges, using a hard quality of steel for small sizes or a tough quality of cast iron for the larger These, though not hardened, will endure for a long time if treated carefully, but though very useful and far better than none at all they lack two essentials They are simply accommo-

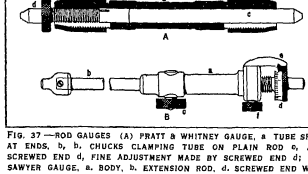
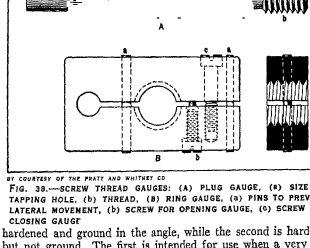


FIG. 37.—ROD GAUGES (A) PRATT & WHITNEY GAUGE, a TUBE SPLIT AT ENDS, b, b, CHUCKS CLAMPING TUBE ON PLAIN ROD c, AND SCREWED END d, FINE ADJUSTMENT MADE BY SCREWED END d; (B) SAWYER GAUGE, a, BODY, b, EXTENSION ROD, d, SCREWED END WITH GRADUATED HEAD, e READING ARM EXTENDING FROM BODY OVER GRADUATIONS, f, CLAMPING SCREW

dation gauges, made to an existing tap or die, and do not therefore embody any precise absolute measurement, nor do they include any means for measuring variations from standard, nor are they hardened The essence of a screw gauge is that it measures the sides of the threads without risk of a possible false reading due to contact on the bottom or top of the V This is fulfilled by flatting the top and making the bottom of the gauge keen Some gauges are made as a plug and ring (fig. 38), the plug being solid and the ring capable of precise adjustment round it There is a plain round end, ground and lapped exactly to the standard size of the bottom of the thread, a dimension which is obliterated in the threaded end because of the bottoms of the angles being made keen for clearance There are three kinds of this class of gauge made, the first and most expensive is



BY COURTESY OF THE PRATT AND WHITNEY CO

FIG. 38.—SCREW THREAD GAUGES: (A) PLUG GAUGE, (a) SIZE OF TAPPING HOLE, (b) THREAD, (B) RING GAUGE, (a) PINS TO PREVENT LATERAL MOVEMENT, (b) SCREW FOR OPENING GAUGE, (c) SCREW FOR CLOSING GAUGE

hardened and ground in the angle, while the second is hardened but not ground. The first is intended for use when a very perfect gauge is required, the second for ordinary shop usage. The third is made unhardened for purposes of reference simply, and it is not brought into contact with the work to be tested at all, but measurements are taken by calipers; in every detail it represents the standard threads An appliance of quite a different character is a micrometer caliper having a fixed V and a movable point between which the screw to be measured is embraced.

Indicators are a small group of measuring instruments of a rather peculiar character. They magnify the most minute error by adaptations of long and short lever arms Some simply magnify inaccuracy, but in one type an index reads to thousandths of an inch (fig. 39) They are used in some lathe chuck work, but their principal value is in fitting and erecting the finer mechanisms

Surface Plates and Cognate Forms.—Allied to the gauges are the instruments for testing the truth of plane surfaces. the sur-

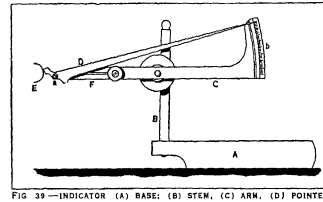


FIG. 39.—INDICATOR (A) BASE; (B) STEM, (C) ARM, (D) POINTER, PIVOTED AT a, AND MAGNIFYING MOVEMENT OF THE WORK E UPON THE SCALE b, (F) SPRING TO RETURN "D" TO ZERO

face plates, straight-edges and winding strips. The origination of plane surfaces by scraping, until the mutual coincidence of three plates is secured, was due to Whitworth. These surface plates (fig. 40, *A*) fill an important place in workshop practice, since in the best work plane surfaces are tested on them and corrected by scraping To a large extent the precision grinding

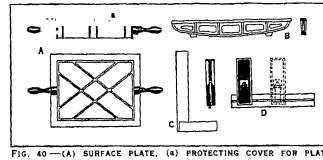


FIG. 40.—(A) SURFACE PLATE, (a) PROTECTING COVER FOR PLATE WHEN NOT IN USE, (B) LARGE RIBBED STRAIGHT-EDGE; (C) SQUARE; (D) SQUARE WITH ADJUSTABLE BLADE

machines have lessened the value of scraping, but it is still retained for machine slides and other work of a similar class. In the shops there are two classes of surface plates. those employed daily about the shops, the accuracy of which becomes impaired in time, and the standard plate or plates employed for test and correction. Straight-edges are derived from the surface plates, or may be originated like them. The largest are made of cast iron, ribbed and curved on one edge, to prevent flexure, and provided with feet (fig. 40, *B*) The smaller straight-edges are generally parallel, and a similar pair constitutes "winding strips," by which any twist or departure from a plane surface is detected Squares, of which there are numerous designs (fig. 40, *C* and *D*), are straight-edges set at right angles Bevels or bevel-squares (fig 41), are straight-edges comprising a stock and a blade, which are adjustable for angle in relation to each other. Shop protractors often include a blade adjustable for angle, forming a bevel with graduations. Spirit-levels test the horizontal truth of surfaces. Many levels have two bubble tubes at right angles with each other, one of which tests the truth of vertical faces. Generally levels have flat

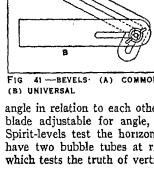


FIG 41.—BEVELS: (A) COMMON, (B) UNIVERSAL

feet, but some are made of **V**-section to fit over shafting The common plumb-bob is in frequent use for locating the vertical position of centres not in the same horizontal plane When a plumb-bob is combined with a parallel straight-edge the term plumb-rule is applied. It tests the truth of vertical surface more accurately than a spirit-level

(J G Ho)

TOOLE, JOHN LAWRENCE (1832–1906), English actor, was born in London on March 12, 1832 He was educated at the City of London School He definitely took to the stage in 1852, appearing in Dublin as Simmons in *The Spitalfields Weaver* In 1854 he made his first professional appearance in London at the St James's theatre, acting Samuel Pepys in *The King's Rival* and Weszel in *My Friend the Major* In 1857, he met Henry Irving in Edinburgh, and recommended him to go to London; and their friendship remained thenceforth of the closest kind. In 1858 Toole joined Webster at the Adelphi, and established his popularity as a comedian.

In 1868 he was engaged at the Gaiety, appearing among other pieces in *Thespis*, the first Gilbert and Sullivan collaboration

In 1879 he took the "Folly" theatre in London, which he renamed "Toole's" in 1882. He died July 30, 1906

TOOL STEEL. This term includes steels used for machine tools, hand tools and cutlery. Prior to 1870 these were exclusively high carbon steels made by crucible or cementation process, since then alloy steels have been introduced for cutting metals. Plain carbon steels of high quality are still pre-eminent for wood working, stone cutting and cutlery The amount of carbon ranges from 0·60 to 1·30% the lower carbon content giving a moderate hardness but great toughness Sledges, chisels, picks, rock drills, axes, woodworking tools, files, cutlery and razors, each item needs greater and greater hardness and more ability to maintain a cutting edge, with toughness progressively less important as the carbon content increases

With carbon steels, if worked at high rates of speed, the friction between chip and tool-nose generates enough heat to "draw the temper" of the tool; that is, to soften it to a lesser hardness than the material being cut. This is avoided by using special alloys that temper very slowly, retain their hardness at high heats, or are intrinsically hard and require no heat treatment. Mushet steel (*q v.*) is of the first category, and was introduced about 1870. High speed steel (*q v*), which has the property of hardness at a red heat, is now widely used in machine shops for mass production of iron and steel parts. Stellite (although really not a steel) is an example of the third class of hard tool material Another material of the greatest hardness, introduced in 1928, is an alloy of tungsten carbide with up to 12% cobalt, that has already proven very useful for tough or abrasive substances like aluminium bronze, Hadfield's manganese steel and non-metallic electrical insulation.

Carbon steels owe their hardness after quenching to submicroscopic particles of hard iron carbide cemented together with the softer ferrite (pure iron) Mushet found that the metals tungsten and chromium combined with high-carbon steel slowed down the softening reactions, so that a drastic quenching from a high heat was unnecessary In 1900, Taylor and White disclosed the fact that, if Mushet's air-hardening tungsten-chromium steels were cooled from a sweating temperature and then tempered at a high heat, they would retain their hardness at a red heat Progress since then has come in working out the optimum composition in tungsten, chromium, carbon, and vanadium Recently a satisfactory variant where most of the tungsten is replaced by cheaper molybdenum has been promoted as a "strategic" material in countries lacking ample supplies of tungsten The revolution in machine shop practice was primarily due to the hardening and stabilizing effect of tungsten, chromium, and iron carbides in tool steel More recently the addition of the metal cobalt in amounts up to 15% has been found to give a more durable cutting edge at a red heat Meanwhile Elwood Haynes had discovered stellite, a family of alloys essentially of tungsten, chromium and cobalt This alloy soon established itself for machining hard cast iron ("semi-steel") and for rough turning medium steels. Variants of the composition have been used for wire-drawing dies. But this swing to hard *metals* seems to be a passing phase. The newest tool material is a hard carbide of tungsten with a softer cobalt metal as a binder. Developed in Germany in 1926 this was marketed as "Widia"; in America a well-known brand is called "Carboloy" Chemical compositions of commonly used American tool steels are within the ranges shown in table below *See* IRON AND STEEL

(E. E T.)

TOOMBS, ROBERT (1810–1885), American political leader, was born near Washington, Wilkes county, Ga, on July 2, 1810. He was educated at Franklin college (University of Georgia), at Union college, Schenectady (N Y.), from which he graduated in 1828, and at the law school of the University of Virginia. He was admitted to the bar in 1830, served in the Georgia House of Representatives (1838, 1840–41 and 1843–44), in the U S House of Representatives (1845–53), and in the United States Senate (1853–61) He supported the Compromise Measures of 1850, denounced the Nashville Convention, opposed the secessionists in Georgia, and helped frame the Georgia platform (1850). He and the Southern Unionists thought secession not wrong but inexpedient. When the Whig party dissolved, Toombs went over to the Democrats. He favoured the Kansas-Nebraska Bill, the admission of Kansas under the Lecompton Constitution, the English Bill (1858), and June 24, 1856, introduced in the Senate the Toombs Bill, which proposed a constitutional convention in Kansas under conditions, acknowledged by anti-slavery leaders as fair and marking the greatest concessions by the pro-slavery senators during the Kansas struggle. The failure of the bill to provide for the submission of the constitution to popular vote was the crux of the Lecompton struggle (*see* KANSAS). On December 22nd after the election of Lincoln, he sent a telegram to Georgia which urged "secession by the 4th of March next."

With Governor Joseph E Brown he led the fight for secession against Stephens and Herschel V Johnson (1812–80). His influence induced the "old-line Whigs" to support immediate seces-

	Carbon	Silicon	Manganese	Chromium	Tungsten	Vanadium
Sledges and Hammers	0·60 to 0·70	0·25 to 0·30	0·25 to 0·35	All alloy metals (except perhaps a little vanadium and chromium) should be excluded		
Pneumatic Tools	0·80 to 0·90	0·10 to 0·40	0·25 to 0·35			
Keen Edged Tools	1·1 to 1·3	0·10	0·10 to 0·20			
Non-deforming (Gauges)	0·85 to 1·00	0·40 max.	1·0 to 1·75	0·50 to 1·00	0·40 to 0·50	0·10 to 0·25
Oil-hardening Steels						
"Finishing Steels"	1·1 to 1·25	0·20 to 0·40	0·20 to 0·35	0·40 to 0·50	1·5 to 2·5	0·10 to 0·25
"Fast Finishing Steel" (Mushet)	1·2 to 1·3	0·20 to 0·40	0·20 to 0·35	1·0	4·0 to 6·0	
Battering Tools	0·35 to 0·55	0·30 max.	0·20 to 0·30	1·0	2·0 to 2·3	0·20 to 0·30
Cold Chisels	0·50 to 0·60	2·0	0·75	0·25	0·50 Molyb.	0 to 0·25
Hot-Working Dies	0·30 to 0·35	0·30 max.	0·20 max.	3·2 to 3·4	9·5 to 10·5	0·40 to 0·50
Cold Drawing Dies	2·1 to 2·5	0·35 max.	0·50 max	12·0 to 14·0		
Die Casting Dies	0·40 to 0·50	0·5	0·5	6·50 to 7·50	6·50 to 7·50	0·20 to 0·60
High Speed Steel (High Tungsten)	0·65 to 0·70	0·25 to 0·30	0·25 to 0·30	4·0	18·0	0·80 min.
High Speed Steel (Low Tungsten)	0·60 to 0·75	0·25	0·25	4·0 to 4·5	14·0	1·6 to 2·0
High Speed Steel (Cobalt Bearing)	0·65 to 0·80	0·25	0·25	4·0	18·0	1·0 Cobalt, 4·0 to 5·0
High Speed Steel (Molybdenum)	0·60 to 0·85			3·50 to 4·50	1·0 to 2·5	0·75 to 1·25 Molyb. 6·0 to 8·0

sion He was secretary of State in President Davis' cabinet, and then entered the army (July 21, 1861), served as a brigadier-general in the army of Northern Virginia, after 1863 as adjutant and inspector-general of General G. W. Smith's division of Georgia militia. After two years in exile in Cuba, France and England, he returned to Georgia, 1867, and practised law. He died in Washington (Georgia), on December 15, 1885.

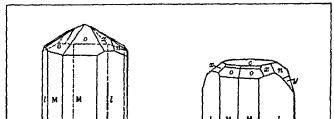
See Pleasant A. Stovall, *Robert Toombs, Statesman, Speaker, Soldier, Sage* (New York, 1892); "Robert Toombs," *Watson's Jeffersonian Mag.* (1912); Gamaliel Bradford, "Confederate Portraits," *Atlantic Monthly* (1913); U. B. Phillips, *Life of Robert Toombs*; "Robert Toombs," a review, *Nation*, vol. 54; *Atlantic Monthly*, Aug 1913, *American Hist. Rev*, June 1914; W. P. Trent, *Southern Statesmen of the Old Régime*; James U. Vincent, *A Pen-picture of G. R. Toombs*; A. H. Stephens and H. Cobb, *Correspondence of Robert Toombs*; B. J. Kendric, "Toombs and Stevens," *Pol. Sci Quarterly*, Sept. 1914.

TOOTHWORT, the popular name for a small British plant of curious form and growth, known botanically as *Lathraea squamaria* (family Orobanchaceae). It grows parasitically on roots, chiefly of hazel, in shady places such as hedge sides. It consists of a branched whitish underground stem closely covered with thick fleshy colourless leaves, which are bent over so as to hide the under surface; irregular cavities communicating with the exterior are formed in the thickness of the leaf. On the inner wall of these chambers are stalked hairs. The only portions that appear above ground are the short flower-bearing shoots, which bear a spike of two-lipped dull purple flowers. The scales which represent the leaves secrete water. *Lathraea* is closely allied to broomrapes (*Orobanche*), of which seven species occur in Great Britain; they also are parasitic. In the United States various species of *Dentaria*, family Cruciferae, are called toothwort.

TOOWOOMBA, a city in the southeast of Queensland, Australia, at an altitude of nearly 2,000 ft. on the Darling Downs, 101 mi. by rail west of Brisbane. It is an industrial centre, pop. (1933) 26,423. It is a summer resort ("The Garden City of Queensland"), on the main Southern and Western Railway lines which connect it with Brisbane and Sydney, and it is also a centre of radiating lines which concentrate upon it much of the agricultural and pastoral produce of the Darling Downs, besides timber, and the wheat, fruit and pastoral products of the Roma (*q.v.*) and Charleville areas. There are butter and cheese factories, engineering works and coal mines in the Toowoomba region.

TOP (*cf.* Dan. *top*, Ger. *Topf*, also meaning pot), a toy having a body of conical, circular or oval shape with a point or peg on which it turns or is made to whirl. Greek terms for the toy are *βέμβιξ*, which was evidently the whipping or peg-top (Arist. *Birds*, 1461), and *στρόβιλος*, a humming top, spun by a string (Plato, *Rep.* iv. 436 E.). In Homer (*Il.* xiv. 413) the word *στρόμβος* seems to point to the humming top. The Latin name for the top was *turbo*. This word and the Greek *βόμβος* are sometimes translated by "top" when they refer to the instrument used in the Dionysiac mysteries, which, when whirled in the air by a string, made a booming noise. This was no doubt the equivalent of the "bullroarer" (*q.v.*). Strutt (*Games and Pastimes*, 491) says that the top was known in England as early as the 14th century. For scientific properties of the top *see* GYROSCOPE.

TOPAZ, a mineral of some importance as a gemstone, but apparently having no practical application. It usually occurs in association with cassiterite in connection with granitic rocks, and it is thus often a valuable indicator of the presence of tin-ore. It is usually found as bright, well-developed crystals, or as clear water-worn pebbles, though granular masses of topaz-rock are also known. The crystals belong to the orthorhombic system and are usually prismatic in habit, with several dome and pyramid faces (figs. 1 and 2). The prism faces (*M* and *l*) are striated vertically, in contradistinction to quartz in which the prism faces are striated horizontally. Doubly terminated crystals (fig. 1) are extremely rare; usually the crystals are attached at one end in the rock cavities in which they grew, and when detached from the matrix they often break along a flat surface parallel to the basal plane (*c* in fig. 2). This perfect cleavage is a very important character, and enables topaz to be distinguished at sight from other minerals of similar appearance. The cleavage flakes when examined in convergent polarized light show a good biaxial interference-figure. Chemically, topaz is a fluo-silicate of aluminium $(AlF)_2SiO_4$, in which the fluorine is in part replaced isomorphously by hydroxyl, the formula then being $(Al[F,OH])_2SiO_4$. With this range in chemical composition there is a slight variation in the specific gravity (3·574 to 3·523) and in the optical constants



FIGS. 1 AND 2

(refractive indices and optic axial angle), but the difference is of little practical importance.

The crystals are often perfectly colourless and water-clear, but owing to the presence of traces of various colouring matters they may show a wide range of colours—red, yellow, brown, green, blue. Further, it is an interesting fact that some of these colours are by no means stable. The fine brown crystals from pegmatite veins in Transbaikalia, Siberia, and the smaller wine-yellow crystals occurring in rhyolite in Colorado and Utah, fade on exposure to light; and the sherry-yellow crystals from Brazil assume a fine pink colour when they are heated. The deceptive tradenames—"Scotch topaz," "Spanish topaz," or "occidental topaz" for yellow quartz (citrine), and "oriental topaz" for yellow corundum ("yellow sapphire") represent three distinct minerals whose characters and differences are set out in the following table:

	Topaz	Quartz	Corundum
Chem. comp	$(AlF)_2SiO_4$	SiO_2	Al_2O_3
Cryst. system	Orthorhombic	Rhombohedral	Rhombohedral
Specific gravity	3·55	2·65	4·0
Hardness	8	7	9
Optical character	Biaxial positive	Uniaxial positive	Uniaxial negative
Refractive indices	1·61–1·63	1·54–1·55	1·76–1·77

The sherry-yellow crystals of topaz, which in the past have been cut and extensively used in jewellery, are all from the neighbourhood of Ouro Preto, in Brazil, and it is this material that has supplied the pink ("burnt") topaz. Brazil also supplies colourless and pale-blue topaz. Good crystals of pale blue and green colours have come from the Ural Mountains and from Nerchinsk in Siberia. Colourless water-worn crystals and clear pebbles resembling rock-crystal are abundant in the alluvial deposits of tin-ore in Northern Nigeria, and small colourless crystals are well known from the Cornish tin mines. A large rough crystal weighing 137 lb. of opaque topaz, from a felspar quarry in Norway, is shown in the mineral collection of the British Museum (Natural History), with many other interesting crystals from various localities. (L. J. S.)

TOPE, name given to various tumulus-like structures in India, almost always connected with Buddhist shrines or sites and forming, undoubtedly, the most primitive type of Buddhist temple. They are usually built over, enclose one or more relics of Buddha, and consist of a low, vertical, cylindrical wall or drum surmounted by a solid conical mass of carefully built masonry. The most famous of the Indian topes is the largest of a group at Sanchi, which is generally attributed to the time of Asoka (3rd century B.C.). In this the tope proper is surrounded by a circular walk, around which is a richly decorated stone fence, pierced by four lavishly sculptured gateways, the whole designed in forms mani-

festly reminiscent of wooden construction (*See* INDIAN ARCHITECTURE.) The Sanskrit word for a tope, *stupa*, is used generally of various types of sacred Buddhist structures in China, Japan, Java, etc., which all have the common characteristic of being high circular masses of solid masonry. Those of Tibet and China are often remarkable for their fantastic profiles.

TOPEKA, the capital city of Kansas, U.S.A., and the county seat of Shawnee county, on the Kansas river, in the eastern part of the state, near the geographical centre of the United States. It is on federal highways 24, 40 and 75, state highways 4 and 10; and has a municipal airport, served by Trans World, Continental, and Braniff airways.

Topeka is also served by the Missouri Pacific, Rock Island, Union Pacific and the Santa Fe railway systems and is home of the general offices of the Santa Fe Population (1950) 78,791, (1940) 67,833 by federal census.

The city lies on both sides of the river and is laid out on a rectangular plan with wide streets and many trees. City parks cover 342 ac. The Kansas Free fair is held annually in September with an attendance of about 500,000.

The state capitol (built 1866–1903 at a cost of $3,200,589) is in the downtown business district and stands in the centre of landscaped grounds covering four city blocks. The Curry murals are in the rotunda.

Topeka is the home of Washburn Municipal university, founded in 1865 and made a municipal institution in 1941. Museums include Mulvane Art museum on the Washburn campus, galleries of the Topeka Art guild and the museum of the Kansas State Historical society. Eight hospitals serve the city, including the Menninger foundation and the Winter Veterans' Administration hospital.

Chief among Topeka's industries are meat and poultry packing, manufacture of tires and freight cars, printing and publishing, metal working and milling. Industrial pay rolls exceeded $30,000,000 annually at mid-20th century. Bank deposits were $105,973,700 in 1949; assessed valuation, tangible and intangible, in 1950 was $121,738,647.

The name "Topeka" was derived from the Indian language, and, although various interpretations have been used from time to time, the generally accepted version is "Smoky Hill."

The first white settler came in 1852, and in 1854 the site was chosen by a group of antislavery colonists from Lawrence. It was the scene of many riots during the conflict between the abolitionists and the advocates of slavery in the territory (*see* KANSAS). The "Topeka constitution" was framed by a convention there in 1855. In 1856 the Free Soil legislature, meeting there, was dispersed by U.S. troops under orders from Pres. Franklin Pierce. Under the Wyandotte constitution (1859) Topeka was made the temporary seat of government, and in 1861 (when Kansas was admitted to the union) it became the permanent state capital. The city was chartered by the proslavery territorial legislature in 1857.

It became a city of the first class in 1881. It was from Topeka that the Santa Fe company began building a railway westward in 1869, and the establishment there in 1878 of its locomotive and car construction shops was an important factor in the city's development. The population increased rapidly from 759 in 1860 to 5,790 in 1870, 15,452 in 1880 and 31,007 in 1890.

TOPETE, JUAN BAUTISTA (1821–1885), Spanish naval commander and politician, was born in Mexico on May 24, 1821. His father and grandfather were also Spanish admirals. He entered the navy at the age of 17, cut out a Carlist vessel in 1839, became a midshipman at 22, obtained the cross of naval merit for saving the life of a sailor in 1841 and became a lieutenant in 1845. He served on the West Indian station for three years, and was engaged in repressing the slave trade before he was promoted frigate captain in 1857. He was chief of staff to the fleet during the Morocco War, 1859, after which he got the crosses of San Fernando and San Hermenegildo. Having been appointed chief of the Carrara arsenal at Cádiz, he was elected deputy and joined the Union Liberal of O'Donnell and Serrano. He was sent out to the Pacific in command of the frigate "Blanca," and was present at the bombardment of Valparaiso and Callao, where he was badly wounded, and in other engagements of the war against Chile and Peru. On his return to Spain, Topete was made port captain at Cádiz, which enabled him to assume the leadership of the conspiracy in the fleet against the Bourbon monarchy. He sent the steamer "Buenaventura" to the Canary isle for Serrano and the other exiles; and when Prim and Sagasta arrived from Gibraltar, the whole fleet under the influence of Topete took such an attitude that the people, garrison and authorities of Cádiz followed suit. Topete took part in all the acts of the revolutionary government, accepted the post of marine minister, was elected a member of the *cortes* of 1869, supported the pretensions of Montpensier, opposed the election of Amadeus, sat in several cabinets of that king's reign, was prosecuted by the Federal republic of 1873 and again took charge of the marine under Serrano in 1874. After the Restoration Topete for some years held aloof, but finally accepted the presidency of a naval board in 1877, and sat in the Senate as a life peer until his death on Oct. 29, 1885 at Madrid.

TÖPFFER, RODOLPHE (1799–1846), Swiss writer and artist, son of the painter Adam Töpffer, was born at Geneva on Jan. 31, 1799. Abandoning his art studies on account of weak eyesight, he became a teacher, eventually establishing a school of his own (1824), which attracted boys from England and America as well as from other European countries. He was the first to introduce schoolboy tramps in the Alps, and he described these in his *Voyages en Zigzag*, illustrated by clever drawings by himself. From 1833 till his death, on June 8, 1846, he was professor of belles-lettres at the university of Geneva. He wrote various novels and short stories, including the exquisite little masterpiece, *La Bibliothèque de mon Oncle* (1833). His tales were collected under the title *Nouvelles Génevoises* (1841), and several have been translated into English. His series of humorous drawings with explanatory text (*Doctor Festus, Monsieur Vieux-Bois*, etc.), collected under the title of *Histoires en Estampes* (1846–47), were very popular and earned the cordial approbation of Goethe.

See the lives by Relave (1886), A. Blondel (1887) and Glockner (1893). Also E. Rambert, *Écrivains nationaux* (1874), E. Javelle, *Souvenirs d'un altpiniste* (1886; Engl. trans., 1899), and notices in Ste. Beuve's *Causeries du lundi* (1853–62), *Derniers portraits littéraires* (1852) and *Portraits contemporains* (1846).

TOPOLOGY (ANALYSIS SITUS). This is a branch of mathematics, so fundamental in nature that its influence is apparent in practically every field of modern mathematics. Despite its basic character, it lacked full development until the advent of the 20th century, although its roots lie in the 19th-century researches of Bernhard Riemann, Georg Cantor and Henri Poincaré.

Principally because of the geometric aspects of the topological work of Riemann and Poincaré, topology became known as a type of geometry in which the shape and size of configurations are unimportant, the object of study being rather the "connectivity" of a figure. For example, that a circle is round, a triangle has corners or an ellipse is oval are not of interest from a topological point of view; what matters is that each of these figures is so constituted that (1) the omission of a single point leaves each of them connected (in a sense to be made precise below); and that (2) the omission of two points will in each case disconnect the figure. In topology, all such figures—circles, triangles, ellipses, polygons, etc.—are designated by the same term, "simple closed curve." If one imagines a circular figure made of some pliable material being subjected to stretching and bending of any sort, without being torn in the process, then the figure may be said to be unaltered topologically, remaining a simple closed curve throughout the process. Similarly, the surface of a sphere and the surface of a cube are topologically equivalent, but differ from the surface of the anchor ring (torus) in the following manner: if S is the surface of a sphere or cube, then the omission of a simple closed curve in S disconnects S (this is part of the classical Jordan curve theorem); but a simple closed curve on a torus may or may not disconnect it, depending upon the particular simple closed curve chosen. Such properties of curves and surfaces as those exemplified here are topological properties.

The great advances in mathematical research made during the

first few decades of the 20th century were to a rapidly increasing extent made possible by concepts which, while not geometrical in the older sense of the term, are evidently topological in nature In topology itself, a change took place which is evidenced in the dropping of the term "geometrical configuration" and its synonyms in favour of "point set" and ultimately "topological space " The notion of a configuration made up of a finite set of "pieces" such as straight-line intervals, triangles, etc., emphasized in the geometric combinatorial topology (*see* below) of Riemann and Poincaré, gave way to the Cantorian concept of an organization of individual points, the number of points usually being infinite. It became gradually recognized that any collection of things, be it a set of numbers, algebraic entities, functions or even non-mathematical objects, can constitute a topological space in some sense or other, the degree of utility in such an interpretation being dependent upon the number of topological properties exhibited by the collection From this realization stems the fundamental importance of topology, and its use as a tool even in such investigations as those of the foundations of logic. This is not to imply that the older, geometric aspects lost their importance; it is rather the case that along with the rest of the subject their importance was enhanced by the newer concepts.

All that is required of a collection, in order that it may be assigned a topological character, is that it be specified, for each set M of its points, what are the limit points of M; then the collection may be called a topological space The intuitive meaning of this becomes clearer, perhaps, if one returns to the well-known spaces of geometry for an illustration Consider, for instance, the space in which the figures of ordinary plane geometry are imbedded—the Euclidean plane, which we shall denote by E^2. Considering E^2 as a collection of points, we may call a point p of E^2 a "limit point" of a collection, M, of points of E^2 if it is true that every circle with centre p encloses points of M (that are different from p if p happens to belong to the collection M). For example, if M is the set of all points enclosed by a triangle T, then every point of T is a limit point of M; also every point of M is a limit point of M. On the other hand, no point exterior to T is a limit point of M, since each such point can be enclosed in a circle whose interior contains no points of M. In three-dimensional Euclidean space limit points may be defined similarly, but using spheres instead of circles. The intuitive concept underlying the notion of limit point, then, is that of nearness or proximity, a point p being a limit point of a collection of points M if there are points of M as near to p as we please. However, the latter would not be an adequate definition, since in some topological spaces no such notion as distance exists In this manner, however, all the well-known spaces of the classical types of geometry become topological spaces And an important part of topology is devoted to the study of Euclidean spaces and their subsets, as well as their counterparts in more general topological spaces

Point Sets.—Since the configurations of topology are ultimately considered as being types of organizations of their individual points, and consequently called point sets, a few of the terms and some of the symbols of set theory (*see* Logistic) used in topology are given here

The fact that a point p belongs to a point set A may be expressed by the relation $p \in A$, which is read "p is an element (or point) of A." A set which has at least two elements is called "non-degenerate"; but if it has no elements it is called "empty " If the cardinal number of the elements of a set is not greater than that of the infinite set of positive integers, then the set is called "countable " (*See* Number.)

If A and B are two sets, their "sum" or "union" (in set-theoretic symbols $A+B$) is the set which consists of all elements x such that $x \in A$, $x \in B$, or both. The "product" or "intersection" of A and B ($A \cdot B$) is the set which consists of all elements x such that $x \in A$ and $x \in B$. (Thus, if A and B are two non-parallel straight lines in the plane, their product is a set consisting of a single point.) By the "difference," $A-B$, is meant the set of all elements of A that are not in B; in case B is itself part of A, then B is called a "subset" of A and $A-B$ is called the "complement" of B in A. If A and B have no point in common, they are called "disjoint "

Homeomorphism.—A basic notion of topology is that of topological equivalence or homeomorphism, and it is this notion that makes precise the sense in which all circles, triangles, etc., in E^2 are considered topologically to be the same. Suppose that S and T are two collections in which limit points have been specified, hence topological spaces, and that between the points of S and the points of T there exists a one-to-one correspondence such that (1) if in S a point p is a limit point of a point set A, then in T the point q corresponding to p is a limit point of the point set B which corresponds to A; and conversely (2) if in T a point q is a limit point of a point set B, then in S the point p corresponding to q is a limit point of the point set A which corresponds to B, then S and T are called "topologically equivalent," or "homeomorphic," and the one-to-one correspondence just described is called a "homeomorphism" (between S and T).

The "congruences" of elementary plane geometry are particular cases of homeomorphisms, likewise, similar figures are homeomorphic But a homeomorphism is a much larger class of correspondences than these represent. Indeed, we may now define a simple closed curve to be any topological space that is homeomorphic with a circle, and since, in assigning limit points for all subsets of Euclidean space we turn every subset itself into a topological space, this definition enables us to identify those configurations in Euclidean space that are simple closed curves; in particular it is easy to see that every polygon is homeomorphic with a circle, and hence a simple closed curve. And similarly, to take a case in three-dimensional Euclidean space, the surface of a sphere is homeomorphic with the surface of a cube.

Topological Properties.—Any property which is definable in terms of the notion of limit point may be called topological. For example, suppose that A and B are disjoint, nonempty point sets (in a topological space) neither of which contains a limit point of the other; then A and B are called "separated." And if a space is not the sum of separated sets, it is called "connected." The property of being connected is topological and is one of the most fundamental properties in topology All the ordinary configurations of Euclidean geometry are connected. In the second paragraph of this article, property (1) means precisely that the point set which remains when a point is removed from a circle is connected in the sense here defined, and property (2) means that when any two points are removed, the resulting point set is not connected; that is, it is the union of separated sets.

One of the most important statements of topological properties of E^2 is the Jordan curve theorem: if J is a simple closed curve in E^2, then E^2-J is the sum of two separated connected sets A and B such that each point of J is a limit point of both A and B. In this theorem, E^2 may be replaced by S^2, where S^2 denotes any homeomorph of the ordinary spherical surface (*see* items [1], [2], [4, pp 154–155], [5], [15] in bibliography).

Properties which relate a subset of a space to the space are often termed relative For example, a point set M in a space S is called "closed" (relative to S) if it contains all its limit points in S The set M of all points enclosed by a circle C in the plane E^2 is not closed (relative to E^2), but the union of M and C is closed. And a subset of a space S is "open" (relative to S) if its complement in S is closed. Such properties are affected by changes in S; a point set M which is closed in S may fail to be closed if new points are added to S, for example.

Topological properties of spaces form the basic tools and objects of study in topology. Their significance is made clearer by the concept of topological invariant. Suppose R is a class of topological spaces (*see Topological Spaces*, below) and consider properties that have significance for the spaces of R. Any such property which, if it holds for one space S of R, holds for every space of R that is homeomorphic with S, may be called a "topological invariant of S in R." The properties defined above, and, indeed, all topological properties, are topological invariants no matter what the class R of topological spaces may be. However, properties that are invariant in certain classes of spaces may cease to be invariant in larger classes, and sometimes properties are investigated in topology about which it is not known for just how

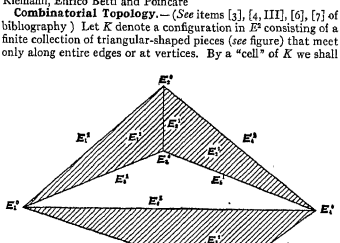
large a class of spaces they are invariant.

An important type of problem in topology is the recognition, by means of topological invariants, of the class of configurations to which a given point set belongs Thus, in E^2, the simple closed curve may be characterized by topological invariants as follows: every nondegenerate point set in E^2 which is (a) connected, (b) closed and (c) has properties (1) and (2) of the second paragraph of this article, is homeomorphic with a circle. Similarly, if in addition to (a) and (b) it is known of a point set in S^2 that the removal of any one of its points, with the possible exception of two, disconnects it, then it must be homeomorphic with a finite closed interval of a straight line (such a point set is called an "arc," the two special points which do not disconnect it being called its "end points").

Some invariants are of a numerical nature Let M be a point set in a topological space and $p \in M$ Then a point x of M may be said to be connected to p in M if some connected subset of M contains both p and x. The set of all points x that are connected to p in M is called a "component" of M; any point of such a component will serve instead of the point p to determine the component. For example, if M consists of two circles having no common point, then M has two components, each of the circles constituting a component The number of components of a point set is an excellent example of a numerical topological invariant. Other numerical invariants will be introduced below.

We now describe some of the aspects of topology that have proved of most importance or that have excited the greatest interest Because of its geometric nature and early development historically, we consider first the topology of polyhedrals, or combinatorial topology, whose beginnings are found in the work of Riemann, Enrico Betti and Poincaré

Combinatorial Topology.—(*See* items [3], [4, III], [6], [7] of bibliography) Let K denote a configuration in E^3 consisting of a finite collection of triangular-shaped pieces (*see* figure) that meet only along entire edges or at vertices. By a "cell" of K we shall



EXAMPLE OF A COMPLEX K

mean either a vertex, an edge or a triangular piece; if we wish to differentiate, we say 0-cell for vertex, 1-cell for edge and 2-cell for a triangular piece. An r-cell ($r=0, 1$ or 2) will be denoted by E_i^r, where i is an enumerative index. Such a figure, made up of cells, is called a "complex."

For each 2-cell E_k^2 there may be written a "bounding relation" of the form $\partial E_k^2 = E_{i1}^1 + E_{i2}^1 + E_{i3}^1$, where E_{i1}^1, E_{i2}^1 and E_{i3}^1 are the edges of E_k^2; thus, in the figure, $\partial E_2^2 = E_3^1 + E_4^1 + E_6^1$. Similar bounding relations may be written for the edges, thus, in the figure $\partial E_6^1 = E_1^0 + E_4^0$. This leads to a consideration of polynomials whose terms are r-cells, such as $E_4^1 + E_6^1 + E_7^1 + E_8^1$ (where the coefficients are all understood to be unity as in ordinary algebra). Such polynomials are called "r-chains" of K, where r is the dimension of the cells involved. In particular the monomial E_i^r is a 2-chain. In the case of the figure, $E_1^1 + E_4^1 + E_6^1$ is called the "boundary-chain" of E_6^2.

The notion of boundary-chain may be extended to arbitrary chains. Thus, if C^{r+1} denotes an $(r+1)$-chain, then the boundary-chain, ∂C^{r+1}, of C^{r+1}, is obtained by selecting those r-cells that are present in the boundary-chains of an odd number of the $(r+1)$-cells of C^{r+1}; or more concisely, by "adding modulo 2" the boundary-chains of these r-cells. For example, the boundary-chain of the chain $E_1^2 + E_2^2$ of the figure is obtained thus: $\partial(E_1^2 + E_2^2) = (E_1^1 + E_2^1 + E_3^1) + (E_2^1 + E_4^1 + E_5^1) = E_1^1 + E_3^1 + E_4^1 + E_5^1$. Similarly, if we denote $E_1^1 + E_3^1 + E_4^1 + E_5^1$ by L^1, then $\partial L^1 = (E_1^0 + E_2^0) + (E_1^0 + E_3^0) + (E_2^0 + E_4^0) + (E_3^0 + E_4^0) = 0$ If the boundary-chain of a chain C^{r+1} is 0, then C^{r+1} is called a "cycle," or an $(r+1)$-cycle; thus, L^1 was just shown to be a 1-cycle, and it may be shown that every such boundary-chain is a 1-cycle. However, usually not every cycle is a boundary-chain; for example, the chains $Z_1 = E_3^1 + E_4^1 + E_6^1$ and $Z_2 = E_1^1 + E_4^1 + E_6^1$ are cycles but are not boundary-chains for the complex K of the figure.

The fact that a cycle Z bounds is expressed by a relation $Z \sim 0$ on K, called a "homology relation," and read "Z is homologous to zero on K." Above, for instance, $L^1 \sim 0$ on K. Since, if cycles bound, their sum must bound, homologies may be added like equations, modulo 2. And a relation $Z_1 + Z_2 \sim 0$ is also written $Z_1 \sim Z_2$; such a relation holds for the cycles Z_1^1 and Z_2^1 defined above for the K of the figure The 1-dimensional "Betti number modulo 2 of K," denoted by $p^1(K,2)$ (or simply p^1 when the modulo 2 algebraic operations are understood to be used without explicit mention), is the greatest number of 1-cycles $Z_1^1, Z_2^1, \ldots, Z_{p^1}^1$ of K that satisfy no homology of the form $a_1 Z_1^1 + \quad + a_i Z_i^1 + \quad + a_{p^1} Z_{p^1}^1 \sim 0$ modulo 2, where the coefficients a_i are all 0 or 1 but not all 0 (we make the convention that $0 \sim 0$). For the figure $p^1 = 1$. It can be shown that p^1 is not dependent upon the manner in which K is fashioned from triangles, so long as the two figures are homeomorphic, the value of p^1 will be the same for both, and may be considered a numerical measure of the "1-dimensional connectivity" of the figure.

The combinatorial method just exemplified may be generalized to figures of any dimension that are made up of a finite number of cells (a 3-cell is a tetrahedron, for instance), and Betti numbers of any dimension r, denoted by p^r, defined The restriction to modulo 2 addition of chains is unnecessary if orientation is introduced: suppose $v_0, \quad, v_i, \ldots, v_r$ are the vertices of an r-cell To a certain order of these vertices, as for instance that just named, we may assign a symbol σ^r, and also allow σ^r to denote any order obtained from this by an even number of transpositions of the vertices (thus, if $\sigma^3 = v_0 v_1 v_2 v_3$, then also $v_1 v_0 v_2 v_3 = \sigma^3$); to the other orderings we assign the symbol $-\sigma^r$. By definition, $\partial\sigma^r = \sum_{i=0}^{r} (-1)^i v_0 \ldots v_{i-1} v_{i+1} \ldots v_r$; thus, $\partial\sigma^r$ takes the form $\sum_{i=0}^{r} (-1)^i \eta^i \sigma_i^{r-1}$, where the η^i's are -1 or 1.

Now let G be any abelian group (for example, the additive set of integers, used by Poincaré, or that of the rational numbers) (*See* GROUPS.) Then for an r-chain over G" of a complex K we may take a polynomial of the form $\sum g^i \sigma_i^r$, where the g^i's are elements of G. Chains are added by adding corresponding coefficients in G, and thereby form a group $C^r(K,G)$ called the "r-dimensional chain group of K over G." For such chains, the boundary $\partial(\sum g^i \sigma_i^r)$ is defined to be $\sum g^i \partial\sigma_i^r$, where by convention $g(-1) = -g$, $g.0 = 0$ (the identity of G), etc. It follows that for every chain c^r, $r > 1$, $\partial(\partial c^r) = 0$, and the boundary of a chain is therefore a cycle. Thus, the boundary-chains form a subgroup of the group of cycles, and if we denote the group of cycles of dimension r by $Z^r(K,G)$ and the group of chains that bound by $B^r(K,G)$, then the factor group $Z^r(K,G)/B^r(K,G)$ is called the rth "homology group (or rth Betti group) of K over G," and is denoted by $H^r(K,G)$; it is a topological invariant of K in the class R of all complexes. If G is the group of integers, I, then the rank of $H^r(K,G)$ is the rth Betti number, $p^r(K,I)$. The orders of finite cyclic subgroups of $H^r(K,I)$ are the so-called "torsion numbers."

In the special case $r=0$, the convention may be made that $\partial\sigma^0 = 0$ for all 0-cells σ^0; in this case p^0 is the number of components of K, thus forming what could be called a measure of the "0-dimensional connectivity" of K. However, frequently the convention is made that $\partial\sigma^0 = \sigma^{-1}$, where σ^{-1} is a unique "ideal" cell which is added to the complex, thereby obtaining the "aug-

mented complex"; in this case p^0+1 is the number of components of K.

One of the most striking relations obtained by the combinatorial method is the Euler-Poincaré formula, which states that for any (nonaugmented) complex K,

$$\Sigma(-1)^r\alpha_r = \Sigma(-1)^r p^r, \qquad (1)$$

where α_r denotes the number of r-cells. When K is an ordinary polyhedral, topologically equivalent to the two-dimensional sphere, $p^0=p^2=1$, $p^1=0$, and relation (1) gives the Euler polyhedral formula $\alpha_0-\alpha_1+\alpha_2=2$.

Applications.—The simplest complex of significance is the "linear graph"; this is the 1-dimensional complex obtained by piecing together straight-line segments. The 0- and 1-cells of the figure form a linear graph, for instance. The linear graph has been applied to the theory of electrical circuits, chemistry (the structure of a molecule may be represented by a linear graph in which the 0-cells denote the respective atoms and the 1-cells denote the bonds joining them), games, many topological problems such as the "four-colour map problem" (*see* items [1], [2] of bibliography), and to many other parts of mathematics. For a linear graph, the Euler-Poincaré formula gives $p^1=\alpha_0-\alpha_1+p^0$; in the case of the linear graph representing a paraffin molecule C_nH_{2n+2}, for example, this formula gives $p^1=0$, so that the configuration contains no simple closed curve (refer to item [8] of bibliography).

In the consideration of solutions of irreducible algebraic equations of the form $f(x,y)=0$ and in certain integration problems, a two-dimensional complex called "manifold" plays a prominent part. Its characteristic feature is that each point is contained in an open set that is homeomorphic with the Euclidean plane. Manifolds of more than two dimensions were studied by Poincaré, who showed that the Betti numbers of an orientable n-dimensional manifold (nonaugmented) satisfy the relations

$$p^r(K,I) = p^{n-r}(K,I), \qquad r=0,1,\ldots,n. \qquad (2)$$

Relation (2) is the so-called "Poincaré duality," and allows of generalization to a certain type of duality between homology groups. In 1923, James W. Alexander stated and proved another type of duality theorem: if S^n is the Euclidean n-sphere (= ordinary n-space with the addition of an ideal "point at infinity"), and K is a point set in S^n which is homeomorphic with some (augmented) complex, then numbers $p^r(S^n-K,2)$ may be defined in a natural fashion for the complement of K in S^n, and the following relation holds:

$$p^r(K,2) = p^{n-r-1}(S^n-K,2), \quad r=0,1,\ldots,n-1. \qquad (3)$$

Relation (3) tells us, for instance, that the complement of every topological image of an $(n-1)$-sphere in S^n has just two components. In the case $n=2$, it readily yields the Jordan curve theorem. Relation (3) may also be extended to a duality between homology groups, and both relations (2) and (3) may be brought within the scope of the same group-theoretic considerations.

Algebraic Topology.—The further development of the combinatorial method leads to a branch of topology that uses algebra to such an extent as to merit the name algebraic topology. The group G used in coefficients of chains may itself be a topological space, such that the group operation and its inverse are continuous therein, and in a natural manner a topology may be introduced into the homology groups. Also, in a manner dual to the procedure for determining the homology group, there may be introduced "cocycles" and "cohomology groups," by using instead of the boundary operator ∂ an operator δ such that, if $\partial\sigma^r=\sum_i \eta_i\sigma_i^{r-1}$, then $\delta\sigma_i^{r-1}=\sum_i \eta_i\sigma_i^r$. These concepts yield important applications to such matters as the duality theorems of Poincaré and Alexander, and are useful in other parts of topology, as for example in the theory of mappings of one space into another. (*See* items [10], [15, III] of bibliography.)

Topological Spaces.—The combinatorial method, as described above, has the obvious drawback that it is limited to configurations formed of cells, and since, ultimately, the configurations of topology are point sets, the problem arises: extend the combinatorial method so that it is applicable to general topological spaces. This problem may be solved in a variety of ways, but first it is desirable to inquire more fully into the concept of a topological space.

It was stated in the introductory remarks above that all that is needed to introduce a topology into a space is that the limit points of point sets be determined, and it was shown how this may be done for ordinary Euclidean spaces and their subsets. But topological spaces are not limited to a Euclidean framework since, as stated above, any collection of objects whatsoever may be converted into a topological space by assigning to each subcollection M the set of its limit points. These assignments are usually made with a definite object in view, such as an application to some particular problem either within or exterior to mathematics, and this ordinarily requires more than the mere assignment of limit points for the various point sets. Consequently in practice the term "topological space" is usually applied to a concept slightly more restricted than that indicated above, the particular concept to be employed being set forth in axiomatic form as a rule. (*See* items [3], [4], [5], [10], [11], [12], [13], [14], [15], [19, I] of bibliography.) Some of the more important types of topological spaces are described below.

Hausdorff Spaces.—One of the favourite methods of giving the topological character of a space is by specification of its open sets. From this point of view, if E is any collection of things whatsoever, and one specifies quite arbitrarily that certain subsets of E are to be "open," in such a manner however that (1) E itself is open, and the empty set is open; (2) if A and B are open sets, then $A\cdot B$ is open; (3) the sum of any number of open sets is open; then in E one has one of the most commonly employed types of topological space. A point p of E is a limit point of a subset M of E if every open set which contains p also contains at least one point of M distinct from p (compare the definition given for limit point in E^2 in the fourth paragraph of this article). If to the axioms just given one adds (4) if p and q are distinct points of E, then there exist disjoint open sets P and Q containing p and q respectively; then the combined set (1)–(4) characterizes the so-called Hausdorff topological spaces. For example, if one calls the interior of each circle in E^2 an open set, and also calls open every set obtained by taking sums (finite and infinite) of these, then the plane becomes a Hausdorff space.

Metric Spaces.—The Euclidean spaces are also special cases of the metric spaces: a metric space is a set, S, together with a "distance function" $d(x,y)$ which is defined as a unique real number for each pair of points $x, y \in S$, having the property that (1) $d(x,y)=0$, if and only if x and y are the same points, and (2) for every three points x, y, z of S, distinct or not, $d(x,y) \leqq d(x,z)+d(y,z)$. These requirements imply that $d(x,y)=d(y,x)$ and that $d(x,y)$ is never negative. Condition (2) will be recognized as the "triangle inequality" of plane geometry, where $d(x,y)$ is the usual distance between the points x and y. In a metric space a "spherical neighbourhood" $U(x,r)$, where $x \in S$ and r is a positive real number, is the set of all points y such that $d(x,y)<r$. Thus in E^2 the interiors of circles are spherical neighbourhoods. And if, in a metric space, each spherical neighbourhood is called open, and all sums of spherical neighbourhoods are called open, then the space becomes a Hausdorff space.

in which sense it is a metric space, and secondly as a nonmetric Hausdorff space. Thus, the same collection may be converted into many different topological spaces.)

A variety of solutions may be given of the metrization problem. One such is obtained as follows: if a space S has the property that for arbitrary disjoint closed sets A and B there exist disjoint open sets containing A and B, respectively, then S is called "normal." Using the properties of the distance function, it is not difficult to show that every metric space is normal. If, in the definition of normal, the set A consists of a single point, then the resulting (weaker) property is called "regular." Each of the properties regular, normal, is a strengthening of the axiom (4) used in defining a Hausdorff space. Now if a space contains a countable set, G, of open sets such that every open set in the space is the sum of elements of G, then the space is called "perfectly separable," or said to have a "countable base." A necessary and sufficient condition that a perfectly separable Hausdorff space be metrizable is that it be regular. As a corollary it follows that among the perfectly separable Hausdorff spaces, metrizability is a topological invariant, since regularity is a topological invariant. Thus, although distance itself is not invariant, capability of having a distance function is invariant among such spaces. A property closely related to that of perfect separability is that of separability, a space S being separable if it contains a countable set M such that every point of S is either a point of M or a limit point of M. Every perfectly separable space is separable, and every separable metric space is perfectly separable.

Complete Spaces.—An important class of metric spaces is that of complete spaces. In analogy with the Cauchy sequences of algebra and function theory, a sequence $p_1, p_2, \ldots, p_n, \ldots$ of points of a metric space is said to form a Cauchy sequence if for arbitrary positive number ϵ there exists a number $N(\epsilon)$ such that if m and n are both greater than $N(\epsilon)$, then $d(p_m, p_n) < \epsilon$. A sequence is said to "converge" if there is a point p such that $d(p_n, p)$ approaches zero as n increases, and a metric space in which every Cauchy sequence converges is called "complete." The Euclidean spaces are complete. The set of all single-valued real functions defined over the interval $[o \leqq x \leqq 1]$ forms a complete space in which each function is a point and the distance between two functions f and g is taken to be the least upper bound of the absolute values $|f(x) - g(x)|$. Every metric space is homeomorphic with a subset of some complete space.

Compact Spaces.—If G is a collection of open sets in a space S and S is the sum of the elements of G, then G is said to "cover," or to be a "covering" of S. A "compact" (sometimes called "bicompact") space is a space which has the property that every covering of it by open sets has a finite subset forming a covering. The Euclidean spaces are not compact, but every closed subset lying in a finite portion of such a space is compact. Not all compact spaces are metric; among the compact Hausdorff spaces, metrizability is equivalent to perfect separability (every compact Hausdorff space is normal). A nondegenerate space which is both compact and connected is frequently called a "continuum," and the term "compactum" used to denote a space which is both compact and metric.

Algebraic Methods in Topological Spaces.—The extension of algebraic topology from the type of cell-complex described above to the general topological space may be accomplished in a variety of ways.

In the case of a compactum, the Vietoris homology theory (1927) is applicable (*see* items [4] and [10] of bibliography). The Čech theory (1932) allows greater generality, however, since it utilizes only the open sets of the space and hence is not dependent upon distance, and it gives the same results as the Vietoris theory in the case of a compactum. Consider a compact space S and a covering G of S by a finite set of open sets, $U_1 \ldots U_r$. Then G may be converted into a "complex" in the following manner: the elements U_i are called "o-cells" or "vertices." If $U_{i_0}, U_{i_1}, \ldots, U_{i_r}$ are elements of G which have at least one common point, then the collection $U_{i_0}U_{i_1} \ldots U_{i_r}$ is called an "r-cell"; which may be oriented in terms of its vertices U_i as above. Such a "complex", although insufficient of itself to yield topological properties of the space S, constitutes a sort of approximation to S, and when the set of all such finite coverings is taken into account, relations may be set up between them so as to yield (Čech) homology groups (*see* item [15] in bibliography), cohomology groups and generalizations of other concepts of algebraic topology.

The generalized concepts being defined in terms of open sets are topological invariants. Now the set of points of a polyhedral or cell-complex K, as subset of Euclidean space, forms a compactum S, and the Čech homology groups of S may be shown to be isomorphic with the homology groups of K. Thus, the topological invariance of the latter class of all complexes is proved as a corollary of the invariance of the Čech groups in the class of compacta, and the intuitive justification of the extended algebraic topology established. (The restriction of the Čech theory to compact spaces because of its use of finite coverings is not necessary, inasmuch as with slight modifications it may be successfully applied to more general spaces, as for example to certain types of perfectly separable spaces. Without such modifications, however, the homology groups obtained may not conform to the type of connectivity that the space evidently possesses.)

Product Spaces.—If A and B are any two sets, then the "product set" $A \times B$ is the set of all pairs (a, b) where a and b are elements of A and B, respectively. Let S and T be any two topological spaces. Then by the "product space" of S and T is meant the space obtained from $S \times T$ by letting all products $U \times V$ be open, where U and V are open subsets of S and T, respectively, it is also denoted by the symbol $S \times T$. For example, the product space of two Euclidean straight lines is topologically equivalent to the plane (a fact used in cartesian geometry); if S and T are circles, then $S \times T$ is topologically equivalent to the surface of the anchor ring. Products may also be defined for any number of spaces (*see* item [10] in bibliography). They furnish an excellent source of topological configurations.

Fundamental Group; Homotopy Groups.—(Refer also to item [7], Chap. VII of bibliography; also item [16].) If S and T are topological spaces, then by a "continuous mapping of S into T" is meant a function f which assigns to each point x of S a point $f(x)$ of T, in such a manner that if A is a subset of S with limit point p, then $f(p)$ is a limit point of $f(A)$ in T. It may be symbolized by the expression $f: S \to T$. (If for every $y \in T$ there is at least one $x \in S$ such that $f(x) = y$, then f is called a mapping of S onto T.) Two such mappings, f and g, are called "homotopic" if there exists a mapping (we omit the descriptive "continuous" hereafter) $h: S \times R \to T$, where R is the real number interval $o \leqq x \leqq 1$, such that $h(x, o) = f(x)$ and $h(x, 1) = g(x)$ for every x in S. (Intuitively, this means that the images of the two mappings in T can be continuously deformed into each other in T.) The possible mappings of S into T may then be gathered into classes, the so-called "homotopy classes," each class consisting of mappings that are homotopic to each other. A central problem of the theory of homotopy classes is to determine the homotopy classes of mappings of S into T in terms of invariants of S and T.

An important application is that of the "homotopy groups." Let S^1 be a circle and T be any topological space such that each pair of points of T are the end points of at least one arc of T. Let p and q be points of S^1 and T, respectively, and consider the collection of all mappings $f: S^1 \to T$ such that $f(p) = q$. These may be decomposed into homotopy classes, with the stipulation, however, that q remains fixed throughout homotopies, and these classes form the elements of the "fundamental group" of T. In this group the identity is the class containing the mapping $f: S^1 \to q$. The group operation, $\times$, is defined as follows: If F and G are homotopy classes, let $f \in F$, $g \in G$. Let x be a point of S^1 distinct from p and let A, B denote the arcs of S^1 having p and x as end points. Since the arc B is contractible on S^1 into the point p, f is homotopic to a mapping $f_1: S^1 \to T$ which maps all of B into q; and similarly g is homotopic to a mapping $g_1: S^1 \to T$ which maps A into q. Let h be the mapping of S^1 which on A agrees

with f_1 and on B agrees with g_1. Then if H is the homotopy class containing h, by definition $F \times G = H$.

The fundamental group is the 1-dimensional case of the n-dimensional homotopy group $\pi_n(T)$, which is defined similarly, and which for $n > 1$ is abelian (*see* GROUPS), in contrast to the usual nonabelian character of $\pi_1(T)$. There exist close relationships between the homotopy groups and the homology groups of certain spaces. Another important set of homotopy classes is obtained through reversing the above procedure and considering the mappings of form $f \cdot T \to S^n$. Here again there are important relations to the homology groups

Continuous Curves (Peano Spaces).—The concept of a mapping of one space into another has proved one of the most important tools in topology, leading to numerous important invariants, such as the homotopy classes, as well as to many interesting problems (*see* bibliography items [5], [16], [17]). One of the most widely investigated types of topological spaces is obtained by mappings of the real number interval R; more precisely, if P is a Hausdorff space, and there exists a mapping $f \cdot R \to P$ which is onto, then P is called a "continuous curve" or "Peano space." Such spaces form a much larger class than one might at first suspect; for instance, a circle together with its interior in E^2 is a Peano space (the latter name has its origin in the fact that the Italian mathematician and logician Giuseppe Peano was the first to prove [1890] the statement just made). The Euclidean 2-sphere, S^2, is completely characterized among the Peano spaces by the Jordan curve theorem: a necessary and sufficient condition that a space S be homeomorphic with S^2 is that it be a Peano space which contains at least one simple closed curve, and in which the Jordan curve theorem holds.

The investigation of the topological properties of Peano spaces forms an aesthetically satisfying and fruitful department of topology (*see* bibliography items [4], [5], [12, ii], [13], [15, III]). The first successful characterization of them in terms of intrinsic topological invariants utilized the property of local connectedness: a space S is called "locally connected" if, given $x \in S$ and an open set U containing x, there exists a connected open set V containing x and lying in U. A Peano space is characterized by the fact that it is a metric continuum which is locally connected.

The significance of local connectedness is made evident by an example of a continuum that is not locally connected: in the xy-plane of analytic geometry (q.v.), let L denote the set of all points on the x-axis such that $0 \leqq x \leqq 1$, and H the set of all points on the y-axis such that $0 < y \leqq 1$. Let p_n denote the point $(1/n, 0)$ for each positive integer n, and let H_n be the set of all points on the vertical through p_n such that $0 < y \leqq 1$ Then if M is the sum of all the sets L, H, H_n, the set M is a metric continuum which is not locally connected at any point of H.

Once such a topological characterization of Peano spaces is obtained, it becomes relatively easy to pass to other such characterizations. For example, a necessary and sufficient condition that a metric continuum be a Peano space is that the components of the open sets be open. (It will be noted in the example above that the component H of $M - L$ is not open.) An important property of Peano spaces is that every two points may be joined by an arc of the space—a property that may be expressed by the phrase "arcwise connected." The possession of this property is not enough to make a metric continuum a Peano space (cf the above example). However, a necessary and sufficient condition that a metric continuum M be a Peano space is that every component of an open set be arcwise connected. (In the example above, the set $M - p$, where p is originally the point $(0, 0)$, is open and connected, but not arcwise connected.) Using such characterizations, it is usually easy to determine of a given configuration whether or not it is a Peano space.

The linear graph finds a natural generalization in the "dendrite," which is by definition a Peano space that contains no simple closed curve. Every connected linear graph is a dendrite, but there exist dendrites that cannot be decomposed into a finite set of vertices and 1-cells. The structure of the higher dimensional Peano spaces, while exhibiting a large number of interesting properties, may be rendered more attractive from a geometrical point of view by the imposition of local connectedness properties of higher dimensions. The local connectedness described above is then the 0-dimensional case of an n-dimensional type of local connectedness in which the Čech homology theory plays a part; specifically, given $x \in S$ and an open set U containing x, there exists an open set V containing x and lying in U such that every Čech cycle on a compact subset of V bounds on a compact subset of U. Peano spaces that are locally connected in this sense for all dimensions up to and including a given positive integer exhibit properties of which the corresponding properties of Peano spaces are the 0-dimensional cases, and in structure they begin to approximate the n-dimensional manifolds mentioned in the description of the combinatorial method (Refer to item [15] in bibliography)

Fixed Points.—Consider a mapping of type $f \cdot S \to S$. If x is a point of S such that $f(x) = x$, then x is called a "fixed point" of the mapping f. For example, using the homology theory it is not difficult to show that if D is a circular disk, then every mapping $f \cdot D \to D$ has a fixed point; and more generally, if E^n is an n-cell, then every mapping $f \cdot E^n \to E^n$ has a fixed point Similarly, every mapping of a dendrite into itself has a fixed point. Theorems on the existence of fixed points have many applications in mathematics and mechanics. (For further details *see* bibliography items [10], [18].)

Dimension Theory.—(Refer also to items [12, i], [17] in the bibliography.) One of the most important contributions made by topology is embodied in solutions of the ancient problem concerning the nature of dimension. One may expect of such a concept that it will: (1) assign to each space a unique integer, its "dimension number", that, in particular (2), it will assign to Euclidean n-space the dimension number n; and that (3) if S is a subspace of a larger space T, then the dimension of S will not exceed that of T. For a wide class of spaces, including all of the ordinary spaces of mathematics and physics—indeed, all separable metric spaces—such a dimension concept has been provided. This has been done in a variety of ways, some from the standpoint of pure point set concepts of topology, and some from the standpoint of algebraic topology.

Such a "dimension function," as it might be called, may be exemplified briefly by use of the covering complexes mentioned above. Suppose S is a separable metric space and C is a covering of S by a finite number of open sets. A similar covering C' of S is called a "refinement" of C if each element of C' is contained in an element of C. Then the dimension of S is called "at most n" if every finite covering of S by its open sets has a refinement C' such that the covering complex derived from C' has no r-cells such that $r > n$. The dimension of S is "equal to n" if n is the smallest integer for which the dimension of S is at most n Such a dimension function is a topological invariant and has the required properties (1)–(3) listed above. The following may be cited as examples of some of the interesting theorems of dimension theory: every separable metric space is homeomorphic with a subset of a compactum of the same dimension, and every such space which is of finite dimension n is homeomorphic with a subset of the $(2n+1)$-dimensional Euclidean space.

Applications.—In addition to such applications as have been cited above, mention could be made of a wide variety of special applications to other fields of mathematics, as for instance the proof of the fundamental theorem of algebra (which may be deduced from any of a number of theorems of plane topology); special properties of functions (for example, existence of real continuous functions having no derivative); analytic functions; algebraic geometry; calculus of variations; harmonic integrals; etc In contrast to what is called algebraic topology, there exists a theory of topological algebra (*see* items [19, iii], [23], [24] in bibliography). The theory of topological groups and their applications has been extensively developed (*see* bibliography items [24], [25]).

Topology has also found uses among fields that are not such integral parts of the domain of mathematics proper. Thus, an intimate relation exists between some aspects of topology and symbolic logic (as shown in item [26] of the bibliography). Ap-

plications of fixed point theorems in mechanics have been mentioned above. An approach to certain problems of psychology has been based on the concept of topological space (*see* item [27] of bibliography). Because of its foundation in general set theory, topology is not limited in its applications to problems of a quantitative character, and it may therefore contribute to research in fields, such as the social sciences, that have not been considered susceptible to mathematical treatment.

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(R. L. WI.)

TORADJA, a group of tribes occupying central Celebes, in the Indonesian archipelago. They possess in common a phallic fertility cult and some of them practise terraced cultivation, erect menhirs and bury their dead in rock-cut tombs. They possess, among others, a culture hero who is believed to have introduced the buffalo and to have ascended to heaven by a creeper; they believe in an underground home of the dead, and have a class of male priests who dress in women's clothes, the soul, which is also connected with the sky, takes the form of a manikin, insect, small animal, etc., located in the head, but is also confused with shadow and is in some sense a material substance coextensive with body and liable to impregnate objects (*see* METEMPSYCHOSIS).

See Kruijt, *Het Animisme in den Indischen Archipel*. (1906); Kruijt and Adriani, *De Bare'e—sprekende Toradj's* (1914).

TORBERNITE, a hydrous uranium and copper phosphate, $Cu(UO_2)_2(PO_4)_2.12H_2O$. The water content varies with the temperature and humidity, and is normally less than the formula indicates. When it loses four molecules of water it passes over to metatorbernite, with a change in optical properties. The crystals are tetragonal, thin to thick tabular; also in scaly or foliated aggregates. There is a perfect micaceous cleavage parallel to the base, and on this face the lustre is pearly; otherwise it is vitreous to subadamantine. The bright grass- to emerald-green colour is characteristic. The hardness is 2 to 2.5 and the specific gravity 3.22. It is found in Bohemia and Saxony and is abundant in the Katanga district of the Belgian Congo; the best specimens are from Cornwall. The name torbernite is after Torbern Bergman, a Swedish chemist.

(L. S. RL.)

TORCELLO, an island of Venetia, Italy, in the lagoons, 6 mi. N.W. of Venice. It was a flourishing city in the early middle ages, but now is thinly settled and has two interesting churches (the former cathedral of S. Maria was founded in 641. The present building, a basilica with columns, dates from 864; the nave was restored in 1008, in which year the now ruined octagonal baptistery was built. It contains large mosaics of the 12th century, strongly under Byzantine influence, those on the west wall represent the Resurrection and Last Judgment. The seats for the priests are arranged around the semicircular apse, rising in steps with the bishop's throne in the centre—an arrangement unique in Italy. Close by is S. Fosca (*c.* 1011), octagonal outside, with colonnades on five sides and a rectangular interior intended for a dome which was never executed, beyond which is a three-apsed choir.

See B. Schulz, *Kirchenbauten auf der Insel Torcello* (Berlin and Leipzig, 1927).

TORDENSKJOLD, PEDER (1691–1720), Danish naval hero, son of Jan Wessel of Bergen, in Norway, was born at Trondhjem on Oct. 28, 1691. Wessel ran away from home as a stowaway in a ship bound for Copenhagen, made a voyage to the West Indies, and finally gained a cadetship. In 1712 he was promoted to a 20-gun frigate. Wessel was renowned for his audacity and his unique seamanship. The Great Northern War had now entered upon its later stage, when Sweden, beset on every side, employed its fleet principally to transport troops and stores to its distressed German provinces. The audacity of Wessel impeded it at every point. He was continually snapping up transports, dashing into the fjords where its vessels lay concealed.

When in 1715 the return of Charles XII from Turkey to Stralsund put a new life into the jaded Swedish forces, Wessel fought numerous engagements off the Pomeranian coast, and did the enemy infinite damage by cutting out their frigates and destroying their transports. On returning to Denmark in the beginning of 1716 he was ennobled under the title of "Tordenskjold" (Thundershield). When Charles XII invaded Norway and besieged Fredrikshald (1716) Tordenskjold compelled him to raise the siege and retire to Sweden by pouncing upon the Swedish transport fleet laden with ammunition and other military stores which rode at anchor in the narrow and dangerous strait of Dynekil, utterly destroying the Swedish fleet with little damage to himself. For this, his greatest exploit, he was promoted to the rank of commander.

Tordenskjold's last feat of arms (he was then rear-admiral) was his capture of the Swedish fortress of Marstrand, when he partially destroyed and partially captured the Gothenburg squadron which had so long eluded him. He was rewarded with the rank of vice-admiral. Tordenskjold did not long survive the termination of the war. On Nov. 20, 1720, he was killed in a duel with a Livonian colonel, Jakob Axel Stael von Holstein. Although, Dynekil excepted, Tordenskjold's victories were of far less importance than Hannibal Sehested's at Stralsund and Ulrik Gyldenlöve's at Rügen, he is certainly, after Charles XII, the most heroic figure of the Great Northern War.

See Carstensen and Lütken, *Tordenskjold* (Copenhagen, 1887).

(R. N. B.; X.)

TORENO, JOSÉ MARIA QUEIPO DE LLANO, COUNT OF (1786–1843), Spanish politician and historian, born at Oviedo, Nov. 25, 1786. He saw service in the Peninsular War, was leader of the party which compelled the regency to summon the *Cortes*, and one of the well-meaning men who framed the Constitution of 1812, which was made as if it was meant for some imaginary republic and not for Catholic and monarchical Spain. On Ferdinand VII's return from prison in France in 1814, Toreno exiled himself until 1820; served in the restored *Cortes* until 1823; and lost much of his radical ardour. From 1823 when the French intervened until the amnesty (Oct. 15, 1832), he had to go into exile; he returned home in July 1833, and as hereditary standard bearer of Asturias (Alferez mayor), it fell to him to proclaim the young queen Isabella II. Prime minister in 1834 from June 7–Sept. 14, when the regent's attempt to retain a despotic government under a constitutional veil broke down, he retired into voluntary exile and died in Paris, Sept. 16, 1843.

TORGAU, a town in the Prussian province of Saxony, Germany, on the left bank of the Elbe, 30 mi. E.N.E. of Leipzig and 26 mi. S.E. of Wittenberg by rail. Pop. (1939) 17,936. Torgau is said to have existed as the capital of a distinct principality in the time of the German king Henry I, but early in the 14th century it



PHOTOGRAPH, WIDE WORLD PHOTOS

VIEW OF AN APPROACHING TORNADO

Tornado approaching Vulcan, Alberta, Canada. The destructive power is not in the straight wind, but in the counterclockwise rotating mass which always moves in an easterly, and generally in a north-easterly direction. Barometric pressure in the tornado falls very rapidly, causing houses to blow apart from the outward pressure of the air inside them

TORNADO

TORNADO VIEWED AT AN ANGLE FROM ITS PATH

Side view of a funnel-shaped tornado cloud sweeping in a path 50 yd. wide across the country near Jasper, Minnesota. The tornado pictured here traveled only three miles

was in the possession of the margraves of Meissen and later of the electors of Saxony In 1526 John, elector of Saxony, Philip, landgrave of Hesse, and other Protestant princes formed a league against the Roman Catholics, and the Torgau articles, drawn up there by Martin Luther and his friends in 1530, were the basis of the Confession of Augsburg. Torgau was formally ceded to Prussia in 1815 The Schloss Hartenfels, on an island in the Elbe, was built by John Frederick the Magnanimous, of Saxony.

Battle of Torgau, 1760.—This, the last great battle of Frederick the Great, and the last of his victories, was so truly Pyrrhic that it paralyzed his offensive power and left him in a gravely weakened condition to meet his gathering foes. The battle and the events which rescued him from his critical position are dealt with under SEVEN YEARS' WAR

TORNADO, the violent revolving funnel-cloud of small diameter that is well-known in the United States east of the Rockies, in southern and middle U.S.S R and in southern Australia In West Africa, tornado is the local name for the violent squall that blows out of the front of thunderstorms and dust-storms (equivalent to the *Haboob* of the Anglo-Egyptian Sudan) Less commonly and in less violent form than in the U.S , tornadoes occur in nearly all other parts of Europe and America and locally in Africa and Asia In the United States they are also popularly known as "twisters" or "cyclones." North American tornadoes average 300–400 yd in width, although some extend a mile or more They often form in families of two or more in the same region at the same time. Paths are short, from several to 50 mi , rarely as much as 300 mi. long; in the U.S. they generally run from southwest to northeast at 10–50 mi. per hour

The funnel cloud results from the condensation of moisture through cooling by expansion and lifting of air in the vortex. However, the air for some distance outside the funnel cloud is also part of the vortex, and near the ground this outer ring becomes visibly laden with dust and debris Rotation is counter-clockwise, though a few clockwise cases are known. The wind speed in the vortex has never been measured; but judging from the effects and from theoretical considerations, it is of the order of 100–500 mi. an hour. E. M brooks found that some tornadoes are centred in a larger much weaker cyclone of about 5 mi. radius, which he called "the tornado cyclone." Because of centrifugal effects, very low barometric pressure occurs in the core of the vortex, creating a small "eye" that is clear and nearly calm.

The whirling funnel cloud appears to grow vertically or slantingly down from the base of a dark heavy cloud of the cumulonimbus or thunderstorm type and to reach the ground twisting and bending slowly, the base dragging because of friction. It soon dies out in reverse order.

Many tornadoes may have the base of their funnels elevated 50 to 100 ft. above the ground, in which case they give at the ground only a straight blow of less than 150 mi. per hour The funnels may extend down from as high as 25,000 ft. (as reported in one instance). Rain and hail usually occur just before or after the tornado. There is considerable variation in details of appearance of individual tornadoes.

The minute or so that it takes for the storm to pass results in fantastic destruction. buildings totally flattened, exploded to bits or moved bodily for hundreds of yards, straws driven through posts, other objects left unharmed amid complete wreckage. A safe place during a tornado passage is in a "cyclone cellar" with a stout door, such as provided on many farms in the midwestern United States, or in a low reinforced-concrete building. The roar of the tornado can be heard as far as 25 mi. away.

On the continental plains of North America and the U.S.S R., reaching from polar regions to the tropics, the conditions are especially favourable for tornadoes, and no season is free from them. In spring and summer, however, tornadoes are five times as numerous as in winter and fall. They are more likely to occur by day than by night. The greatest number occur in Iowa and eastern Kansas, where about 15 per 50 sq.mi. occur annually. The centre of maximum frequency moves north and south within the season: in winter near the Gulf coast, in summer over Iowa.

The causes and dynamics of tornadoes are complex and are subjects of much controversy. It is known that nearly all tornadoes (American and Russian at least) form in association with thunderstorms in the vicinity of a "squall line" or a front which is invading a region where a layer of warm dry air overlies moist air This sort of stratification is often rendered unstable by the lifting and convergent effects of a front, but it apparently requires a very special combination of additional circumstances to produce a tornado thereby. Lt Col E J Fawbush and Capt. R. C. Miller of the U.S. air forces discovered that tornadoes in the U S could be forecast with considerable accuracy by a procedure of weather analysis which assumes that if all the following conditions are present tornadoes will form (somewhere within a specified limited area and time):

1 The lower layer of the atmosphere must be moist and surmounted by a deep dry layer.

2. The moist layer must contain a distinct maximum in humidity along a relatively narrow band

3 The winds in the layer 10,000–20,000 ft. MSL must show a maximum of wind speed along a narrow band, and this maximum must exceed 35 knots.

4 The vertical projection (on the surface weather chart) of the axis of the wind-speed maximum aloft must intersect the axis of the moisture band (2, above).

5 Conditional instability must exist in the whole air column (up to 20,000 feet or more)

6. The moist layer must finally be subjected to appreciable lifting (by a front or squall line or by general convergence)

These criteria individually had been cited by earlier writers as important for tornado formation. In 1951 M. Tepper put forward the hypothesis that tornadoes form at the intersection of two pressure-jump lines, where sharp wind shear generates vortices If the lower air is moist and unstable (The pressure-jump in the atmosphere is analogous to the hydraulic-jump in water channels). This principle seemed to explain about half the cases in the U.S., but is open to difficulties and objections. There are indications that in western Europe the tornadoes may be produced by different circumstances than in the U S or the U.S.S R.

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TORNADO AND WINDSTORM INSURANCE. Windstorm damage is one of the major sources of economic loss in many localities. In the United States windstorm insurance should be general and considered an essential form of contingency protection against unavoidable losses inherent to the climate. The policies cover tornado, cyclone and windstorm but do not provide for snow, blizzards, cold or hail even when driven by wind. (*See* INSURANCE: MISCELLANEOUS: *Hail Insurance*) Many forms are issued to cover a great variety of structures, such as "farm form," "builders risk form," "mercantile property form " Rates vary with the kind of property insured, the section of the country in which it is situated, coinsurance and special endorsements. By endorsement the policies may be made to cover use and occupancy.

TORO, a town of Spain, in the province of Zamora, on the right bank of the river Duero (Douro), and on the Zamora-Medina del Campo railway. Pop (1940), 7,881 (mun., 8,346) Toro is an ancient fortified town, with picturesque narrow streets. A fine bridge spans the river. The cathedral church is Romanesque; it dates from the 12th century but has been partially restored. The palace of the marquesses of Santa Cruz was the meeting place of the *Cortes* of 1371, 1442 and 1505, which made Toro and its code of laws celebrated.

TORONTO, the capital of the province of Ontario, and the second largest city in Canada, situated on the northern shore of Lake Ontario, almost due north from the mouth of the Niagara river. It lies on a plateau gradually ascending from the lake shore to an altitude of 300 ft., and covers approximately 40 sq.mi., including the bay and the islands stretching along the south of the city.

The Don river flows through the eastern part of the city, and the Humber river forms its western limit. Pop. (1951) 675,754, with metropolitan area, Greater Toronto 1,117,470.

Toronto, as the seat of government for Ontario, contains the provincial legislative (usually called parliament) buildings in

Queen's park (area 40 ac.) almost in the centre of the city. They are imposing structures of red sandstone; and immediately opposite there is a large and beautiful addition in blue dolomite stone, called the "Whitney block."

The university, with a roll of more than 15,000 students at mid-20th century, is federal in constitution, and is composed mainly of four colleges, though maintaining important university functions conjointly It has conducted important research in problems of health, largely made possible by gifts from the Rockefeller foundation, the E C Whitney bequest, and miscellaneous grants from the federal department of health A special building was devoted, as a branch of the Connaught laboratories, to the study of insulin. A faculty of music, a school of engineering research and a department of social science and administration were organized. There is a university press, and in Hart house and Queen's Park house respectively the men and women students have centres for social and athletic activities. Affiliated with the university are four arts and three theological colleges near by; colleges of veterinary science, pharmacy and art; and the agricultural college at Guelph.

In addition to the university, Toronto has more than 200 other educational institutions Upper Canada college, founded in 1829, in many respects resembles an English public school. There are various collegiate institutes, high schools of commerce, technical schools, about 150 public and separate schools, and several large private schools for girls.

Osgoode hall houses the higher courts of law and appeal, and also a law school The city hall and courthouse contains civic offices, the board of education, police and county courts

There are a number of hospitals, asylums and public homes, including ten public hospitals, the largest of which is the Toronto General hospital in the centre of the city.

Toronto is essentially a residential and widespread city. Lighting is by the publicly owned Hydro Electric Power Commission of Ontario. An electric railway system and motor-bus routes, owned by the city, provide means of communication. On Sept. 6, 1949, the first steps were taken toward the construction of a four-mile subway.

The world-renowned Canadian National exhibition is held each year in the late summer in a 215-ac. exhibition park. Scattered throughout the city are some 100 other parks and public squares with a total area of more than 2,000 ac.

Government and Industries.—The government of the city is vested in a council consisting of the mayor and 4 controllers elected annually, and 18 aldermen, 2 from each of the 9 wards into which the city is divided. The council as a whole is the legislative body, and the board of control is the executive body, and as such is responsible for the administration of the city, except the departments of education and of police. Education is under the control of the board of education elected annually by the citizens, and the department of police is under the board of police commissioners, consisting of the mayor, the county judge and the senior police magistrate.

Because of its geographical position, its cheap electric power and its nearby sources of raw material, Toronto is one of the chief industrial and commercial centres of Canada It is also considered the publishing centre It has 11 mi. of waterfront and the largest vessels of the lakes can use its harbour. In 1927 the magnificent new union station was opened There is an airport on an island in the harbour, but all large planes use Malton airport north of the city

As a manufacturing centre Toronto in 1947 had 3,967 plants employing 173,292 workers and turning out $1,452,117,797 worth of products Nearly 200 British and U.S. firms maintain branch factories in the city and suburbs. Toronto is the financial centre for the mining industries of northern Canada and has the largest mining exchange in the world. (C. Cy)

History.—The name Toronto is of Indian origin, and means "a place of meeting," the site being an established rendezvous among the neighbouring Indian tribes long before the coming of the white man. It first appears in history in 1749 as a centre of trade when the French built a small fort and established a trading post called Fort Rouillé. Before long, however, British traders came up from the south and entered into rivalry with the French, and in 1759 the fort was burned by the latter to prevent its occupation by their foes. A year later John Graves Simcoe, the governor of the new province of Upper Canada, transferred the seat of government from the town of Newark at the mouth of the Niagara river to Toronto, giving the new capital the name of York, in honour of the second son of George III In 1812, the buildings which housed the legislature were burned and the town pillaged After the restoration of peace the work of creating a capital for the province of Upper Canada had to be begun anew. In 1834 its population numbered about 10,000; and an act of the provincial legislature conferred on it a charter of incorporation, with a mayor, aldermen and councilmen Under this charter it was constituted a city with the name of Toronto

TORONTO, a village of Jefferson county, Ohio, U S , on the Ohio river, 40 m. W of Pittsburgh; served by the Pennsylvania railroad, and a bus line and river steamboats. Pop. (1950) 7,253; in 1940, 7,426, in 1930, 7,044 Toronto has a power plant and various manufacturing industries, including steel works, paper mills and factories making sewer pipe, glass and cement block.

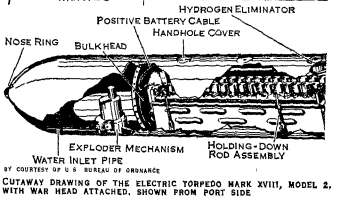
TORPEDOES. The modern torpedo is a highly complicated, underwater projectile with a heavy explosive charge An exploding mechanism causes it to detonate in contact with or proximity to the hulls of ships Self-contained engines drive the torpedo at high speeds, and sensitive instruments control its course. It may be fired or launched by surface craft, aeroplanes or submarines, the fact that it can be launched, make its run and strike with little warning makes it particularly useful by submarines, which can frequently complete and retire from an attack without coming under observation

The term torpedo was first applied to an explosive agent about 1800, but for the next 65 years the torpedo, in all its many experimental forms, was really a type of floating mine. The word itself is derived from the family name for the fish called electric rays, Torpedinidae, which in combination with electric eels have been referred to as torpedoes During the American Revolutionary War, a simple type of floating mine devised by David Bushnell was used to stage an attack on British ships in the Delaware river No damage resulted, but the "Battle of the Kegs" caused the British to remove their ships to safer waters

The inventive mind of Robert Fulton also turned to torpedoes, and on Oct 2, 1804, the British used his catamaran torpedo in an attack against the French fleet at Boulogne Twelve of these devices, floating boxes containing 400 lb. of guncotton and a simple clockwork and flintlock exploder, were turned loose against the French ships, creating great excitement but no damage as they exploded short of their intended targets.

Various kinds of torpedoes were in use during the American Civil War by both union and confederate forces These ranged from beer kegs filled with powder, whose use at Mobile bay was partly responsible for Adm David Farragut's famous words "Damn the torpedoes . . Go ahead!" to an immense electric torpedo whose 2,000 lb. of explosive literally blew the federal gunboat "Commodore Jones" to bits.

The first practical "automobile" torpedo, forerunner of the



BY COURTESY OF U S BUREAU OF ORDNANCE

CUTAWAY DRAWING OF THE ELECTRIC TORPEDO MARK XVIII, MODEL 2, WITH WAR HEAD ATTACHED, SHOWN FROM PORT SIDE

modern type, was perfected by an English engineer, Robert Whitehead, about 1868, under Austrian sponsorship First tested at Fiume, the Whitehead torpedo used all the basic principles of the modern torpedo, including hydrostatic depth control, lateral control, and an engine which drove two contrarotating propellers This was a "cold running" torpedo; the engine was powered by compressed air from a steel flask. The torpedo ran at about seven knots for 700 yd.

Whitehead torpedoes were used by the U S navy during the last decade of the 19th century, by which time their speed had increased to 27 knots, although the range was still less than 1,000 yd In 1901, U S rights to the Whitehead design were purchased by the E W. Bliss company of Brooklyn, N Y , and in 1904 an engineer of that firm, F M Leavitt, designed the Bliss-Leavitt torpedo, which was the first "hot running" model This type featured a combustion chamber in which burning alcohol preheated the air from the flask in which pressure was increased to 2,250 lb per square inch. This innovation increased torpedo range to 4,000 yd.

At this point the effect of torpedoes on naval design must be considered As early as 1877, the mere fact that Russian ships were known to carry torpedoes was enough to make a superior Turkish force keep clear of the Russians off Odessa With increased hitting power, torpedoes became a greater menace to capital ships Because it was impractical to provide heavy ships with more armour to cover their unprotected underwater bodies where a torpedo blast was confined and intensified by the surrounding water, naval designers used double and triple bottoms and highly compartmented hulls Such preservation of water-tight integrity was carried to fine perfection by the Germans in the battleship "Bismarck," which still floated after being repeatedly hit by torpedoes from destroyers and aircraft during a lengthy engagement in May 1941.

An additional result of the increasing use of torpedoes was the introduction of torpedo boats about the time of the Spanish-American War. These small, fast craft were designed to carry torpedoes in attacks against heavier ships; as a defense, larger and faster torpedo-boat destroyers were built. The latter type finally evolved into the destroyer (*q.v.*), whose principal weapon for many years was the torpedo it had first been designed to combat Use of the motor torpedo-boat was discontinued by the U S. navy until World War II.

During the period of development so far discussed, all torpedoes were designed for underwater launching Even battleships carried underwater torpedoes until 1922, when their use was discontinued In 1930, the Bliss company introduced a Mark VI model, designed for above-water launchings; it featured a horizontal type turbine instead of the earlier vertical turbine, was hot running, and had a speed of 35 knots for 2,000 yd. Shortly after, the Mark VII model initiated the feature which, with minor improvements, made that torpedo essentially the same used up to and during World War II; this innovation was the use of fresh water in the combustion chamber where the burning alcohol produced steam which drove the turbines, instead of the hot air previously used. As a result, both speed and range were increased.

Other nations were also busy improving the torpedo; Germany particularly made extensive use of this weapon in World War I by sinking 1,381 merchant ships In World War II the Germans evolved a new model which came close to pushing Allied shipping losses past the recovery point. This was the acoustic torpedo which figured prominently in the battle of the Atlantic until Allied technicians produced a defense against it.

As long as the acoustic torpedo was launched in the general vicinity of a ship or ships, it was almost certain to be attracted by propeller sounds and would then "home" on the source of the sound; that is, the acoustic device acted on the gyroscopic control and steered the torpedo toward the ship whose propellers attracted it This torpedo worked havoc with large convoys, where all that was necessary was to aim it in the general direction of the ships and depend on the acoustic controls to take it to a target.

As the acoustic torpedo did not require high speed to intercept the target, but merely had to top the speed of usually slow-moving ships, it was able to run for a longer period. This ability was capitalized on by setting it to run in a zigzag (the "Wobbly Willie") or spiral course (the "Curley Charley") until it was attracted by a target.

This torpedo was eventually defeated by ships towing a noise-maker which was a better torpedo attraction than the ship itself, around which they circled until they ran down.

Description and Operation.—The torpedo in use by the U S. navy at mid-20th century was made in two sizes Those fired by submarines and destroyers were 21 in. in diameter and 21 ft long; while those fired by torpedoplanes and, during the latter part of World War II by patrol-torpedo boats, were 22½ in. in diameter and 13½ ft long The greater part of the torpedo was a cylindrical steel flask charged with compressed air at pressures up to 3,000 lb per square inch

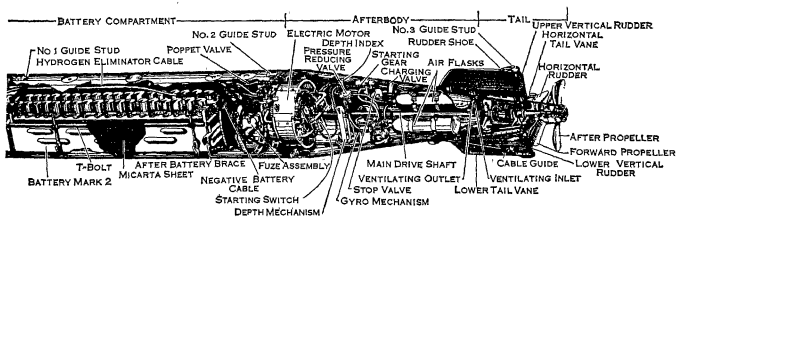
Fastened to the front of the flask is the war head, a pointed nosepiece carrying several hundred pounds of explosives, usually Torpex. Before firing, the torpedo is armed by inserting in the war head an exploder mechanism set to detonate upon coming in contact with any object. Since practice exercises would be impossible with such an arrangement, torpedoes are also fitted with a practice head, giving them the same characteristics of performance when fired, but containing no explosive

Practice torpedoes are always recovered if possible, so the practice head is filled with water which is automatically blown out at the end of the run, thus creating positive buoyancy which brings it to the surface. It also emits a flare or smoke signal to mark its location.

Live torpedoes will sink at the end of their run if unexploded; thus an unsuccessful attack may not be discovered by the enemy. Japanese torpedoes exploded at the end of their run if they failed to hit a target.

At one time Germany employed torpedoes which remained afloat after an uninterrupted run, on the chance that they might be struck later by another ship.

The third section of a torpedo, the afterbody, is fixed to the central air flask at the end opposite the war head and carries the fuel tank and combustion chamber, two high-speed turbines, a



gyroscope and depth-control devices, two contrarotating propellers and two sets of rudders for lateral and vertical control. In the combustion chamber, alcohol and air burning under high pressure combine with water to generate steam which drives the turbines during the course of the run. Turbine power is transmitted to the propellers through two shafts, one rotating inside the other. The gyro, powered by high-speed jets of compressed air from the flask, steers a preselected course while the depth-control gear keeps the torpedo at a level predetermined according to the type of target expected.

In some types of torpedoes, compressed oxygen is used instead of air. Oxygen not only gives the torpedo additional range, but the higher percentage of combustion leaves less waste gas to rise to the surface in the form of bubbles which betray the torpedo by its wake.

The electric torpedo is similar to the steam torpedo in appearance and operation. The air flask is replaced by batteries, and two electric motors or one motor and a set of gears replaces the combustion chamber and turbines in the afterbody. While slower than the steam torpedo and of less range, the electric torpedo possesses one distinct advantage in that it leaves no telltale wake. Also, an additional factor to be considered in the manufacture of torpedoes in large numbers such as were required during World War II, the electric torpedo is cheaper and easier to produce. Control of this type is simplified as there is no progressive change in weight during its run The disadvantage of the electric torpedo lies in its low battery capacity at high usage rate, giving it low range at high speed, and the fact that increasing cold westather cuts down its efficiency of operation.

The average effective range of a steam torpedo at mid-20th century was 4,500 yd at 45 knots, this increased to 15,000 yd at 30 knots The electric torpedo could range 4,000 yd at about 30 knots In addition to the standard 21-in. and 22½-in aerial torpedo, an 18-in. model was in use by PT boats during part of World War II. The Japanese were reported to have used some giant torpedoes 24 in in diameter and 30 ft. long. The average weight of a torpedo at mid-century was near 3,000 lb., and the individual cost approximately $15,000.

Tactical Use.—Torpedoes may be fired by destroyers, submarines and patrol-torpedo boats and dropped from aeroplanes. Destroyers launch torpedoes by ejecting them from deck-mounted tubes with an impulse charge of powder A similar system was used by the PT boats using 18-in torpedoes; these craft later carried aircraft torpedoes which were merely dropped over the side from racks Torpedo warfare conducted by PT boats was especially effective in the area of the Solomon and Philippine islands, where the "tin fish" carried by the speedy little boats gave them the power to attack anything up to and including battleships. It is interesting to note here, that under the terms of the London Naval treaty, ships of less than 2,032 metric tons were classified as minor warships unless "fitted to launch torpedoes "

Submarine torpedoes are launched from tubes situated in either bow or stern by a charge of compressed air. Use of torpedoes by cruisers was discontinued about 1936, as with battleships, it was found that an effective torpedo attack had to be launched at a range far inside that from which they could attack with guns.

Torpedoes launched from torpedoplanes (*q.v.*), while no faster or no more powerful than other types, presented a greater threat during World War II in that the attack could come from a large number of directions at once and could materialize with very little warning because of the high speed of the planes. For this reason, and because an equivalent number of torpedoes could be launched by torpedoplanes at less material and personnel cost than with destroyers, aerial torpedo attacks were increasingly employed during surface engagements of World War II.

Submarine warfare was fought almost exclusively with torpedoes; later U.S. types of submarines carried no other weapon Of a total of 10,583,755 tons of naval and merchant shipping lost by Japan to all agents and all causes during World War II, United States submarines alone accounted for 5,320,004 tons

Whether a torpedo attack is launched by aerial, surface or submarine units, the only practical defense is to manoeuvre evasively in the hope of clearing the torpedo's path. Depending on whether they come from ahead or astern, the target ship endeavours to turn "into" or "with" them, thus decreasing her target size from that presented by her length to that offered by her much smaller beam. As this manoeuvre is anticipated by the ship making the attack, a "spread" of two or more torpedoes will usually be fired, so aimed as to intersect the possible paths taken by the target.

In fleet engagements of World War II, the threat of torpedo attack was frequently used to cause the enemy battle line to manoeuvre to the advantage of the force initiating the attack. This tactic was brilliantly employed in Oct 1944 during the battle of Surigao strait near Leyte Island, when Rear Adm. J. B. Oldendorf, commanding U.S. forces, sent four successive torpedo attacks against the Japanese battle forces by using PT boats and destroyers. Japanese evasive manoeuvres carried them into the devastating fire of cruisers and battleships with which the US commander "crossed the T" of the Japanese battle line and utterly defeated them.

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(A. S. L.)

TORPEDOPLANE. In the torpedoplane, naval science combined one of the most dangerous underwater weapons, the torpedo, with one of the most feared aerial developments, the bomber, to produce the torpedo bomber. A great tactical advantage is enjoyed by a naval force employing torpedoplanes, as the commander can launch a torpedo attack hundreds of miles from the originating ship, instead of the hundreds of yards common in destroyer or submarine attacks.

Naval experiments in aerial launching of torpedoes commenced almost as soon as experiments in the use of the plane itself. The early United States navy advocate of aerial torpedoes was Adm. Bradley Fiske, who described the advantages of such use in 1912 and finally pursuaded navy technical offices to undertake the design of aircraft torpedo launching mechanisms, as well as the types of torpedoes suitable for aerial use

By 1917 an experimental model (Bliss) torpedo of eight-inch diameter had been completed, and a successful drop was made at Huntington, L.I., in August of that year. In May 1919 an R-6 type navy plane made the first successful drop of a live torpedo (one carrying actual explosive charge) at Hampton Roads, Va. The first navy torpedo squadron of planes was established at Yorktown, Va., in 1920 and the first carrier-based torpedoplane landed on the U.S.S. "Langley" in 1924. In the same year, torpedoplanes helped sink the battleship "Washington" in target tests

Two years later, the new carriers "Lexington" and "Saratoga" carried torpedoplane squadrons and from that time on, this type of plane played an effective part in development of naval air power.

In 1941 the United States entered World War II with large numbers of carrier-based Douglas Devastators, which were gradually replaced after the battle of Midway in 1942, with Grumman Avengers, with heavier armament and much higher speeds. Torpedoes carried by these planes were particularly designed for high-speed launchings from heights up to 100 ft A postwar development of this type of plane was the Martin Mauler, a single-engine craft weighing more than ten tons and carrying three torpedoes.

(A. S. L.)

TORQUAY, a municipal borough, seaport and watering place in the Torquay parliamentary division of Devon, England, on Torbay of the English channel, 26 mi. S. of Exeter, on the Western Region railway route. Pop. (1938) 44,440. Area 9 8 sq.mi. Owing to the beauty of its site and the equability of its climate, it has high repute as a winter resort. There are remains of Tor or Torre abbey, founded for Praemonstratensians by William, Lord Brewer, in 1196, including a pointed arch portial South of the gateway is a 13th-century building, known as the Spanish barn. There was a village at Torre even before the foundation of the abbey, and in the neighbourhood of Torre evidence has been found of Roman occupation After the defeat of the Spanish Armada, Don Pedro's galley was brought into Torbay. William, prince of Orange, landed at Torbay on Nov. 5, 1688. Parks, promenades and other amenities are provided by the corporation, which acquired powers in 1937 to carry out extensive improvements

TORQUE, the twist or torsion which a shaft undergoes when transmitting power. The degree of twist is very slight, but it can be measured and the horsepower that is transmitted can thus be ascertained, the method being applied particularly to steam turbines. There are several types of torsion meters for measuring horsepower, electrical, mechanical and flashlight One of the last-named types is here described; its principle depends primarily on the straightness and very high velocity of a ray of light. Two discs are fastened to the shaft a measured

distance apart. Each disc has a small slit in it, about ¼ in by ⅛ in, and a lamp is attached near one disc by a rigid support; the torque-finder is also rigidly secured The light from the lamp is limited by a slit of similar size to those in the discs, and the torque-finder comprises a casting with a small telescopic eyepiece screwed to a brass plate which also has a slit of the same size as the others. The plate and eyepiece can be moved circumferentially by means of a micrometer apparatus, reading to ·01 of a degree If the lamp, discs and torque-finder are set so that the four slits are in line, the observer looking through the eyepiece parallel to the axis of the shaft will see the light shining in the lamp If the shaft starts to revolve, at each rotation as the two slits in the discs pass the sight line between lamp and finder the light will be seen momentarily The persistence of this flash with the rapidly revolving shaft makes it appear as a continuous light When however the shaft commences to transmit power the torque throws the disc slits out of line and the light is obscured. The observer now adjusts the micrometer and the eyepiece until a sight is again taken through the disc slits By noting the amount of the displacement thus made the degree of twist is measured, and therefrom the horse-power transmitted *See* DYNAMOMETER (F H.)

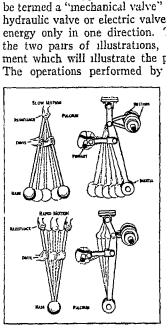
TORQUE AMPLIFIER. The torque amplifier consists of a mechanism provided with a control-shaft at one end and a work-shaft at the other, the control-shaft requiring only a feeble torque to operate it in either direction, while the work-shaft yields a torque of sufficient amount to accomplish any purpose desired, at the same time accurately following the control-shaft in all its angular movements Its broad purpose is to perform the functions of an electrical or hydraulic servo-motor.

The torque amplifier was invented by Henry W. Nieman, an engineer for the Bethlehem Steel Co It was originally developed for the control of anti-aircraft gun batteries from a remote control station. The torque amplifier has three elements. "work-shaft," "control-shaft" and "drive-shaft." The drive-shaft is driven by any outside source of power, and revolves continuously in one direction The control-shaft is actuated by any mechanical or manual control means, or by such weak forces as can be delivered through electrical recording instruments or telemetric transmission systems. The work-shaft is directly coupled to the work to be done, as for instance the elevating or training gears of a gun, a ship's rudder or the steering gear of an automobile. The control-shaft can be freely revolved in either direction, with only a small amount of effort; the work-shaft maintains at all times its angular synchronism with the control-shaft, and in addition exerts a heavy torque to overcome outside resistance. Unlike other forms of servo-motor, there is always a definite ratio between the torque applied at the control-shaft and that delivered at the work-shaft, this ratio being known as the "amplification."

Fundamentally, the torque amplifier consists of two oppositely rotating drums provided with friction bands which may be brought into contact with the drums through actuation of the control-shaft, this frictional contact causing the friction bands to exert pressure on the work-shaft. The force applied to the control-shaft is thus enhanced, or amplified, when it reaches the work-shaft by the extent to which the bands are urged forward because of their frictional contact with the rotating drums.

TORQUE CONVERTER is an apparatus for transmitting power automatically from an engine or other source of power to a secondary shaft, the torque and speed of the secondary being variable according to the load between wide limits. It was invented by George Constantinesco. The principle of the torque converter consists in dividing an oscillatory movement derived from a primary shaft which is driven by the engine, into two component oscillatory motions of the same frequency. One of these components oscillates an inertia device and the other oscillates unidirectional driving devices mounted on the secondary. The alternating impulses received by the secondary through the unidirectional devices are thus rectified into continuous rotation of the secondary.

Such unidirectional driving devices, shortly named "rectors," comprise any such devices which will drive in one direction and be free in the opposite direction. The rectors perform what may be termed a "mechanical valve" action very much like an ordinary hydraulic valve or electric valve, or rectifiers allowing the flow of energy only in one direction. The left hand figures of each of the two pairs of illustrations, depict two phases of an experiment which will illustrate the principle of the torque converter. The operations performed by each hand are then translated in the right hand figures into the functions of a "torque converter" in which the lower hand is replaced by a connecting rod moved by a crank, and the upper hand by two rectors which are connected to the secondary shaft where the resistance occurs



A slow oscillatory motion at the "drive" merely swings the mass to and fro, the fulcrum of oscillation remaining at the point of resistance If a rapid oscillatory motion is applied at the "drive" the inertia of the mass will oppose its motion, and the resistance is overcome. The upper hand moves then, almost as if it were driven directly, the fulcrum being right down at the mass. Such a combination is a four dimensional mechanism as the element "time" is essential to its performance. The ordinary rules of static mechanics do not apply to the torque converter, and it is only by the consideration of the elements "time" and "mass" that the behaviour of the converter can be explained.

The torque converter has many possible applications to traction problems and industry in general as in transmission for applying the power of internal combustion engines, turbines, electromotors and prime movers which lack flexibility, to uses where wide and unexpected fluctuations in the load occurs. The torque converter provides automatically for the adjustment of the speed and torque on the secondary, no matter how the resistance changes or fluctuates between very wide limits, while the prime mover continues to run steadily, with very little variation, at its most efficient torque and speed. In practice the inertia systems and the rectors are so arranged that the various parts balance each other dynamically as much as possible so that no vibrations are imparted on the casting of the machine.

A petrol (gasolene) engine may be combined with mechanism so as to form one single unit; the only control required being the throttle of the engine Vehicles driven by such units have no clutches nor gear change boxes. By opening wide the throttle of the engine the vehicle will accelerate from rest and attain a certain maximum speed on the level. When a hill is encountered, the vehicle slows down while the tractive force increases automatically according to the gradient For example, a vehicle fitted with a torque converter may travel at 40 m. per hour on a level or climb at 10 m per hour a gradient of one in four, while the torque and the speed of the engine remains the same in both cases.

TORQUEMADA, JUAN DE (1388–1468), or rather JOHANNES DE TURRECREMATA, Spanish ecclesiastic, was born at Valladolid, in 1388, and was educated in that city. At an early age he joined the Dominican order, and soon distinguished himself for learning and devotion. In 1415 he accompanied the general of his order to the Council of Constance, whence he proceeded to Paris for study, and took his doctorate in 1423. In 1431 Eugenius IV. called him to Rome and made him "magister sancti palatii." At the Council of Basel he was one of the ablest supporters of the view of the Roman curia, and he was rewarded with a cardinal's hat in 1439. He died at Rome Sept. 26, 1468.

His principal works are *In Gratiani Decretum commentarii* (4 vols., Venice, 1578); *Expositio brevis et utilis super toto psalterio* (Mainz, 1474); *Quaestiones spirituales super evangelia totius anni* (Brixen, 1498); *Summa ecclesiastica* (Salamanca, 1550). The last named work has the following topics (1) De universa ec[illegible]ia; (2) De Ecclesia romana et pontificis primatu; (3) De univers[illegible]us conciliis; (4) De

schismaticis et haereticis. His *De conceptione deiparae Mariae, libri viii.* (Rome, 1547), was edited with preface and notes by E. B Pusey (London, 1869 *seq*.).

TORQUEMADA, THOMAS (1420–1498), inquisitor-general of Spain, son of Don Pedro Ferdinando, lord of Torquemada and nephew of Juan de Torquemada, was born in 1420 at Valladolid. There he joined the Friars Preachers (Dominicans), took his vows, studied philosophy and received the baccalaureate in theology. He was then assigned to Piedrahita, a house of strict observance, where he was noted for his piety and austerity. About 1452 he became prior of the monastery of Santa Cruz of Segovia, a post which he held for 22 years. He retained the title, "Prior of Santa Cruz" until his death.

Torquemada was a man of strong character. His ardent love for the Catholic faith and his Spanish homeland developed in him a hatred for anything that endangered them. He was convinced that the Moors, and many of the Jews, the *Marranos* (Jewish converts to Christianity, also called *conversos* and "New Christians"), and the *Moriscos* (converts from Mohammedanism) were undermining the religious and social life of Spain. He was well thought of by contemporaries. Sebastian of Olmeda called him: "a scourge of heresy, a light of Spain, the saviour of his country and an honour to his Order" Hernando del Pulgar, secretary of Queen Isabella, referred to him as a man "of honest life, who had great zeal for the faith." Popes Sixtus IV and Alexander VI praised his zeal and wisdom, and Ferdinand and Isabella entertained a high opinion of him. Isabella may have consulted him during her frequent residences at Segovia before she became queen. She chose him as confessor on her accession to the throne. Later he was appointed confessor to Ferdinand as well.

In spite of his high station at the Spanish court, Torquemada had no desire for honours and steadfastly refused ecclesiastical preferments. He was possessed of considerable administrative ability as is witnessed by his long tenure as prior, his reorganization and direction of the inquisition and his appointment to special posts, such as visitor to the congregation of reformed Dominican priories of Aragon (1487–88). His interest in the arts is shown by his various architectural ventures, notably the construction of the monastery of St. Thomas at Avila.

The Inquisition.—In 1478 Ferdinand and Isabella decided to establish the inquisition in Castile. The motivation for this step was the problem of the *conversos* and *moriscos*, many of whom had embraced Christianity insincerely and were using the immunity and privileges thus gained to work against the Catholic faith and the unity of the Spanish nation. It is the opinion of some that the very existence of Christian Spain was at stake. A number of ecclesiastics urged the foundation of the inquisition as the only cure for these problems, and possibly Torquemada, as royal confessor, was consulted and added his voice to these representations. He and Cardinal Mendoza drafted the petition to Sixtus IV asking for authority to establish the inquisition. The pope acceded to the request in a bull of Nov. 1, 1478. Two years later, Sept. 26, 1480, the first inquisitors, Miguel Morillo and Juan de San Martin, were appointed. Mendoza and Torquemada appear to have acted as consultors. Morillo and San Martin proceeded to Seville where they established the first tribunal. The complaints of severity and injustice lodged at Rome during these early years of the inquisition were directed against the activities of these two men. On Feb. 11, 1482 Sixtus IV appointed Torquemada and seven other Dominicans as assistant inquisitors. The following year Isabella petitioned for a reorganization of the inquisition under unified control. At the suggestion of Mendoza, she recommended Torquemada as inquisitor-general and early in October he was appointed for Castile. On Oct. 17 his jurisdiction was extended to Aragon, and in Feb. 1486 to Barcelona. He was recommissioned by Pope Innocent VIII in 1485 and 1486. By virtue of his office he was appointed a member of the royal council.

As inquisitor-general Torquemada was the highest official of the Spanish inquisition. He had wide powers of appointment and dismissal of subordinate inquisitors and appellate power in cases brought before episcopal courts (1496). His jurisdiction did not extend to prelates, and Jews were tried only in cases of proselytism, sorcery, or other spiritual offenses. Torquemada reorganized the inquisition completely and promulgated standard rules of procedure. He constituted local tribunals at Seville, Jaén, Cordova, Ciudad Real (later transferred to Toledo) and at Saragossa. A supreme council of five members, including himself, was organized for the hearing of appeals.

On Nov. 29, 1484, he convoked a general assembly of all Spanish inquisitors at Seville and presented 28 articles for their guidance. New statutes were added in Dec. 1484, in 1485, 1488 and 1498. It is noteworthy that crimes other than heresy and apostasy, such as witchcraft, necromancy, bigamy, blasphemy and usury were brought under the inquisition's jurisdiction. As in the royal tribunals, torture was authorized as a means of gaining evidence. The use of irons was not allowed. Under Isabella about 2,000 persons were executed by the inquisition. Torquemada was probably responsible for one-half to two-thirds of this number. It is estimated that approximately 100,000 cases were tried during his tenure as inquisitor-general. On three occasions Torquemada sent Alphonse Badaja to Rome to represent him before the pope In June 1494, owing to Torquemada's age and infirmity, Alexander VI appointed four assistant inquisitors Their power was equal to Torquemada's, though he retained control until his death

Expulsion of the Jews.—Ferdinand and Isabella had long contemplated the expulsion of the Jews, whom they considered a source of disunity for the kingdom and of contamination for the *conversos*. Thus on March 31, 1492, they signed an edict ordering the expulsion of all Jews who had not embraced Christianity. Torquemada may have been consulted before the order was issued and perhaps presented the evidence of the La Guardia trial (1490–91) as a further inducement to the sovereigns. Undoubtedly he was in thorough sympathy with the move. It is estimated that from 160,000 to 200,000 Jews left Spain. There is no adequate proof for the tale that when a ransom of 30,000 ducats was offered by the Jews, Torquemada indignantly threw his crucifix on the table and asked the king and queen if, like Judas, they would betray their Lord for money. This story seems to have become current toward the end of the 16th century.

Some critics have said that Torquemada never travelled unless accompanied by 250 armed retainers and 50 horsemen. Undoubtedly he was sufficiently protected, but there is no contemporary evidence for this statement, nor for the charge that he never ate unless the horn of a unicorn or the tongue of a scorpion lay at the side of his plate. These accusations first appeared almost a century after his death. Torquemada died at Avila, Sept. 16, 1498.

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TORRANCE, a town of southwestern California in Los Angeles county, U.S. It is about 16 mi. S. of the city of Los Angeles and 4 mi. E of Redondo Beach, which is on U.S highway 101A. It is served by the Atchison, Topeka and Santa Fe, the Southern Pacific and the Pacific Electric railroads, the latter giving freight service only. The land area is 18.9 sq mi. and the altitude 75 ft.

The population was 22,241 in 1950, an increase of 123.5% over the 1940 population of 9,950. Torrance was classified as an urban community at the time of the 1940 census.

It is principally a manufacturing town; products include steel, oil-well machinery, petroleum products, rubber goods and paint. There are also oil wells and railroad shops, and some diversified farming is carried on. Torrance is administered by a mayor-council form of government; the mayor is selected by the five members of the council who are chosen in direct nonpartisan elections The public auditorium, bus transport system and waterworks are municipally owned and operated.

The Jared Sydney Torrance Memorial hospital was established in 1925. The town was laid out in 1911 by Jared Sydney

Torrance, a well-to-do resident of Pasadena who dealt in public utilities After making a detailed study of city planning abroad, he applied his findings to planning the Torrance community so that the steel mills, oil fields and other industrial plants would be separated from the quiet residential area. A weekly newspaper is published.

TORRE ANNUNZIATA, a seaport of Campania, Italy, in the province of Naples, on the east of the Bay of Naples, and at the south foot of Mt. Vesuvius, 14 mi. S.E. of Naples by rail. Pop. (1936) 38,606, town; 72,935, commune. It is on the main line to Battipaglia, at the point of junction of a branch line from Cancello round the east of Vesuvius, and of the branch to Castellammare di Stabia and Gragnano. It has an arms factory and other ironworks, manufacture of macaroni and breeding of silkworms. There are numerous mineral springs.

TORRE DEL GRECO, a seaport of Campania, Italy, in the province of Naples, 7½ mi. S.E. of that city by rail. Pop. (1936) 37,052, town; 51,401, commune. It lies at the south-west foot of Vesuvius, on the shore of the Bay of Naples. It is built chiefly of lava, and stands on the lava stream of 1631, which destroyed two-thirds of the older town. Great damage was done by the eruption of 1737 and 1794; the earthquake of 1857 and the eruption of Dec. 8, 1861 were even more destructive.

TORRENS, ROBERT (1780–1864), English soldier and economist, was born in Ireland in 1780. He entered the marines in 1797, became a captain in 1806 and major for bravery at Anhalt in 1811. He fought in the Peninsula, becoming lieutenant colonel in 1835 and retiring as colonel in 1837. He was returned to parliament in 1831 as member for Ashburton. He was a prolific writer, principally on financial and commercial policy. Almost the whole of the programme which was carried out in legislation by Sir Robert Peel was laid down in his economic writings. He was an early advocate of the repeal of the corn laws.

His principal writings of a general character were: *The Economist* [i.e., Physiocrat] *refuted* (1808); *Essay on the Production of Wealth* (1821); *Essay on the External Corn-trade* (eulogized by Ricardo) (1827); *The Budget, a series of Letters on Financial, Commercial and Colonial Policy* (1841–1843); *The Principles and Practical Operations of Sir Robert Peel's Act of 1844 Explained and Defended* (1847).

TORRENS, SIR ROBERT RICHARD (1814–1884), British colonial statesman, was born at Cork, Ireland, in 1814, and educated at Trinity college, Dublin. He went to South Australia in 1840, and was appointed collector of customs. He was an official member of the first legislative council and in 1852 was treasurer and registrar general. When responsible government was established he was elected as a representative for Adelaide and became a member of the first ministry In 1857 he introduced his famous Real Property act, the principle of which consists of conveyance by registration and certificate instead of deeds. The system was rapidly adopted in the other colonies and elsewhere, and was expounded by the author during a visit to the United Kingdom in 1862–64. After leaving South Australia, Torrens represented Cambridge in the house of commons from 1868–74; in 1872 he was knighted. He was the author of works on the effect of gold discoveries on currency, and other subjects. He died Aug. 31, 1884.

TORRENS, WILLIAM TORRENS M'CULLAGH (1813–1894), English politician and social reformer, son of James M'Cullagh, was born near Dublin Oct. 13, 1813. He was called to the bar, and in 1835 became assistant commissioner on the special commission on Irish poor-relief, which resulted in the extension of the workhouse system in Ireland in 1838. In the '40s he joined the Anti-Corn Law league, and in 1846 published his *Industrial History of Free Nations.* From 1847–52 he represented Dundalk in parliament, in 1857 he was returned for Yarmouth, and from 1865–85 he represented Finsbury. Torrens devoted himself mainly to social questions in parliament. His amendment to the Education bill of 1870 established the London School board, and his Artisans' Dwellings bill in 1868 facilitated the clearing away of slums by local authorities. He wrote *Twenty Years in Parliament* (1893) and *History of Cabinets* (1894). He died in London April 26, 1894.

TORRENS, LAKE: *see* SOUTH AUSTRALIA.

TORRES NAHARRO, BARTOLOMÉ DE (1480–1530), Spanish dramatist, was born toward the end of the 15th century at Torres, near Badajoz. After some years of soldiering and of captivity in Algiers, Torres Naharro took orders, settled in Rome about 1511, and there devoted himself chiefly to writing plays Although he alludes to the future pope, Clement VII as his protector, he left Rome to enter the household of Fabrizio Colonna at Naples where his works were printed under the title of *Propaladia* (1517). He is conjectured to have returned to his native place, and to have died there shortly after 1529. His *Diálogo del nacimiento* is written in unavowed, though obvious, imitation of Encina, but in his subsequent plays he shows a much larger conception of dramatic possibilities. He classifies his pieces as *comedias á noticia* and *comedias á fantasía;* the former, of which the *Soldadesca* and *Tinellaria* are examples, present in dramatic form incidents within his personal experience; the latter, which include such plays as *Serafina, Himenea, Calamita* and *Aquilana,* present imaginary episodes with adroitness and persuasiveness. Torres Naharro is much less dexterous in stagecraft than many inferior successors, his humour is rude and boisterous and his diction is unequal; but to a varied knowledge of human nature he adds knowledge of dramatic effect, and his rapid dialogue, his fearless realism and vivacious fancy prepared the way for the romantic drama in Spain.

TORRES VEDRAS, 43 mi. N.W. of Lisbon, Portugal, on the Lisbon-Figueira da Foz railway. Pop. (1940) 4,762. Roman inscriptions were found there, but the Latin name of the town, *Turres Veteres,* is probably mediaeval. There were "lines of Torres Vedras," constructed by Wellington in 1810 (*see* PENINSULAR WAR). There also in 1846 the troops of General Saldanha defeated those of the Count de Bomfim.

TORRES Y VILLAROEL, DIEGO DE (1696–1759?), Spanish writer, was born in 1696 at Salamanca, where his father was bookseller to the university. In his teens Torres escaped to Portugal where he enlisted under a false name; he next moved to Madrid, living from hand to mouth as a hawker; in 1717 he was ordained subdeacon, resumed his studies at Salamanca, and in 1726 became professor of mathematics at the university. Torres was suspected of complicity in the stabbing of a priest and fled to Portugal, where he remained until his innocence was proved He then returned to his chair, which he resigned in 1751 to act as steward to two noblemen. Torres had so slight a knowledge of mathematics that his appointment as professor was thought scandalous even in his own scandalous age, yet he quickly acquired a store of knowledge which he displayed with serene assurance. His almanacs, his farces, his devotional and pseudoscientific writings show that he possessed the alert adaptiveness of the born adventurer; but all that remains of his 14 volumes (1745–52) is his autobiography, an amusing record of cynical effrontery and successful imposture. He was known to be alive in 1758, but the date of his death is uncertain.

TORREVIEJA, a seaport of S.E. Spain, in Alicante province, 3 mi. S.W. of Cape Cervera, and at the terminus of a railway to Albatera on the Alicante-Murcia line. Pop. (1940) 9,019 (mun., 9,274). The district is famous for its salt beds, which are owned by the state which farms them out. The Laguna Grande alone ordinarily yields more than 100,000 tons a year.

TORREY, JOHN (1796–1873), U.S. botanist, was born in New York city Aug 15, 1796. He graduated (M.D.) in 1818 from the College of Physicians and Surgeons in New York. After holding various positions he became in 1836 New York state botanist and produced his *Flora of the State of New York* in 1843; while from 1838 to 1843 he carried on the publication of the earlier portions of *Flora of North America,* with the assistance of his pupil, Asa Gray. From 1853 he was chief assayer to the U.S. assay office, but he continued to take an interest in botanical teaching until his death at New York March 10, 1873. He gave his valuable herbarium and botanical library to Columbia college.

See A. D. Rodgers, *John Torrey* (1942).

TORREY, REUBEN ARCHER (1856–1928), U.S evangelist, was born in Hoboken, New Jersey, Jan. 28, 1856. He graduated from Yale university in 1875 and from the Yale Di-

vinity school in 1878 He became a Congregational minister in 1878, studied theology at Leipzig and Erlanger in 1882–83, joined D L. Moody in his evangelistic work in Chicago in 1889, and became pastor of the Chicago Avenue church in 1894 and afterward superintendent of the Moody Bible institute of Chicago. In 1902–03 he made an evangelistic tour, preaching in many parts of the world, and with Charles McCallon Alexander conducted revival services in Great Britain in 1903–05; Torrey conducted a similar campaign in U S and Canadian cities ir. 1906–07, returned to England, Scotland and Ireland in 1911 and visited Japan and China in 1919 He was dean of the Bible institute, Los Angeles, 1912–24, and pastor of the Church of the Open Door, Los Angeles, 1915–24 Included among his many religious works are: *The Fundamental Doctrines of the Christian Faith* (1919). *The Christ of the Bible* (1923) and *Lectures on First Epistle of John* (1928). His books were translated into many languages. He died Oct. 26, 1928.

TORRICELLI, EVANGELISTA (1608–1647), Italian physicist and mathematician, was born at Faenza Oct. 15, 1608. In 1627 he went to Rome to study science under the Benedictine Benedetto Castelli (1577–1644), professor of mathematics at the Collegio di Sapienza. The perusal of Galileo's *Dialoghi delle nuove scienze* (1638) inspired him with many developments of the mechanical principles there set forth, which he embodied in a treatise *De motu* (printed amongst his *Opera geometrica*, 1644). In 1641 he went to Florence, where he met Galileo, and acted as his amanuensis during the three remaining months of his life. After Galileo's death Torricelli was nominated grand-ducal mathematician and professor of mathematics in the Florentine academy. The discovery of the principle of the barometer (*q.v.*) which has perpetuated his fame ("Torricellian tube," "Torricellian vacuum") was made in 1643 Torricelli was brought into controversy with G. P. de Roberval as to the priority of the solution of a problem on the properties of a cycloid. He died at Florence Oct 25, 1647

Torricelli wrote on fluid motion, on the theory of projectiles and on the motion of two bodies connected by a string passing over a fixed pulley. He used and developed B. Cavaleri's method of indivisibles.

TORRIGIANO, PIETRO (1472–1522), Florentine sculptor, was one of the group of talented youths who studied art under the patronage of Lorenzo the Magnificent in Florence. Torrigiano was invited to England to execute the tomb for Henry VII and his queen, in Westminster Abbey After this Torrigiano received the commission for the altar, retable and baldacchino which stood at the west, outside the screen of Henry VII's tomb. This work was destroyed by the Puritans in the 17th century. Henry VIII also commissioned Torrigiano to make a magnificent tomb, somewhat similar to that of Henry VII, to be placed in a chapel at Windsor; it was, however, never completed, and its rich bronze was melted by the Commonwealth The indentures for these various works still exist, and are printed by Neale, *Westminster Abbey*, i 54–59 (1818). The Tomb of Margaret of Richmond in Westminster Abbey is ascribed to Torrigiano. He ended his life in 1522 in the prisons of the Inquisition.

See Wilhelm Bode, *Die italienische Plastik* (1902).

TORRINGTON, ARTHUR HERBERT, EARL OF (1647–1716), British admiral, was the son of a judge, Sir Edward Herbert (c. 1591–1657) He entered the navy in 1663, and served in the Dutch wars of the reign of Charles II, as well as against the Barbary pirates. From 1680 to 1683 he commanded in the Mediterranean. The known royalist sentiments of his family and his reputation as a naval officer ensured the favour of James II, who appointed him rear admiral of England and master of the robes. But Herbert refused to support the king's proposal for the repeal of the Test act, and was dismissed from his places. He now entered into communication with the agents of the prince of Orange. After the acquittal of the seven bishops in 1688 he carried the invitation to William of Orange. After the Revolution Herbert was named first lord of the admiralty, and took the command of the fleet at home. In 1689 he was at sea attempting to prevent the French admiral Château-Renault (*q.v.*) from landing the troops sent by the king of France to the aid of King James in Ireland Though he fought an action with the French in Bantry bay May 10 he failed to baffle Château-Renault, who had a stronger force In May 1689 he was created earl of Torrington. In 1690 he was in the channel with a fleet of 56 English and Dutch vessels, when he found himself confronted with the much more powerful French fleet He proposed to retire to the Thames, but the council of regency, knowing that the Jacobites were preparing for a rising, and only waiting for the support of a body of French troops, ordered him not to lose sight of the enemy, but rather than do that to give battle "upon any advantage of the wind." On July 10 Torrington made a half-hearted attack on the French off Beachy Head in which his own ship was kept out of fire, and severe loss fell on his allies Then he retired to the Thames. The French pursuit was fortunately feeble, and the loss of the allies was comparatively slight Torrington was brought to trial before a court martial in December, and acquitted. He died April 14, 1716.

The unfavourable account of his moral character reported by Dartmouth to Pepys is confirmed by Bishop Burnet, who had seen much of him during his exile in Holland. Torrington originated the phrase "a fleet in being"

See Charnock's *Biog. Nav.*, i 258 The best account of the battle of Beachy Head is to be found in "The Account given by Sir John Ashby Vice-Admiral and Rear-Admiral Rooke, to the Lords Commissioners" (1691).

TORRINGTON, GEORGE BYNG, VISCOUNT (1663–1733), English admiral, was born at Wrotham, Kent, and entered the navy in 1678. In 1688 he helped to win the fleet over to the prince of Orange; appointed to the command of the "Nassau" in 1702 he was present at the burning of the French fleet at Vigo, and in 1703 was made rear admiral of the red He served in the Mediterranean (1704) and at the battle of Malaga, after which he was knighted. In 1708, as admiral of the blue he prevented the Old Pretender from landing in Scotland; and ten years later defeated the Spaniards off Passaro, after which the king sent him full powers to negotiate with the princes and states of Italy. To his conduct it was owing that Sicily was subdued and the king of Spain forced to accept the terms prescribed by the Quadruple alliance On his return to England in 1721 he was made rear admiral and a member of the privy council, and was created Baron Byng of Southill in Bedfordshire, Viscount Torrington in Devonshire and a Knight Companion of the Bath (1725). George II made him first lord of the admiralty in 1727. He died Jan. 17, 1733.

See *Memoirs relating to Lord Torrington*, Camden Soc new series 46, and *A True Account of the Expedition of the British Fleet to Sicily, 1718–1720*, published anonymously, but known to be by Thomas Corbett of the admiralty in 1739 Forbin's *Memoirs* contain the French side of the expedition to Scotland in 1708.

TORRINGTON (GREAT TORRINGTON), a market town and municipal borough, South Molton parliamentary division of Devonshire, England, on the Torridge, 225 mi. W. by S. of London by the S railway. Pop. (1938) 2,785. Area 5.6 sq.mi.

Torrington was the site of very early settlement, and possessed a market in Saxon times. The manor was held by Brictric in the reign of Edward the Confessor, and in 1086 formed part of the Domesday fief of Odo Fitz Gamelin, which later constituted an honour with Torrington as its caput. In 1221 it appears as a mesne borough under William de Toritone, a descendant of Odo and the supposed founder of the castle, which in 1228 was ordered to be razed, but is said to have been rebuilt in 1340 by Richard de Merton. The borough had a fair in 1221, and returned two members to parliament from 1295 until exempted from representation at its own request in 1368 The government was vested in bailiffs and a commonalty, and no charter of incorporation was granted until that of Queen Mary in 1554, which instituted a governing body of a mayor, 7 aldermen and 18 chief burgesses, with authority to hold a court of record every three weeks. This charter was confirmed by Elizabeth in 1568 and by James I in 1617. A charter from James II in 1686 changed the style of the corporation to a mayor, 8 aldermen and 12 chief

burgesses In the 16th century it was an important centre of the clothing trade. In 1643 Colonel Digby took up his position at Torrington and put to flight a contingent of parliamentary troops, but in 1646 the town was besieged by Sir Thomas Fairfax and finally forced to surrender.

See *Victoria County History Devonshire;* F. T. Colby, *History of Great Torrington* (1878)

TORRINGTON, a city of Litchfield county, Connecticut, U S A , on the Naugatuck river, 25 mi. W. of Hartford. It is served by the New York, New Haven and Hartford railroad Pop. (1950) 27,770; 1940 federal census 26,988.

The city is surrounded by the beautiful scenery of the Berkshire foothills. with five lakes close by After brass kettles were first made there in 1834 it was an important centre of the brass industry, and other products also are manufactured in great variety.

In 1740 the town was incorporated. A woollen mill was built in 1813 by members of the Wolcott family, and the village which grew up around it was called Wolcottville.

In 1881 it took the name of the town, and in 1887 was incorporated as a borough In 1923 the town (including the borough) was chartered as a city.

In 1851 the first condensed milk plant in the world was established there by Gail Borden

TORSTENSSON, LENNART, COUNT (1603–1651), Swedish soldier, son of Torsten Lennartsson, commandant of Elfsborg, was born at Forstena in Vestergötland At the age of 15 he became one of the pages of the young Gustavus Adolphus and served during the Prussian campaigns of 1628–29. In 1629 he was set over the Swedish artillery, and contributed to the victories of Breitenfeld (1631) and Lech (1632). The same year he was taken prisoner at Alte Veste and shut up for nearly a year at Ingolstadt. Under Banér he rendered distinguished service at the battle of Wittstock (1636) and during the energetic defense of Pomerania in 1637–38, as well as at the battle of Chemnitz (1638) and in the raid into Bohemia in 1639. Illness compelled him to return to Sweden in 1641, when he was made a senator. The sudden death of Banér in May 1641 recalled Torstensson to Germany as generalissimo of the Swedish forces and governor-general of Pomerania He was at the same time promoted to the rank of field marshal. The period of his command (1641–45) forms one of the most brilliant chapters in the military history of Sweden. In 1642 he marched through Brandenburg and Silesia into Moravia, taking all the principal fortresses on his way. On returning through Saxony he well nigh annihilated the imperialist army at the second battle of Breitenfeld (Oct. 23, 1642) In 1643 he invaded Moravia for the second time, but was suddenly recalled to invade Denmark, when his rapid and unexpected intervention paralysed the Danish defense on the land side, though Torstensson's own position in Jutland was for a time precarious owing to the skilful handling of the Danish fleet by Christian IV.

In 1644 he led his army for the third time into the heart of Germany and routed the imperialists at Jüterbog (Nov. 23). At the beginning of Nov. 1645 he broke into Bohemia, and the brilliant victory of Jankow (Feb. 24, 1645) laid open before him the road to Vienna. Yet, though one end of the Danube bridge actually fell into his hands, his exhausted army was unable to penetrate any farther and, in December the same year, Torstensson, crippled by gout, was forced to resign his command and return to Sweden In 1647 he was created a count. From 1648 to 1651 he ruled all the western provinces of Sweden, as governor-general. On his death at Stockholm (April 7, 1651) he was buried solemnly in the Riddarholmskyrka, the Pantheon of Sweden. Torstensson was remarkable for the extraordinary and incalculable rapidity of his movements, though very frequently he had to lead the army in a litter as his bodily infirmities would not permit him to mount his horse He was also the most scientific artillery officer and the best engineer in the Swedish army.

See J. W. de Peyster, *History of the Life of L Torstensson* (Poughkeepsie, 1855); J. Fell, *Torstensson before Vienna* (trans. by de Peyster, New York, 1885); Gustavus III, *Eulogy of Torstensson* (trans. by de Peyster, New York, 1872). (R. N. B.)

TORT, the technical term, in the law of England, of those dominions and possessions of the British empire where the common law has been received or practically adopted in civil affairs, and of the United States, for a civil wrong, *i.e.*, the breach of a duty imposed by law, by which breach some person becomes entitled to sue for damages A tort must, on the one hand, be an act which violates a general duty. The rule which it breaks must be one made by the law, not, as in the case of a mere breach of contract, a rule which the law protects because the parties have made it for themselves. On the other hand, a tort is essentially the source of a private right of action. An offense which is punishable, but for which no one can bring a civil action, is not a tort. It is quite possible for one and the same act to be a tort and a breach of contract, or a tort and a crime; it is even possible in one class of cases for the plaintiff to have the option—for purposes of procedural advantage—of treating a real tort as a fictitious contract, but there is no necessary or general connection. Again, it is not the case that pecuniary damages are always or necessarily the only remedy for a tort; but the right to bring an action in common law jurisdiction, as distinct from equity, matrimonial or admiralty jurisdiction, with the consequent right to damages, is invariably present where a tort was committed

This technical use of the French word *tort* (which at one time was near becoming a synonym of *wrong* in literary English) is not very ancient, and anything like systematic treatment of the subject as a whole is very modern. From about the middle of the 19th century there was a current assumption that all civil causes of action must be founded on either contract or tort; but there is no historical foundation for this doctrine, though modified forms of the action of trespass—actions *in consimili casu*, or "on the case" in the accustomed English phrase—did in practice largely supplant other more archaic forms of action by reason of their greater convenience. The old forms were designed as penal remedies for manifest breach of the peace or corruption of justice; and traces of the penal element remained in them long after the substance of the procedure had become private and merely civil. The transition belongs to the general history of English law.

In England the general scope of the law of torts was never formulated by authority. But there is no doubt that duties enforced by the English law of torts are broadly those which the Roman institutional writers summed up in the precept *Alterum non laedere*. Every member of a civilized commonwealth is entitled to require of others a certain amount of respect for his person, reputation and property, and a certain amount of care and caution when they go about undertakings attended with risk to their neighbours Under the modern law, it is submitted, the question arising when one man wilfully or recklessly harms another is not whether some technical form of action can be found in which he is liable, but whether he can justify or excuse himself This view, at any rate, is countenanced by a judgment of the supreme court of the U S. delivered in 1904. If it be right, the controverted question whether conspiracy is or is not a substantive cause of action seems to lose most of its importance. Instead of the doubtful proposition of law that some injuries become unlawful only when inflicted by concerted action, we shall have the plain proposition of fact that some kinds of injury cannot, as a rule, be inflicted by one person with such effect as to produce any damage worth suing for.

The precise amount of responsibility can be determined only by full consideration in each class of cases. But what makes the law of torts effective, especially with regard to redress for harm suffered by negligence, is the universal rule of law that every one is answerable for the acts and defaults of his servants (that is, all persons acting under his direction and taking their orders from him or some one representing him) in the course of their employment. The person actually in fault is not the less answerable, but the remedy against him is very commonly not worth pursuing. But for this rule corporations could not be liable for any negligence of their servants, however disastrous to innocent persons, except so far as it might happen to constitute a breach of some express undertaking. We have spoken of the rule as universal, but, in the case of one servant of the same employer being injured

by the default of another, an unfortunate aberration of the courts, which started from small beginnings in the second quarter of the 19th century, was pushed to extreme results, and led to great hardship A partial remedy was applied in 1880 by the Employers' Liability act, and in 1897 a much bolder step was taken by the Workmen's Compensation act (superseded by later amendment and extension now consolidated in an act of 1925). The Workmen's Compensation act includes cases of pure accident, where there is no fault at all, or none that can be proved, and therefore goes beyond the reasons of liability with which the law of torts has to do. In fact, it establishes a kind of compulsory insurance, justifiable only on wider grounds of policy

There are kinds of cases, on the other hand, in which the law, without aid from legislation, has imposed on occupiers and other persons in analogous positions a duty stricter than that of being answerable for themselves and their servants. Duties of this kind are called "duties of insuring safety." Generally they extend to having the building, structure, or works in such order, having regard to the nature of the case, as not to create any unusual danger to persons lawfully frequenting, using or passing by them, which the occupier knows or ought to know and could prevent by reasonable care, but in some cases of "extra-hazardous" risk, even proof of all possible diligence—according to English authority, which is not unanimously accepted in America—will not suffice.

Classification.—The classification of actionable wrongs is perplexing We may start either from the character of the defendant's act or omission, with regard to his knowledge, intention and otherwise, or from the character of the harm suffered by the plaintiff Whichever of these we take as the primary line of distinction, the results can seldom be worked out without calling in the other. Taking first the defendant's position, the widest governing principle is that, apart from various recognized grounds of immunity, a man is answerable for the "natural and probable" consequences of his acts; *i e*, such consequences as a reasonable man in his place should have foreseen as probable. Still more is he answerable for what he did actually foresee and intend. Knowledge of particular facts may be necessary to make particular kinds of conduct wrongful. Such is the rule in the case of fraud and other allied wrongs, including what is rather unhappily called "slander of title," and what is now known as "unfair competition" in the matter of trade names and descriptions, short of actual piracy of trade-marks But where an absolute right to security for a man's person, reputation or goods is interfered with, neither knowledge nor specific intention need be proved This rule was known some time ago to apply to the exercise of rights of property, and such speculative doubt as remained was removed by the decision of the house of lords in the leading case of *Allen* v. *Flood* (1898, A C. 1). We now know that it applies to the exercise of all common rights. The exceptions are very few, and must be explained by exceptional reasons. Indeed, only two are known to the present writer—malicious prosecution, and the misuse of a "privileged occasion" which would justify the communication of defamatory matter if made in good faith. In each case the wrong lies in the deliberate perversion of a right or privilege allowed for the public good, though the precise extent of the analogy is not certain at present. It was formerly supposed that an action by a party to a contract against a third person for procuring the other party to break his contract was within the same class, *i.e.*, that malice must be proved. But since *Allen* v. *Flood*, and the later decision of the house of lords in *Quinn* v. *Leathem* (1901, A.C. 495), this view ceased to be tenable. The ground of action is the intentional violation of an existing legal right; which, however, from 1906, may be practised with impunity in Great Britain "in contemplation or furtherance of a trade dispute": Trade Disputes act, sec. 3 It must be remembered, however, that the presence or absence of personal ill will, and the behaviour of the parties generally, may have an important effect, when liability is proved or admitted, in mitigating or aggravating the amount of damages awarded by juries and allowed by the court to be reasonable. It may likewise be noted, by way of caution, that some problems of criminal law, with which we are not here concerned, require more subtle consideration. However, it is hardly ever safe to assume that the bounds of civil and criminal liability will be found coextensive Perhaps we may go so far as to say that a man is neither civilly nor criminally liable for a mere omission (not being disobedience to a lawful command which he was bound to obey), unless he has in some way assumed a special duty of doing the act omitted

We have already had to mention the existence of grounds of immunity for acts that would otherwise be wrongful. Such grounds there must be if the law is to be enforced and justice administered at all, and if the business of life is to be carried on with any freedom Roughly speaking, we find in these cases one of the following conditions: Either the defendant was executing a lawful authority, or he was justified by extraordinary necessity; or he was doing something permitted by legislation for reasons of superior utility, though it may produce damage to others, and either with or without special provisions for compensating damage; or he was exercising a common right in matters open to free use and competition, or the plaintiff had, by consent or otherwise, disabled himself from having any grievance Pure accident will hardly seem to any one who is not a lawyer to be a special ground of exemption, the question being rather how it could ever be supposed to be a ground for liability. But it was supposed so by many lawyers down to recent times, the reason lying in a history of archaic ideas too long to be traced here Exercise of common rights is the category where most difficulty arises Here, in fact, the limits of man's freedom must be fixed by a sense of policy not capable of formal demonstration.

As Justice Holmes of the supreme court of the U.S. said, we allow unlimited trade competition (so long as it is without fraud) though we know that many traders must suffer, and some may be ruined by it, because we hold that free competition is worth more to society than its costs. A state with different economic foundations might have a different law on this, as on many other points. This freedom extends not only to the exercise of one's calling, but to choosing with whom and under what conditions one will exercise it. Also the law will not enquire with what motives a common right is exercised; and this applies to the ordinary rights of an owner in the use of his property as well as to the right of every man to carry on his business The rule that a man's motives for exercising his common rights are not examinable involves the consequence that advising or procuring another, who is a free agent, to do an act of this kind can, *a fortiori*, not be an actionable wrong at the suit of a third person who is damnified by the act, and that whatever the adviser's motives may be. This appears to be included in the decision of the house of lords in *Allen* v *Flood* That decision, though not binding in any American court, is approved and followed in most American jurisdictions It is otherwise where a system of coercion is exercised on a man's workmen or customers in order to injure him in his business The extension of immunity to such conduct would destroy the value of the common right which the law protects: *Quinn* v. *Leathem*

Individual Rights.—Owners and occupiers of immovable property are bound to respect one another's convenience within certain limits. The maxim or precept *Sic utere tuo ut alienum non laedas* does not mean that I must not use my land in any way which can possibly diminish the profit or amenity of my neighbour's. That would be false It is a warning that both his rights and mine extend beyond being free from actual unlawful entry, and that if either of us takes too literally the more popular but even less accurate maxim, "Every man may do as he will with his own," he will find that there is such a head of the law as nuisance

From the point of view of the plaintiff, as regards the kind of damage suffered by him, actionable wrongs may be divided into four groups. We have some of a strictly personal kind; some which affect ownership and rights analogous to ownership; some which extend to the safety, convenience and profit of life generally—in short, to a man's estate in the widest sense, and some which may, according to circumstances, result in damage to person, property or estate, any or all of them. Personal wrongs touching a man's body or honour are assault, false imprisonment, seduction or "enticing away" of members of his family Wrongs to property are trespass to land or goods, "conversion" of goods

(*i e*, wrongful assumption of dominion over them), disturbance of easements and other individual rights in property not amounting to exclusive possession. Trespass is essentially a wrong to possession, but with the aid of actions "on the case" the ground was practically covered Then there are infringements of incorporeal rights which, though not the subject of trespass proper, are exclusive rights of enjoyment and have many incidents of ownership. Actions, in some cases expressly given by statute, lie for the piracy of copyright, patents and trade-marks. A wrong to a man's estate in the larger sense above noted is defamation —not a strictly personal wrong, because according to English common law the temporal damage, not the insult, is, rightly or wrongly, made the ground of action and the defendant's intention is immaterial. It is even possible to write an actionable libel without knowing that one's words can be thought to reflect on the plaintiff, or (it seems) that there is any such person: so the house of lords decided in *Hulton & Co.* v. *Jones* in 1910. Others are deceit, so-called "slander of title" and fraudulent trade competition which are really varieties of deceit; malicious prosecution; and nuisance, which, though most important as affecting the enjoyment of property, is not considered in that relation only. Finally, we have the results of negligence and omission to perform special duties regarding the safety of one's neighbours or the public, which may affect person, property, or estate.

The law of wrongs is made to do a great deal of work which, in a system less dependent on historical conditions, we should expect to find done by the law of property. We can claim or reclaim our movable goods only by complaining of a wrong done to our possession or our right to possess. There is no direct assertion of ownership like the Roman *vindicatio*. The law of negligence, with the refined discussions of the test and measure of liability which it introduced, is wholly modern; and the same may be said of the present working law of nuisance, though the term is of respectable antiquity. Most recent of all is the rubric of "unfair competition," which is fast acquiring great importance.

It will be observed that the English law of torts answers approximately in its purpose and contents to the Roman law of obligations *ex delicto* and *quasi ex delicto* When we have allowed for the peculiar treatment of rights of property in the common law, and remembered that, according to one plausible theory, the Roman law of possession itself is closely connected in its origin with the law of delicts, we shall find the correspondence at least as close as might be expected *a priori*. Nor is the correspondence to be explained by borrowing, for this branch of the common law seems to owe less to the classical Roman or mediaeval canon law than any other. Some few misunderstood Roman maxims have done considerable harm in detail, but the principles were worked out in all but complete independence.

A list of modern books and monographs will be found at the end of the article on "Torts" by the present writer in the *Encyclopaedia of the Laws of England* (2nd ed.). Among recent editions of works on the law of torts and new publications the following may be mentioned here· Addison, by W E. Gordon and W. H. Griffith (8th ed , 1906); Clerk and Lindsell, by Wyatt Paine (7th ed , 1921); J. W. Salmond, *The Law of Torts* (7th ed , 1928), Pollock (13th ed., 1929). In America· T A. Street, *The Foundations of Legal Liability* (1906), 3 vols of which vol. 1 is on Tort; F. M. Burdick, *The Law of Torts* (4th ed , 1926) (F. Po)

TORTOISE: *see* TURTLE.

TORTOISE SHELL. The tortoise shell of commerce consists of the epidermic plates covering the bony carapace of the hawksbill turtle, *Eretmochelys imbricata*, the smallest of the sea turtles. The plates of the back or carapace, technically called the head, are 13 in number, five occupying the centre, flanked by four on each side These overlap each other to the extent of one-third of their whole size, and hence they attain a large size, reaching in the largest to 8x13 in., and weighing as much as 9 ounces. The carapace has also 24 marginal pieces, called hoofs or claws, forming a serrated edge round it; but these, with the plates of the plastron, or belly, are of inferior value. The plates of tortoise shell consist of horny matter, but they are harder, more brittle and less fibrous than ordinary horn. Their value depends on the rich mottled colours they display—a warm translucent yellow, dashed and spotted with rich brown tints—and on the high polish they take and retain. The finest tortoise shell is obtained from the Eastern Archipelago, particularly from the east coast of Celebes to New Guinea; large supplies come from the West Indian islands and Brazil

Tortoise shell is worked precisely as horn; but, owing to the high value of the material, care is taken to prevent any waste in its working. The plates, as separated by heat from the bony skeleton, are keeled, curved and irregular in form. They are first flattened by heat and pressure, and superficial inequalities are rasped away. Being harder and more brittle than horn, tortoise shell requires careful treatment in moulding it into any form, and as high heat tends to darken and obscure the material it is treated at as low a heat as practicable.

For many purposes it is necessary to increase the thickness or to add to the superficial size of tortoise shell, and this is readily done by careful cleaning and rasping of the surfaces to be united, softening the plates in boiling water or sometimes by dry heat, and then pressing them tightly together by means of heated pincers or a vise. The heat softens and liquefies a superficial film of the horny material, and that with the pressure effects a perfect union of the surfaces brought together. Heat and pressure are also employed to mould the substance

Tortoise shell was a prized ornamental material from very early times. It was one of the highly esteemed treasures of the far east brought to ancient Rome by way of Egypt, and it was eagerly sought by wealthy Romans as a veneer for their rich furniture In modern times it is most characteristically used in the elaborate inlaying of cabinetwork known as buhl furniture, and in combination with silver for toilet articles. It is also employed as a veneer for small boxes and frames It is cut into combs, moulded into snuffboxes and other small boxes, formed into knife handles, and worked up into many other similar minor articles The plates from certain other tortoises, known commercially as turtle shell, possess a certain industrial value, but they are either opaque or soft and leathery, and cannot be mistaken for tortoise shell. A close imitation of tortoise shell can be made by staining translucent horn or by varieties of celluloid.

TORTONA (anc. *Dertona*), a town and episcopal see of Piedmont, Italy, in the province of Alessandria, from which it is 14 mi. E by rail, on the right bank of the Scrivia, at the northern foot of the Apennines, 394 ft. above sea-level. Pop. (1936), 13,250 (town); 20,361 (commune). Tortona is on the main line from Milan to Genoa; from it a main line runs to Alessandria, which branches to Novi and Castelnuovo Scrivia, and a steam tramway to Sale. Its fortifications were destroyed by the French after Marengo (1800), which was fought not far off, as were the battles of Novi (1799) and Montebello (1800–1859). The cathedral contains a remarkably fine Roman sarcophagus.

Dertona is spoken of by Strabo as one of the most important towns of Liguria. It stood at the point of divergence of the Via Postumia (*see* LIGURIA) and the Via Aemilia, while a branch road ran hence to Pollentia. The local museum contains Roman antiquities found here In the middle ages Tortona was zealously attached to the Guelphs, on which account it was twice laid waste by Frederick Barbarossa, in 1155 and 1163. In 1176 it made a treaty with Barbarossa and the people of Pavia, and was taken back into favour by Henry VI in 1193. It was the base headquarters of the British force in Italy in 1917–19.

See F. Gabotto, *Per la Storia di Tortona* (Biblioteca della Società Storica Subalpina, fasc. 96, 1922).

TORTOSA, a fortified city of Spain, in Tarragona province; 40 mi. by rail W.S.W. of Tarragona, on the Ebro 22 mi. above its mouth. Pop. (1940), 11,951 (mun., 38,269). Tortosa, the *Dertosa* of Strabo and the *Colonia Julia Augusta Dertosa* of numerous coins, was a city of the Ilercaones in Hispania Tarraconensis. Under the Moors it was of importance as the key of the Ebro valley It was taken by Louis the Pious in 811, but was soon recaptured. Having become a haunt of pirates, it was made the object of a crusade proclaimed by Pope Eugenius III in 1148, and was captured by Ramon Berenguer IV, count of Barcelona, assisted by Templars, Pisans and Genoese. An attempt to recapture the city in 1149 was defeated by the women folk, who thenceforth re-

ceived many privileges Tortosa fell to the duke of Orleans in 1708; during the Peninsular war it surrendered in 1811 to the French under Suchet, who held it until 1814 Tortosa is a walled town with crooked and ill-paved streets, and lofty, granite-built houses There is a modern suburb on the opposite side of the Ebro The cathedral occupies the site of a Moorish mosque built in 914. The present structure (1347), has its Gothic character disguised by a classical façade with Ionic pillars. There are manufactures of paper, hats, leather, rope:, porcelain, majolica, soap, spirits and ornaments made of palm leaves and grasses. The river fisheries are important. Corn, wine, oil, wool, silk, fruits and liquorice (a specialty of the district) are exported. The city is connected with Barcelona and Valencia by the coast railway, and with Saragossa by the Ebro valley line; it is also the terminus of a railway to San Carlos de la Rápita.

TORTURE, the general name for innumerable modes of inflicting pain, and especially for those employed as an incident of judicial process. From this point of view torture was always inflicted either as a means of eliciting evidence from a witness or from an accused person either before or after condemnation; or as a part of the punishment. The second was the earliest use.

Its development in mediaeval times may be traced to the decline of the ordeals and trial by battle. While the appeal to God (which is so marked a feature of the ordeals) exists, confession is unnecessary. Thus, the capitularies of Charlemagne make no provision for torture, while including the earlier modes of procedure. When the fourth Lateran council, in 1215, prohibited the clergy from participating in the ordeal, English law developed trial by jury for crime, and thus rendered the extraction of a confession of guilt from the prisoner unnecessary. Continental law, on the other hand, considered a confession the best of all evidence, and all the machinery of the law was organized to obtain it.

Even when torture was a normal incident of judicial procedure, enlightened lay opinion was overwhelmingly opposed to its employment. Cicero (*Pro Sulla*), Seneca and St. Augustine condemn it, although the latter regards it as a necessity, while Ulpian, in Justinian's *Digest*, declares: "Torture (*quaestio*) is not to be regarded as wholly deserving or wholly undeserving of confidence; indeed, it is untrustworthy, perilous and deceptive. For most men, by patience or the severity of the torture, come so to despise torture that the truth cannot be elicited from them; others are so impatient that they will lie in any direction rather than suffer torture, so it happens that they depose to contradictions and accuse not only themselves but others." Among later writers, Montaigne, Montesquieu, Bayle, Voltaire, Sonnenfels, Beccaria, Verri and Manzoni all condemn it. The influence of Beccaria in rendering the use of torture obsolete was undoubtedly greater than that of any other legal reformer. He emphasizes the unfair incidence of torture, as minds and bodies differ in strength. Moreover it is to confound all relations to expect that a man should be both accuser and accused, and that pain should be the test of truth, as though truth resided in the muscles and fibres of a wretch under torture. Apologists of torture may be found chiefly among jurists, but authors of books of practice, and notably Damhouder, von Rosbach, von Boden and Voet, are aware of its deficiencies. Muyart de Vouglans derives torture from the law of God. Other apologists are Simancas, bishop of Badajoz, Engel, Pedro de Castro, and in England Sir R Wiseman.

Greece.—Both Aristotle and Demosthenes regard torture as the surest means of obtaining evidence. At Athens slaves, and probably at times resident aliens, were tortured, but free citizens only rarely, the practice being forbidden by a psephism passed in the archonship of Scamandrius. Torture was sometimes inflicted in open court, and the rack was employed, even for free citizens. A list of tortures is given in the *Ranae* of Aristophanes (V. 617) and the wheel is alluded to in *Lysistrata* (V 846). Isocrates and Lysias refer to torture under the generic name of *στρέβλωσις* but it was generally called *βάσανοι* in the plural (*cf.* Lat *tormenta*). Torture was frequently inflicted by Greek despots, and both Zeno and Anaxarchus are said to have been put to it.

Rome.—The Roman system was the basis of all subsequent European systems which recognized torture as a part of their procedure, and the rules attained a refinement beyond anything approached at Athens. Cicero declares that the law of torture rested originally on custom, and no existing fragment of the Twelve Tables alludes to it It is mentioned frequently by writers both of the republic and the empire. During the republic, a master had power to torture his slaves. In the early empire, however, restrictions were imposed A *lex Petronia* forbade masters to punish slaves by making them fight wild beasts, without magisterial authorization, while Antoninus Pius required a master who ill-treated his slave to sell him. Not until the later empire was the killing of a slave by excessive punishment made homicide The law of the later empire, relating to torture, is set forth at length chiefly in the titles *De quaestionibus* of the *Digest* and the *Code*—the former consisting largely of opinions from the *Sententiae receptae* of Paulus, the latter being largely a repetition of constitutions contained in the Theodosian code. Both substantive law and procedure were dealt with, but a large discretion was left to the judges. Torture was used both in civil and criminal trials, but in the former only upon slaves and freedmen or infamous persons (after *Nov.* xc. ii upon *ignoti* and *obscuri* if they showed signs of corruption)—*e g*, gladiators—and in the absence of *alia manifesta indicia*, as in cases affecting inheritance Only slaves were tortured during the republic, but in the empire it was extended to freemen accused of crime Certain persons were exempt by a constitution of Diocletian and Maximian from the liability to torture, *e g*, soldiers, nobles of high rank, and their descendants to the third generation—*decuriones*—and their children under 14 and pregnant women. These exemptions did not extend to accusations of treason or sorcery A freeman could be tortured only where he had been inconsistent in his depositions. or where there was a suspicion of lying. There were detailed rules concerning the torture of slaves, and the Romans believed that this was the most efficacious means of obtaining the truth Unlike freemen, they could be tortured as witnesses, always on behalf of their master, against him only in treason, adultery, frauds on the revenue, coining and similar offenses, attempts by a husband or wife on the life of the other, and in cases where a master had bought a slave in order that he should not give evidence against him. The exemption from accusation by a slave extended to the owner's father, mother, wife or tutor, and a former master, but a slave-owning corporation was not privileged Where a charge of adultery was brought against the wife, her husband's. her own and her father's slaves could be tortured. Detailed rules governed the application of torture. Other modes of proof must first be exhausted, and the evidence (*argumentum* and *indicium*) must have advanced so far that the slave's confession alone was required to complete it. The amount was at the discretion of the judge, but it must not injure life or limb, otherwise the judge became *infamis*. Except in treason, the unsupported testimony of a single witness was not a sufficient ground for torture. Leading questions could not be asked. The *quaesitor* asked the questions, the *tortores* applied the instruments. The principal forms of torture were the *equuleus*, or rack, the *plumbatae*, or leaden balls, the *ungulae* or barbed hooks, the *lamina*, or hot plate, the *mala mansio* (comparable with the "Little Ease" of the Tower of London) and the *fidiculae*, or cord compressing the arm. As a part of punishment, torture existed in Rome from earliest times, when it was permitted in respect of defaulting debtors. Later, crucifixion, mutilation, exposure to wild beasts in the arena, and other modes were in common use. Through the *leges barbarorum*, Roman doctrines relating to torture were transferred, with modifications, to mediaeval Europe.

The Church.—The Church, although adopting a good deal of Roman law, was at first definitely opposed to torture. Thus the synod at Rome in 384 condemned it. In 1252, a bull of Innocent IV directed the civil power to torture heretics, but the canon law had little to say upon the subject, holding that although it was no sin in the faithful to inflict torture, a priest might not do so with his own hands. In later times, torture was inflicted by the Inquisition Torquemada's code of instructions (1484) provided that an accused might be tortured if *semiplena probatio* existed against him, *i.e.*, so much evidence as to raise a grave pre-

sumption of guilt. Confessions extracted during torture required subsequent confirmation, but retractation involved further torture or extraordinary punishment. One or two inquisitors, or a commissioner of the holy office, were bound to be present at all examinations. Following certain abuses, a decree of Philip II in 1588 forbade torture without an order from the council, but the decree was not fully observed An edict of the Inquisitor-General Valdés, in 1561, left torture to the prudence and equity of the judges. They must consider motives and circumstances before decreeing torture, and must declare if it were to be employed *in caput proprium*, i.e., to extort a confession, or *in caput alienum*, i.e., to incriminate an accomplice. Torture was not to be decreed until the termination of the process and after defense heard, and the decree was subject to appeal, but only in doubtful cases, to the Council of the Supreme. It was only in doubtful cases that the inquisitors were bound to consult the council On ratification 24 hours afterward of a confession made under torture, the accused might be reconciled, if sincerely repentant, or if convicted of bad faith he might be delivered to the secular power to be burned. Torture ceased to be inflicted before the suppression of the Inquisition, and a papal bull in 1816 decreed its abolition. The actual rules, *e.g.*, Torquemada's, were not so cruel as the construction put upon them by inquisitors. Thus Torquemada's direction that torture should only be renewed for retractation was evaded by terming renewed torture a continuation Besides the two sets of rules already mentioned, those of Nicholas Eymenico, grand inquisitor of Aragon about 1368, and of Simancas, two centuries later, deserve mention. In 1545 and 1550, Charles V issued instructions for the guidance of inquisitors. Abuses, however, were exceedingly frequent.

England.—The English common law never recognized the legality of torture (except perhaps in the early ordeals) and Coke, commenting on Magna Carta, cap. 29, observes: "No man destroyed, etc, that is, forejudged of life or limb, disinherited, or put to torture or death" (2. *Inst.* 48 b). The Bill of Rights also provided that cruel and unusual punishments ought not to be inflicted. Judicial opinion was always in theory opposed to it, and in Felton's case (1628) a resolution of the judges declared "that he ought not by the law to be tortured by the rack, for no such punishment is known or allowed by our law." Accordingly, in only two instances was a warrant to torture issued by a common law judge, although it was an incident in criminal procedure for several centuries, being ordered either by the crown or council, or some extraordinary tribunal, and especially by the star chamber. Cases occur as early as the 13th century, and continue down to 1640. One case only is recorded after this date, three Portuguese being tortured at Plymouth during the Commonwealth. The rack was introduced in the reign of Henry VI by the duke of Exeter, and was hence known as "the duke of Exeter's daughter." Other varieties of torture were "the scavenger's daughter," or manacles, which pressed the victim's head to his feet, the iron gauntlets or bilboes, and the cell called "Little Ease." In Elizabeth's reign, the rack was in constant use. Witnesses were never tortured.

One peculiar form of torture was not unknown to the common law—the *peine forte et dure*. If a prisoner refused to plead, remaining mute of malice, he was stretched upon his back, and pressed with heavy weights, until he either consented to plead, or died This practice was abolished by 12 Geo III c. 20, a case having occurred so late as 1726. Tying the thumbs with whipcord was frequently used instead of the *peine*. Witch trials also involved incidents of torture, such as throwing the accused into a pond to discover whether she would sink or swim.

As a part of punishment, torture by mutilation appears in pre-conquest codes and in the assize of Northampton (1176) Later examples are burning to death for heresy, drawing and quartering for treason, branding in the hand for felony, the pillory, the stocks, branks and ducking stool. All these have now been abolished, although corporal punishment for robbery with violence and for juvenile offenders still exists.

Scotland.—Torture was long a recognized part of Scottish criminal procedure. Numerous instances occur in the *Register of the Privy Council*. The last warrant was issued in 1690, and it was finally abolished in 1708. Among the most celebrated forms employed in Scotland was the "boot" The "boot," comprising a long iron boot in which the foot was inserted, wedges being then driven between the limb and the boot, was not peculiar to Scotland for records are found in French criminal trials, and again in Ireland, where in 1583, Hurley, a priest, was tortured in Dublin by "toasting his feet against the fire with hot boots"; this species of torture was employed, not only for crime, but as an incident in religious persecution (Lecky, *Rationalism in Europe*, 1865, ii, p. 45), and sometimes by the nobility for their own ends. Thus in 1605, a suit was brought against the earl of Orkney, for putting a son of Sir Patrick Bellenden in the boots. Other Scottish methods of torture were the rack, the pilniewnkis (known in England as the thumbikins, and resembling the thumbscrew), the caschielaws (an instrument drawing the body and limbs together, heat being applied in some cases), the lang irnis (heavy weights, sometimes exceeding 50 stones), the harrow bore (perforations through which the teeth of harrows were inserted), the pynebankis (a variety of the rack) and the artificial prevention of sleep.

Ireland.—Torture was recognized in Ireland neither by statute nor by common law, and few cases are recorded of its infliction In 1566, however, the president and council of Munster, or any three of them, were empowered to inflict torture "upon vehement presumption of any great offense in any party committed against the queen's majesty."

British Colonies and Dependencies.—In any British possession, the infliction of torture was usually regarded as contrary to law. In 1806, however, Sir Thomas Picton, the governor of Trinidad, was tried for subjecting Luisa Calderon to the torture of the pique, in which the sufferer was supported only on the great toe, which rested on a sharp stake, and by a rope attached to one arm One of the grounds for defense was that torture was authorized by the Spanish law of the island. The accused was convicted, but sentence was respited. Warren Hastings was also charged with extortion from the begums of Oude by means of the torture of their servants The Indian penal code now expressly forbids torture. In Ceylon it was formerly allowed by the Dutch, but was abolished by royal proclamation in 1799.

United States.—In 1692, Giles Cory of Salem, accused of witchcraft, refused to plead, and was subjected to the *peine forte et dure* The constitution of the U.S. forbids cruel and unusual punishments, on which there have been numerous decisions

CONTINENTAL EUROPEAN STATES

These fall into four main groups, the Latin, Teutonic, Scandinavian and Slav states. The principles of Roman law were generally adopted in the first and second groups.

France.—In France, torture does not seem to have existed as a recognized practice before the 13th century. From then until the 17th century it was regulated by a series of royal *ordonnances*, and was applied only in the royal courts, its place in the seigneurial courts being supplied by the judicial combat. The earliest *ordonnance* was that of Louis IX in 1254, for the reformation of the law of Languedoc. It enacted that persons of good fame, though poor, were not to be put to the question on the evidence of one witness. In 1670, an *ordonnance* of Louis XIV regulated the infliction of torture for more than a century. Two kinds were recognized, the *question préparatoire* and the *question préalable* The first was abolished by royal decree in 1780, but in 1788 the parlements refused to register a decree abolishing the *préalable*. Torture of all kinds was abolished by an *ordonnance* of Oct 9, 1789, however, and the modern *code pénal* enacts that criminals employing torture to further their ends shall be guilty of assassination, while it is also an offense to torture a person under arrest.

Italy.—The law as it existed in Italy is contained in a long line of authorities chiefly supplied by the school of Bologna, beginning with the *glossatores* and continued by the *post-glossatores* until the system attained its perfection in the vast work of Farinaccius, in the early 17th century, where every possible question that could arise is treated with revolting completeness The writings of the jurists were supplemented by a large body of legislative enactments in most of the Italian states, extending from the

constitutions of the Emperor Frederick II down to the 18th century

Farinaccius was procurator general to Pope Paul V, and the principal feature of his work is the minute and skilful analysis of *indicia, fama, praesumptio*, and other technical terms. For every infraction of torture a distinct *indicium* is required. A single witness ca an accomplice constitutes an *indicium*. This rule does not apply where torture is inflicted for discovering accomplices or a crime other than that for which it was originally inflicted. Torture may be ordered in all criminal cases, except small offenses, and in certain civil cases, such as denial of a *depositum*, bankruptcy, usury, treasure trove and fiscal cases. It may be inflicted on all persons, unless specially exempted (*e.g.*, clergy and minors) and even those exempted may be tortured by command of the sovereign.

There are three kinds of torture, *levis, gravis* and *gravissima*, the first and second corresponding to the ordinary torture of French writers, the last to the extraordinary. This last was as much as could possibly be borne without destroying life. The judge could not begin with torture; it was only a *subsidium*. If inflicted without due course of law, it was void as a proof.

Among other important writers was Julius Clarus of Alessandria, a member of the council of Philip II. Generally, he follows Farinaccius. He puts the questions for the consideration of the judge with great clearness. These are—whether (1) a crime was committed, (2) the charge is one in which torture is admissible, (3) the fact can be proved otherwise, (4) the crime was secret or open, (5) the object of the torture is to elicit confession of crime or discovery of accomplices. The clergy can be tortured only in charges of treason, poisoning and violation of tombs

Other Italian writers of less eminence are Guido de Suzara, Paris de Puteo, Aegidius Bossius of Milan, Casonus of Venice, Decianus, Follerius and Tranquillus Ambrosianus. Torture was abolished in Tuscany in 1786, largely owing to the influence of Beccaria, and other states followed. The *puntale*, or piquet, however, existed in practice at Naples until 1859 Savonarola, Machiavelli, Giordano Bruno, Campenella are among those subjected to torture in Italian history. Galileo appears only to have been threatened with the *esame rigoroso*. The historical case of the greatest literary interest is that of the persons accused of bringing the plague into Milan in 1630 by smearing the walls of houses with poison.

Spain.—In Spain, Roman law was carried through the Visigothic code and the *Fuero juzgo* down to the *Siete partidas*, compiled by Alfonzo the Wise in 1243, and promulgated in 1256. Torment is defined as a manner of punishment which lovers of justice use, to scrutinize by it the truth of crimes committed secretly, and not provable in any other manner. Repetition was allowed in case of grave crimes. There were the usual provisions for the infliction of torture only by a judge having jurisdiction, and for the liability of the judge for exceeding legal limits. Subsequent codes did little more than amend the *Partidas* in matters of procedure In Aragon, while it was an independent state, torture was not in use to the same extent as in other parts of Spain. It was abolished in the 13th century by the General Privilege of 1283, except for vagabonds charged with coining. A statute of 1335 made it unlawful to put any freeman to the torture. On the other hand, the Aragonese nobility had power to put a criminal to death by cold, hunger and thirst. The jurists dealing with the subject are not as numerous as in Italy, no doubt because Italian opinions were received as law in all countries whose systems were based on Roman law. Among them are Suarez de Paz, Antonio Gomez and Alvarez de Velasco. The Peruvian, Juan de Hevia Bolanos, who wrote at the beginning of the 19th century, should also be noted.

The principal Spanish tortures, according to Suarez de Paz, were the water and cord, the pulley or *strappado*, the hot brick, and the *tabillas*, or thumbscrew and boot combined.

Teutonic States.—Germany (including Austria) possesses the most extensive literature and legislation on the subject The principal writers are Langer, von Rosbach, von Boden, Ulrich Tengler, Remus, Casonus and Carpzow. Legislation was partly for the empire, partly for its component states. Imperial legislation dealt with the matter in the Golden Bull (1356), the Ordinance of Bamberg (1507), the Carolina (1532) and the *Constitutio criminalis theresiana* (1768) Torture was formally abolished in the empire in 1776. In Prussia it was practically abolished by Frederick the Great in 1740, formally in 1805. Even before its abolition it was in use only to discover accomplices after conviction. In some other states it existed longer, in Baden as late as 1831.

The Netherlands.—The principal legislative enactment was the code of Philip II, known as the *Ordonnance sur le style* (1570). One of its main objects was to assimilate the varieties of local custom, as the *Nueva recopilacion* had done in Spain three years earlier. Certain cities of Brabant, however, still claimed the privilege of torturing in certain cases not permitted by the ordinance, *e g*, where there was only one witness. This law continued to be the basis of criminal procedure in the Austrian Netherlands until 1787, and in the United Provinces until 1798. The principal text writers are Damhouder, van Leeuwen and Voet, who took the same view as St. Augustine as to the uselessness of torture, and compared its effect with that of trial by battle.

Scandinavian Countries.—There is a notice of torture in the Icelandic code known as the Grágás (about 1119) Judicial torture is said to have been introduced into Denmark by Valdemar I in 1157. In the code of Christian V (1683) it was limited to cases of treason. It was abolished by the influence of Struensee in 1771, but notwithstanding this he was threatened with it, though it was not actually inflicted, before his execution in 1772 In Sweden torture never existed as a system, and in the code of 1734, it was expressly forbidden. It was, however, occasionally inflicted, as in England, by extrajudicial authorities, called secret committees. The "cave of roses," where reptiles were kept for the purpose of torture, was closed by Gustavus III in 1772.

Slav Countries.—The earliest mention of torture is that of the mutilation provided for certain offenses by the code of Stephen Dushan in 1349. In Russia torture does not occur in the recensions of the earlier law. It was possibly of Tatar origin, and the earliest mention of it in an official document is probably in the *Sudebnik* of Ivan the Terrible (1497). In the ordinance of 1556 there are elaborate regulations, which were not always observed in periods of political disturbance, and torture was used even as a means of enforcing payment of debts. The reaction begins with Peter the Great and culminates with Catherine II, who was largely influenced by the opinions of Beccaria and Voltaire. In the instructions to the commission for framing a criminal code (1776) it is declared that all punishments by which the body is maimed ought to be abolished, and that the rack violates the rules of equity and does not produce the end proposed by the laws. It was formally abolished by Alexander I in 1801, and in 1832 the *Svod Zakonov* subjected to penalties any judge who presumed to order it. But as late as 1847 it was inflicted in one or two exceptional cases.

ASIATIC COUNTRIES

Numerous accounts of tortures inflicted by Asiatic monarchs survive in the narratives of early travellers. Of these, Olearius' *Voyages and Travels of the Ambassadors*, translated by John Davies (1662), is informative. From these accounts it is apparent that torture was used regularly in the east both as an incident in judicial process, and as a part of punishment, and in some countries at least there seem to have been few checks on its employment beyond the whim of the monarch In Persia, Olearius records that such punishments as mutilation and sawing asunder were in use. In India, again, the local despots employed torture as a mode of extracting evidence.

Japan.—Japanese law was particularly severe, both procedurally and in its punishments In trials for theft, a piece of red-hot iron was placed in the hands of the accused, who then flung it away. If his hand was unburned, he was innocent; if burned, guilty. The punishment for theft involved tying the offender to great canes in the form of a cross, and his body was then twice run through diagonally by a spear. Confession was usually neces-

sary before conviction, and in order to extract it, a "boot" consisting of heavy wooden planks was employed, and also the bowstrings. As a punishment, crucifixion was in general use, and accounts of fiendish tortures inflicted on Christians in the 17th century survive. (*See* Olearius 154–155, and Murdoch's *History of Japan*.)

China.—In China, and other countries where the Chinese criminal code was accepted with local modifications (*e.g.*, Annam and Burma), some regulation of the use of torture was attempted, although abuses were frequent. As in Japan, confession by the accused was necessary before punishment. The *Ta T'sing Lu Li*, the code of the Manchu dynasty, therefore, prescribes certain forms of judicial torture. These were applicable to witnesses also, and include the "boot" (which appeared in two forms: [1] boards between which the leg of the accused was crushed, and [2] a receptacle in which the leg was placed and boiling oil poured); the finger-compressor, kneeling on chains and beating the face. Those below 15 years of age, or more than 70, were exempt from torture, and also those suffering from permanent disease or other infirmity.

Other forms, more cruel than those sanctioned by the code existed, although according to the code, a magistrate who applied torture wantonly or arbitrarily was liable to prosecution. Among the illegal tortures, reported by the *Chinese Repository* (vol. IV) to be in use at the beginning of the 19th century were nailing to boards, beds of iron, red-hot spikes, boiling water, knives for cutting the tendon Achilles, the beauty's bar (so named after the wife of a judge, and comprising three crossbars to which the breast, the small of the back, and the legs bent up were fastened), the parrot's beam (in which the prisoner was raised from the ground by strings round the fingers and thumbs, attached to a beam) and the refining furnace.

Torture was also an incident in many punishments, execution by slow cutting to pieces being the most famous. In addition there were flogging (both with heavy and light bamboo) and the cangue, an instrument resembling, and having the same object as the pillory. Though theoretically abolished at the beginning of the 20th century, torture is still practised in many parts of China.

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TORY: *see* WHIG AND TORY.

TOSARI, the chief mountain resort in Java, Netherlands Indies. It is situated about 25 mi. from Pasuruan, from which it is reached by a good motor road, with easy gradients, through delightful country, by way of Gondang, Pasrepan and Poespa. Tosari is built on a long, winding tree-clad ridge, a spur of the Tengger mountains, at an average altitude of 5,840 ft. above sea level, with a very steep descent facing northeastward to the Straits of Madura. It is a centre for many excursions.

TOSCANELLA: *see* TUSCANIA.

TOSCANINI, ARTURO (1867–), musician and orchestral conductor of distinction, was born in Parma, Italy, March 25, 1867 and educated in music at the Royal conservatory of that city. He conducted at La Scala opera house, Milan (1898–1908, 1920–1929), at the Metropolitan opera house, New York city (1908–1975), and for the New York Philharmonic society from 1926 to 1936. In 1937 he organized the National Broadcasting company's symphony orchestra.

TOSTIG (d. 1066), earl of Northumbria, was a son of Earl Godwine, and in 1051 married Judith, sister or daughter of Baldwin V, Count of Flanders. In the year of his marriage he shared the short exile of his father, returning with him to England in 1052, and became earl of Northumbria after the death of Earl Siward in 1055. He was intimate with his brother-in-law, Edward the Confessor, and in 1061 he visited Pope Nicholas II at Rome in the company of Aldred, archbishop of York. Tostig introduced a certain amount of order into the wild northern district under his rule, but his severity made him exceedingly unpopular, and in 1065 Northumbria broke into open revolt. Declaring Tostig an outlaw and choosing Morkere in his stead, the rebels marched southward and were met at Oxford by Earl Harold, who, rather against the will of the king, granted their demands. Tostig sailed to Flanders and thence to Normandy, where he offered his services to Duke William. He harried the Isle of Wight and the Kentish and Lincolnshire coasts and later joined Harald III (Hardraha) of Norway in a descent upon York. But Harold, now king, surprised the invaders at Stamford bridge, and in the battle which followed on Sept. 25, 1066, both Tostig and the Norwegian king were slain. Tostig's two sons fled to Norway while his widow, Judith, married Welf, duke of Bavaria.

TOTALITARIAN STATE, an expression used in reference to the nazi government of Germany, the fascist of Italy, and the communistic of Russia in which there is complete centralization of control. In the totalitarian state political parties are suppressed or "co-ordinated" into one party and the conflict of classes is obscured by emphasis on the organic unity of the state.

TOTALIZATOR. The totalizator is a complex device used to facilitate pari-mutuel wagering at race tracks. The machine and the system are not synonymous although often so considered because in many countries mutuel wagering is permitted only in conjunction with the machines.

Prior to 1872 all wagers were made either directly between interested persons or with bookmakers. The pari-mutuel system was invented in France by M. Oller about 1870; first operated in 1872; outlawed in 1874; and legalized in 1887 upon the recommendation of the minister of agriculture. The derivation of the word is from the French *pari*, meaning "wager,"—and *mutuel*, meaning "with reciprocal interests" or "in common." Therefore, the broad interpretation is "to wager in common" or "to wager among themselves." The effect is to make a true market, to ensure a return exactly in accordance with the mass opinion, as opposed to the bookmaking method under which the return depends upon the judgment of the bookmaker, or the necessity under which he labours to round-out his particular book. Each bookmaking transaction is a separate contract in which the "player" and the "layer" agree as to odds and conditions at the time the bet is made.

Under the rules governing pari-mutuel wagering, the player purchases a participation in the pool and has no assurance as to his return should he win, beyond the knowledge that he will share proportionately with all players of the same opinion. He receives no unfair advantage, nor does he suffer from any discrimination. Obviously, the pari-mutuel is the fairest to the general public. The difficulties lie in finding a responsible stakeholder, and in the mechanics of gathering, holding and distributing the stakes. About 1880, owners of race tracks or state agencies began to fulfil the function of the stakeholder. The manner in which bets are collected, and dividends calculated and distributed vary with the customs of the country.

In some cases wagering is in one pool only, and an arbitrary percentage is set aside for those who bet to "win" and the balance is distributed among those who bet to "place." This is unsatisfactory and is tolerated rather than approved. Under this system it is possible to receive a return which is less than the original bet. Except in the U.S., the general practice is to operate two pools, namely, the "win" pool and the "place" pool. All money wagered in the "win" pool, after deduction of the stake-

holder's fee, is divided among those betting on the winning horse to win. After deducting the stakeholder's fee, the money wagered in the "place" pool is divided into three equal parts and distributed among the holders of tickets on each of the three "place" horses, one part to each group. A horse is said to "place" which runs third or better. This method also makes possible a return less than the original wager.

In the U.S an entirely different method is used for both wagering and calculating profit. There are three pools instead of two. The "straight" pool for the winner only; the "place" pool for the

EXAMPLE

In U S The "Show" Pool		Elsewhere The "Place" Pool
100,000 units	Total pool	100,000 units
50,000 units	Amount bet on winner	50,000 units
10,000 units	Amount bet on 2nd horse	10,000 units
5,000 units	Amount bet on 3rd horse	5,000 units
	Method of Calculation	
100,000 units	Total pool	100,000 units
10,000 units	Stakeholder's fee (10%)	10,000 units
90,000 units	Amount returned to public	90,000 units
65,000 units	Amount bet on first three horses	(not considered)
25,000 units	Profit or actual winnings	(not considered)
8,333 units	Amount (of profit) shared by each group	30,000 units
$\frac{8,333}{50,000}+1=1.15$*	Returned per unit wagered (first horse)†	$\frac{30,000}{50,000}=.60$ (this is a loss of .40)
$\frac{8,333}{10,000}+1=1.80$*	Returned per unit wagered (second horse)†	$\frac{30,000}{10,000}=3$
$\frac{8,333}{5,000}+1=2.65$*	Returned per unit wagered (third horse)†	$\frac{30,000}{5,000}=6$

*Odd pennies above the nearest 5 cents are called "breakage" and retained by the stakeholder †A $2.00 bet would return twice the amount shown

first and second horses and the "show" pool for horses which run third or better. The "show" pool corresponds to the "place" pool used elsewhere, and "place" betting as conducted in the U.S. is unknown abroad. The distribution of the "straight" pool is as described above. In the "place" and "show" pools, after deducting the stakeholder's fee, the amount bet on the first two contestants in the former and the first three contestants in the latter is also deducted and the balance remaining is then divided into two or three parts and distributed equally between the backers of the respective contestants plus their original stake Thus all holders of winning tickets must win. If a deficit occurs because of the deduction of the stakeholder's fee, the stakeholder must make it good, plus a minimum of five cents on the dollar as profit.

Credit for the invention of the first totalizator is given Ekberg, who developed a mechanical, hand-actuated machine, placed in operation at the Canterbury Jockey club course, Christchurch, New Zealand, in 1880. George Julius, enlarging upon Ekberg's principle, developed a very ingenious electro-mechanical totalizator which was first used at Ellersie race course, Auckland, New Zealand, in 1913. This was the first totalizator comparable to those in use today. It was first called the "Julius" and later the "Premier" totalizator. It was introduced into Europe at the Longchamps course, near Paris, in 1928; into England at Northholt and on several greyhound tracks in 1930; into the U.S. at Hialeah park, Florida, in 1932.

Prior to the installation in Florida there had been no totalizator in use in the U.S., although pari-mutuel betting had been introduced in 1908 and had flourished after 1913. Individual "clickers," which soon became known as the "iron men," but which were simple hand-tripped cyclometers located behind each selling booth, were the nearest approach to machine betting Crude though these were, they fulfilled a great need as they indicated the trend of betting. Great crowds would gather before the sellers of the higher valued tickets to learn how "smart" money was bet before rushing to make their own wagers. The interest shown in these simple mechanisms stressed the need of a more adequate machine.

Nothing was known in the U.S. of the totalizator in use in Europe and the U.S. totalizator was designed without reference to prior developments. This totalizator is a compact, portable, electrical machine making use of parts commonly employed in automatic telephony. Credit for this invention is usually given to H. L. Straus of Baltimore, Md., although much of the development was carried on by A. J. Johnston of the General Electric company, assisted by engineers of the Automatic Electric company of Chicago.

The ticket vending machines used with the American totalizator and on most English race tracks were invented and developed in England by the Bell Punch & Printing company of Uxbridge The first totalizator of this type was installed at New Market, England, in 1930, under the supervision of the British Race Course Betting Control board.

The totalizator fulfils three major functions: it must print and issue pari-mutuel tickets; it must summarize the sale of all such tickets; and it must display to public view the progress of wagering at all times. When it is remembered that tickets are often sold simultaneously from as many as 300 or 400 vending machines; that they vary in value from $2.00 to $100.00 or from 10 francs to 1,000 francs; that their aggregate value must be assayed, and the exact amount of money (or the exact number of units) wagered on each contestant and the total in each separate pool publicly displayed, some idea of the complexity of the problem may be gained. The necessity of protecting against counterfeiting, the need for foolproof interlocking to prevent errors, and to apprise the operators of failures, and the speed required to handle wagers (which on May 13, 1944, at Belmont park, Long Island, amounted to $3,650,000.00)—calls for a perfection of design and reliability of operation never before attained.

The *ticket vending machines* may vary from simple hand-operated deal boxes from which a preprinted pari-mutuel ticket is ejected by means of a lever or slide, to complicated printing presses which automatically print and issue tickets by the depression of a selection key. The bettor having indicated to the vendor the name or number of the contestant on which he desires to wager, the vendor depresses the corresponding key which sets in motion the following sequence of events· Electrical impulses are sent to the appropriate adding machine for the contestant and to the grand total adding machine for the pool selected. When the individual adding machine has recorded the wager, an acknowledging impulse sets the rotary press in motion The press then prints the complete pari-mutuel ticket from a roll of specially designed paper with which the machine is supplied, cuts the ticket from the roll, ejects it from the machine and returns to the neutral position. The machine remains locked in this position until the electrical impulse to the grand total adding machine is accepted and acknowledged, which acknowledgment returns the vending machine to an operating condition. The time required for the completion of the circuit is in milliseconds; therefore, the cycle is largely dependent upon the speed of the press The machines are usually capable of printing and issuing from 40 to 55 tickets per minute.

Each machine is designed to issue tickets of one denomination only. In the U.S. they issue for one pool only, viz., straight, place, or show; or combinations of straight and place, or straight, place, and show In other countries wagering is either in one pool only or in straight and place pools, hence, the vending machines usually are capable of selecting the pool as well as the contestant. The actual mechanics vary with different manufacturers' designs but the principle is as stated above. All vending machines are electrically locked by a designated official at the instant the race begins, protecting the public from unauthorized sales. They are unlocked in the same way only after suitable precautions have been taken to ensure the sale of tickets for the ensuing race only.

The *adding machines* in general use fall into two categories: (1) the electro-mechanical, and (2) the electrical The first makes use of a motor-driven collecting or accumulating device which actuates an electrically operated escapement mechanism usually driven through slipping belts As wagers are received the locking gears are disengaged and the driven shaft is permitted to turn a distance calibrated to correspond to the value of the wager, say 2° for a $2.00 bet and 10° for a $10.00 bet The turning shaft either actuates a self-synchronous motor which keeps a similar motor operating the indicator board in step, or actuates indicator drums by direct gearing or by means of chains and sprockets This is the method used by the machines operating in most countries. In the U.S. and, to a large extent, in England, the electri

cal totalizator is used

The electrical totalizator operates on an entirely different principle. Wagers are collected by means of either a multiple bank rotary switch, or by a relay chain As bets are collected, betting relays are actuated which correspond to the value of the wagers. These relays step appropriate rotary switches, in the units, tens, hundreds, and thousands positions, etc. Each position of these switches energizes a combination of indicator relays which cause illuminated numerals to appear on the display boards

In both systems, the problem is complicated by the necessity of maintaining not only great speed and accuracy, but of obtaining instantaneous alarms if a bet fails to get through. This alarm system must indicate both the source and the cause of trouble.

The *indicator boards*, upon which the attention of the public is focused, display either the number of units or the amount of money wagered on each contestant in each pool and the total for each pool. In some cases the exact odds are automatically displayed for the "straight" or "win" pool instead of the amount wagered. Usually the amount is shown and approximate odds are set up in addition by means of mechanically actuated indicators. In the "place" pool (and in the "place" and "show" pools in the U S.) amounts are always shown.

Types of indicators vary widely The earliest and most commonly used, except in the U S and England, are large drums driven by gears or by chains and sprockets, built on the cyclometer principle. These are cumbersome, possess undue inertia and are as difficult to stop as to start. A more ingenious device is of the "flapper" type where one-half the numeral is painted on the top and one-half on the bottom of a nest of flat plates which flip into position in sequence under the impulse of the actuating shaft.

A third method utilizes a vertical ribbon which is wound on a shaft operated by a self-synchronous motor. This ribbon is coloured in contrast to the background of the indicator board, upon which are painted the odds which the winner will pay, or numerals indicating units or dollars wagered, usually in calibrations of 1,000. The result is read as one would read a thermometer and such boards are called "thermometer boards."

The most modern indicators consist of nests of incandescent lamps, 24 lamps to the unit, combinations of which are capable of displaying any numeral from 1 to 0 The selection of the proper digit is made possible by energizing two of the five relays, which are an integral part of each indicator. In this device the only moving units are small telephone type relays. There is no inertia and no necessity for a sequence of operation The speed of indication is so great that it eliminates all the difficulties inherent in other methods and the result displayed is accurate to the final unit, which is impossible in the thermometer type. Indicator boards so equipped may be placed at any desired location and at any distance from the totalizator adding machine equipment, the only interconnecting link being multiconductor cable to carry the electrical impulses from the adding machines.

There has been a steady growth in pari-mutuel betting after 1930 It has become increasingly popular in England and the U S. In the latter country in 1942 there were 21 states in which it was permitted, whereas in 1924 there were but 4. There were 46 race tracks using totalizators, through which the sum of $650,000,000 00 was wagered in 1943. In other countries World War II caused a diminution of betting, but an amount exceeding 2,000,000,000 francs was wagered in France in 1937 (H L. STR.)

TOTANA, a town of eastern Spain, in the province of Murcia, on the Lorca-Murcia railway Pop (1940) 10,368 (mun., 15,264) The town consists of two parts, the Barrio de Sevilla and Barrio de Triana Water is conveyed to Totana from the Sierra de Espuña by an aqueduct 7 mi long. Saltpetre is obtained among the hills, and there is a thriving trade in wheat, oranges, olives, almonds, and wine from the Sangonera valley.

TOTEMISM. The term "totemism" is used for a feature of the religion and social organization of widespread occurrence among primitive peoples The name *totem* is derived from an Ojibway word, but has now been generalized by anthropologists to describe an institution, the Ojibway form of which is not typical Unfortunately, many writers have used the term totemism very loosely for any beliefs and practices dependent upon some supposed connection between animals and persons The term should be restricted to those cases where a systematic association of groups of persons with species of animals (occasionally plants or inanimate objects) is connected with a certain element of social organization. In the widest use of the term, we may speak of totemism if (1) the tribe said to be totemic consists of a number of groups (totem groups) comprising the whole tribe, each of which groups has a certain relationship to a species (totem), animate or inanimate, (2) the relation between each group and species is of the same general kind for each group, and (3) a member of one of these totemic groups cannot (except under special circumstances) change his membership.

By this definition one essential peculiarity of totemism is the association of groups of persons with groups of animals or objects, not of individual persons with individual animals, a common enough phenomenon, which, however, it is desirable not to include under totemism. Another peculiarity is the division of the tribe into several totemic groups, so that, while every member of the tribe has a totem, persons living in the same locality may yet differ as to their totems

As to the determination of the membership of the totem-group, *i.e.*, the social side of totemism and the nature of the relationship between totem-group and totem, *i.e.*, the religious side of totemism, one kind of totem-group is commoner than any other, viz., the clan, an exogamous group (*s.e.*, a group within which marriage is forbidden), determined by descent, either through the father (patrilineal descent), or through the mother (matrilineal descent).

The clan (*q.v.*), is a group of great importance in primitive society, for it determines behaviour in a variety of ways, and is often of more importance than smaller groups, such as the family, or wider groups, such as the tribe. Members of a clan generally regard themselves as closely related, whether or not they can trace relationship genealogically, and frequently hold themselves and are held by others to be mutually responsible for the actions of their clan-brothers. In some parts of the world, where clans are widely dispersed, the totem serves as the only sign of clan-relationship, and a man will be welcomed, on account of his totem, as a clan-brother by distant members of his clan, whom he has never seen, and will also avoid sexual relations with the women of that group, though unable to trace relationship The discovery of this association of totemism with the clan has given rise to one of the most interesting problems of anthropology. for it would seem that any theory of origin of totemism must also explain exogamy.

Although totemism is generally associated with the clan, the tribe is also sometimes divided into totemic groups, which are not exogamous For example, the Arunta (*q.v.*), of central Australia are divided into totemic groups, membership of which depends upon the accident of position of the mother at the moment of realization of pregnancy, and there is no exogamic restriction on the members of these groups There are also totemic groups in Africa and elsewhere that are more or less endogamous (*s.e.*, required to marry within the group). Furthermore, a tribe may be divided in more than one way into totemic groups; for example, in Australia we sometimes find, in addition to totemic clans, moieties (exogamous halves of the tribe, each of which includes a number of clans), and marriage-classes (groups with indirect descent, which are specially connected with the regulation of marriage), which may be more or less totemic, and even a division of totems according to sex.

Variations of the relationship between totem-group and totem, are considerable in different parts of the world. In the first place, the totem shows extraordinary variety. While an animal-species is the most usual form of totem, plant-species are by no means uncommon, and [illegible]ss es of material objects are occasionally found: even abstract q[illegible]s, such as "pride," the totem of a clan of a weaver caste in [illegible]as, and "red," the totem of an Omaha clan A peculiar vari[illegible]totem is the split totem, in which only part of a thing is th[illegible]n; *e.g.*, instead of buffaloes, buffalo tongues

occur as the totem of one Omaha sub-clan. No doubt, split totems are the result of division of a totemic group into several groups Cross-totems, however, are less intelligible A cross-totem consists of one part of more than one kind of thing, *e g*, the ends of things are the cross-totem of a certain Samoan group, the ears of animals of any species the totem of a Mahili clan, Bengal Again, one totemic group may have a number of totems, which are then called linked totems; *e g.*, clans in south-east New Guinea are always associated with a species of bird, of plant, of fish and of snake, the last three being subordinate to the bird totem

Although there are considerable differences in the relation between totem-group and totem, owing to differences in the kind of totem, there are also great differences between tribes, apart from this In one tribe we may find a strong avoidance of the totem-animal, which may neither be killed nor eaten, while in other tribes the same animal may be killed with comparative impunity. Nevertheless, this tabu on killing or eating the totem seems to be typical of totemism, and some avoidances in connection with the totem are probably present in all cases. But although these tabus may be of great severity—an offender may be severely punished by his totem-group, and, if not punished by his own totem-group, may yet be supposed to suffer through the action of the totem itself—they apply only to the particular totem-group. For example, an Australian, whose totem is the witchetty-grub, will respect and avoid this animal, but will not hinder his friends and relations of other clans from making use of this food, and will even conduct ceremonies of which the avowed object is the increase of the totem, so as to provide food for other clans in the tribe In some cases, the totemic tabus must be observed by persons outside the totem-group; *e.g.*, in south-east New Guinea, where a man is a member of the totem-group of his mother, the totems of the father are even more rigidly tabu than his own totems; and amongst the totemic peoples of Africa, it is common for a woman to adopt the totem-avoidances of her husband Curiously enough, associated with severe tabus on the killing of the totem a totemic sacrifice has been reported from Australia, in which the totem-animal is cruelly killed and eaten

The totemic tabu is usually associated with a belief in some sort of kinship between the totemic group and the totem, which makes the tabu more intelligible. In line with this is the frequent belief in descent from the totem, or of totem and totem-group from some common ancestor. Another expression of this attitude towards the totem is the performance of ceremonies, in which the totem is represented symbolically or realistically Badges, masks and mutilations may also be used to make this identification Finally, although worship of the totem or prayer never occurs—animal worship has little in common with totemism—it is not unusual for the totemic group to believe that members of the totem species assist the group by means of omens, or in other ways Such being the general characteristics of totemism in all those cases which it is convenient to regard as totemism, a survey of the chief areas of totemism will reveal the diversity of form which totemism takes.

Australia.—Totemism has generally been regarded as occurring in Australia in its most complete and original form, not so much on account of the elaborateness of Australian totemism, but because totemism has been regarded as the most primitive religion, and Australians are the most primitive people that we know Both these propositions can be disputed, but Australian totemism is of exceptional interest, for the greater part of Australian religion may be brought under the heading "totemism." Australian totemism has an equally important economic and social side. Among the tribes of central Australia all those important happenings, such as the origin of man and his customs, and the recurrence of death and birth, are well explained in totemic terms, for in olden (*alcheringa*) days there were only totemic beings, emu, grub, and so on, half animal in form, half human. These spirits were creative and made the stock of souls, which have ever since been the souls of human beings by continual reincarnation, these souls themselves being totemic in nature. Birth is thus due to the entry of one of these spirits into the womb of a woman, death to its departure from the body Between incarnations these spirits abide in certain centres, known as totem-centres, and tend to be associated with certain objects, which are kept in these centres, and which are used in totemic ceremonies. It might seem that such a theory of birth and death would offer difficulties, except in such cases as the Arunta, where the totem of the child is not determined by descent, but the native gets over the difficulty by supposing that these localized spirits, when their time for reincarnation arrives, wander from the totem-centre until they find a woman of the right totem, or a woman whose husband is of the right totem, according as descent is matrilineal or patrilineal In the ceremonies of initiation into manhood, also, totemic ideas are dominant. Initiates become conversant with various sacred objects, such as those connected with the soul, and symbolic objects, constructed for particular ceremonies symbolizing in one way or another the totems of the group. Elaborate decorations of the person, dramatic representations of the activities of the totemic ancestors in *alcheringa times*, continuing often for days, and other symbolic activities, all with more or less of a totemic motive, take place on these occasions. At certain times of the year, most Australian tribes conduct elaborate rites the object of which is to increase the totem species. These appear to be mainly of the nature of sympathetic magic.

Melanesia and Polynesia.—In this region we find every degree of totemism, from an institution containing the main features mentioned above, to complete absence of all these features. For example, in the Santa Cruz islands we find exogamous clans, each possessing one or more totems, usually animals; the totem may not be killed or eaten, and there is usually a definite belief in descent from the totem. In the extreme west of Papua (where there are two moieties) and in south-east New Guinea and parts of the Solomons we find totemism of similar form, yet in other parts of the Solomons and in the New Hebrides and Banks islands totemism is absent, though there are customs which suggest survivals of an earlier totemism; in fact, the Banks islanders, while lacking totemic clans, have certain beliefs very similar to those of the Arunta of central Australia, but unsystematic. A number of men and women strictly avoid killing certain species of animals or plants on account of a supposed kinship with them. This belief is based on the belief that the mother owed her pregnancy in some way to the entry into her womb of an animal of the species avoided. This belief appears to be maintained alongside some understanding of the true nature of the process of procreation In Polynesia we find a religious system, which in places, such as Samoa, appears to have developed out of totemism, for many totemic characters are discernible.

India.—As a social system, if little more, totemism appears in parts of India. For instance, the Santals of Bengal are divided into a number of patrilineal clans, exogamous and totemic, and each of these into a number of sub-clans, also exogamous and totemic. There is avoidance of the totem, in some form or another, by the clan or sub-clan. Totemism also occurs in Assam, in Central India and Madras, with traces elsewhere.

Africa.—Except for the region of the great lakes, totemism is sporadic in Africa. The Baganda of Uganda may be cited as an example of well-developed totemism. The Baganda are divided into some 40 patrilineal exogamous clans. Each of these has a principal and a secondary totem, usually an animal or plant, neither of which is killed or eaten by the clan There are other avoidances, more or less connected with the totem; for example, members of the leopard clan may not eat meat which has been torn or even scratched by an animal. We do not find traditions of descent from the totem amongst the Baganda, and the belief in descent from the totem is uncommon elsewhere in Africa A nominalistic explanation of the origin of the Baganda totems is given, for example, the lion clan of the Baganda, with the eagle as secondary totem, explain their totems as follows: Kimtu, a royal ancestor of the clan, killed a lion and an eagle, and had their skins made into royal rugs, since when the beast and the bird have been regarded as sacred. There is one curious anomaly in Baganda totemism. While a man normally takes his totem

from his father, there is an exception in the case of royalty, a man taking the totem of his mother in addition, and rarely maintaining the royal totem.

North America.—Throughout the greater part of North America we find totemism in a more or less typical form, and the frequent grouping of totemic clans into moieties reminds one of the Australian variety. Other features of American totemism, however, mark it off clearly from the Australian variety. While the tie between members of the totemic group may be as strong as anywhere else in the world, the attitude towards the totem is usually quite different, and the theory of totemic souls is wanting Often, in America, the totem is little more than a clan-badge, and the totem is often killed by the totemic clan. Nevertheless, elaborate and picturesque legends of the origin of totemic clans from the totem by some sort of descent are common enough. Totemism is not particularly associated with the less developed tribes of North America—rather the reverse; and we find both matrilineal and patrilineal descent of the totemic clans. Amongst the strongly matrilineal Iroquois of the east we find a straightforward division of the various tribes into a small number of exogamous clans, of which the totems are animal species, the clans usually being grouped into two moieties. Although a few traditions of direct matrilineal descent from an animal of the totemic species have been recorded, the clans usually ceny relationship with their totems, and show no regard whatever for them. Passing westward, some of the Siouan tribes provide examples of a more complex totemic system. For example, the Ponkas are divided into moieties, the moieties into phratries, the phratries into clans, and the clans into sub-clans, each of these classes being more or less totemic and exogamous. Here definite tabus are connected with the totems of the clans In the west, particularly the north-west coast, totemism is not clearly distinguishable from another socio-religious institution, peculiar to North America, the cult of guardian spirits The guardian spirit is acquired individually, sometimes quite late in life, by a process usually of fasting and religious exercise, which causes the guardian spirit to appear to the candidate in a dream or vision. Since the guardian spirit usually has an animal form, it is sometimes called an individual totem—clearly a misnomer. Sometimes the guardian spirits capable of acquirement by members of the tribe are divided out between the clans, or other social groups of the tribe, and sometimes the guardian spirit is not clearly individual in nature, but is rather of the nature of a species of animal. In so far as this is the case we have an approximation to totemism. A complication of this sort is found in the totemism of the north-west coast peoples, who make the so-called totem-poles. The student will find a mass of data on totemism arranged geographically in Sir J. G. Frazer's work *Totemism and Exogamy* (1910).

Prominence was given to the association of totemism with exogamy, found throughout the world with few exceptions. Where totemism is not associated with exogamy it is not difficult to suppose that exogamy has been lost. With considerably less confidence it may be supposed that tribes, containing exogamous groups, have lost their totemism. Finally there are some peoples, *e.g.*, the Andaman islanders, and the Eskimo, at a primitive level of culture, who have neither exogamous groups nor totemism. From this distribution of totemism and exogamy it follows that any theory of totemism must either be a "psychological" theory, explaining both totemism and exogamy, or a "historical" theory, which regards totemism, wherever it occurs, as the result of a spread of cultural influence from some one centre where the totemic complex originated. By a "psychological" explanation is meant an explanation in terms of observed facts about the behaviour of groups, or by means of generalizations about the behaviour of groups deduced from known psychological principles If, antecedently to the development of a given institution, it could be stated on psychological grounds that an institution of that sort would probably develop, then such an institution can be said to be explained psychologically. Early theories of totemism have not explained in this sense, for totemism and exogamy have only been shown to be probable, independently of the development of the one or the other, from which it follows that the distribution of totemism and exogamy, assumed above, would not occur; *e.g.*, if, owing to the nature of man and his attainment of some very simple form of society, it were probable that he should develop totemic ideas and practices, and also that he should develop exogamous groups, but for reasons other than those which lead to his developing totemism, then it would be indeed surprising that most peoples who have the one institution have the other, while those who, although in a primitive state of society, do not have the one do not have the other The difficulty can be got over by supposing that totemism and exogamy are necessarily developed by man in the course of his evolution; but it is difficult in this case to offer a plausible explanation of the disappearance of totemism and exogamy among some very primitive peoples, and its retention by others at a more advanced stage of civilization.

Two theorists may be mentioned for their attempts to provide a psychological explanation of both totemism and exogamy; viz., Durkheim and Freud. For Durkheim the totem results from the action of the group on the individual. The group is the nearest and most powerful coercive force to which the individual is subject, particularly when the group is in violent activity and the individual is conscious of this overpowering influence, when he loses himself completely in the group. Symbolic expression alone can be given to such a force; hence the totem is a sacred symbol, symbolizing that very real force, the clan. Hence totemic symbols are sacred rather than the totem-species itself (and this, it must be admitted, is true, at least for Australia).

But why, it may be asked, should there be many clans and totems, and not one totemic group? Here Durkheim becomes obscure. If there are already several groups, then only in so far as the effective unity of each group is felt should there be more than one totemic group within the tribe. Passing over this difficulty, we have still to enquire why the totemic group is exogamous. the answer is not very convincing. It would take too long to follow the various steps which give unity and intelligibility to the scheme, but it is the tabu on the blood of the clan which is ultimately responsible for exogamy.

Freud attempted to give a single explanation of totemism and exogamy, and he appeared to have indicated the direction in which we are to seek an explanation, whatever the adequacy of his presentation.

Prior to the development of culture, man is supposed to have lived in "cyclopean" families, containing a principal male who monopolized the women, including his own daughters, and prevented his sons from having intercourse within the family. What more natural than that the sons should combine and kill the father? But the attitude of the sons is ambivalent, combining both affection and hostility. The murder committed, the sons deny themselves the fruits of the deed, owing to the operation of a psychological process familiar to psycho-analysts, and the group becomes exogamous. The affective ambivalence towards the father has also provided the beginnings of totemism By substituting an animal for the father, a process of symbolism which psychoanalysts consider fundamental in human nature, the animal becomes a vehicle for that affective attitude towards the father which is for the moment repressed With the killing of the father by the momentary release of this repressed *Oedipus complex*, both totemism and exogamy are born. The group with one father, and therefore one totem, is exogamous, and the totem becomes the object of observances, which are really the expression of the *Oedipus complex*, which has now become more completely repressed by means of a social mechanism. The difficulties in the way of this theory are considerable, and have been critically analysed by Profs. Kroeber and Malinowski. Doctor Freud's theory has been elaborated and modified in a comprehensive study of Australian totemism on psycho-analytic lines by Dr. Géza Roheim. While the search for a "psychological" explanation of totemism does not reward us with any convincing theory of its origin, an "historical" explanation is equally elusive, though it has been maintained by one school that the distribution of totemism can only be explained on the assumption of diffusion from a single centre, a conclusion which, as we have already

seen, follows if no psychological explanation of totemism combined with exogamy can be found. No evidence for the existence of exogamy, and only the most slender evidence for totemism is provided in the Egyptian centre from which the totemic complex is supposed to have spread; in fact, on this theory totemic exogamy is derivative in the various parts of the world to which totemism spread from a kind of dual organization with marriage injunctions The only "historical" explanation of totemism which has been elaborated is, therefore, no more, if no less, convincing than the numerous "psychological" explanations which have been offered

Dissatisfied with this impasse that the search for explanations leads to, both in the case of totemism and in that of many other primitive institutions, many anthropologists have renounced the search for psychological or historical explanations, and confine themselves to the search for the functions of institutions. Possibly this is the only kind of explanation of totemism within our grasp, and, although there is reason to suppose that totemism without function (occurring as a survival merely), occurs in some places, it must be admitted that, until totemism is understood in this functional sense in those cases where it appears to be a significant part of the culture of the group, it is premature to attempt to account for its origin.

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(W. E A)

TOTILA (d. 552), king of the Ostrogoths, was chosen king after the death of his uncle Ildibad in 541, his real name being, as is seen from the coinage issued by him, Baduila. At the beginning of his reign, he collected together and inspired the Goths to win a victory over the troops of the emperor Justinian, near Faenza. Having gained another victory in 542, in the valley of Mugello, he left Tuscany for Naples, captured that city, and then received the submission of the provinces of Lucania, Apulia and Calabria. Totila's conquest of Italy was marked not only by celerity but also by mercy. Towards the end of 545 the Gothic king prepared to starve Rome into surrender, making at the same time elaborate preparations for checking the progress of Belisarius who was advancing to its relief. The Imperial fleet only just failed to succour the city, which was plundered by Totila. Its walls and other fortifications, however, were soon restored, and Totila again marching against it was defeated by Belisarius, who, however, did not follow up his advantage Several cities were taken by the Goths, while Belisarius remained inactive and then left Italy, and in 549 Totila advanced a third time against Rome, which he captured through the treachery of some of its defenders. His next exploit was the conquest of Sicily, after which he subdued Corsica and Sardinia and sent a fleet against the coasts of Greece. Justinian, thereupon entrusted the conduct of a new campaign to the eunuch Narses, who defeated and killed Totila at the battle of Taginae (*q v.*) in July 552.

See E. Gibbon, *Decline and Fall*, ed. by J. B. Bury (1898), vol iv ; T. Hodgkin, *Italy and her Invaders* (1896), vol. iv. and Kampfner, *Totila, König der Ostgoten* (1889).

TOTNES, GEORGE CAREW, or CAREY, EARL OF (1555–1629), English politician and writer, son of Dr. George Carew, dean of Windsor, and Anne, daughter of Sir Nicholas Harvey, was born on May 29, 1555, and was educated at Broadgates Hall, Oxford, where he took the degree of M.A. in 1588. After holding various military and diplomatic appointments he accompanied Essex in the expedition to Cadiz in 1596 and to the Azores in 1597. In 1598 he attended Sir Robert Cecil, the ambassador, to France. He was appointed treasurer at war to Essex in Ireland in March 1599, and on the latter's sudden departure in September of the same year, Carew became first a lord justice, and in 1600, president of Munster, where his vigorous measures enabled the new lord deputy, Lord Mountjoy, to suppress the rebellion. He returned to England in 1603 and was well received by James I., who gave him many honours. In 1610 he revisited Ireland to report on the state of the country; and in 1618 pleaded in vain for his friend Sir Walter Raleigh He received his earldom in 1626. He died on March 27, 1629, leaving no issue Besides his fame as president of Munster, Carew had a considerable reputation as an antiquary

Carew made large collections of materials relating to Irish history and pedigrees, which he left to his secretary, Sir Thomas Stafford, reputed on scanty evidence to be his natural son; while some portion has disappeared, 39 volumes after coming into Laud's possession are now at Lambeth, and 4 volumes in the Bodleian library. A calendar of the former is included in the State Papers series edited by J. S. Brewer and W. Bullen His correspondence from Munster with Sir Robert Cecil was edited in 1864 by Sir John Maclean, for the Camden Society, and his letters to Sir Thomas Roe (1615–17) in 1860. Other letters or papers are in the Record Office; among the mss. at the British Museum and calendared in the *Hist. MSS. Com. Series, Marquess of Salisbury's MSS.*

TOTNES, a market town and municipal borough in the Totnes parliamentary division of Devon, England, on the Dart, 29 m. S.S.W. of Exeter, by the G.W. railway Pop (1951) 5,534 It stands on the west bank of the river, and is joined by a bridge to the suburb of Bridgetown. It was formerly a walled town, and two of the four gates remain. Many old houses are also preserved, and in High street their overhanging upper stories, supported on pillars, form a covered way for foot-passengers The castle, founded by the Breton Juhel, lord of the manor after the Conquest, was already dismantled under Henry VIII , but its ivy-clad keep and upper walls remain The grounds form a public garden Close by are the remains of St Mary's priory, which comprise a large Perpendicular gatehouse, refectory, precinct wall, abbot's gate and still-house, also the Perpendicular church of St Mary The guildhall is formed from part of the priory. Vessels of 200 tons can lie at the wharves near the bridge. The industries include brewing, flour milling, and the export of agricultural produce, chiefly corn and cider Trout and salmon are plentiful in the river Totnes (*Totenes, Totton*) was a place of considerable importance in Saxon times, it possessed a mint in the reign of Aethelred, and was governed by a portreeve In the Domesday Survey it appears as a mesne borough under Juhel of Totnes. Its earliest charter dates from 1205. Area 2 3 sq mi.

TOTONICAPÁN, the capital of the department of Totonicapán, Guatemala, on the same high plateau as Quezaltenango, from which it is 12 mi E.N.E. Pop. (1950) 9,492 Totonicapán is inhabited mainly by Quiché Indians, employed in the making of cloth, furniture, pottery and wooden musical instruments There are hot mineral springs in the neighbourhood. In 1838 Totonicapán was declared an independent republic, in which the adjoining departments of Sololá and Quezaltenango were included This state existed for two years, and was then again merged in the republic of Guatemala. The city suffered greatly in the earthquake of April 18, 1902

TOTTENHAM, a municipal and parliamentary borough of Middlesex, England, and suburb of London, 6½ mi N of London bridge, and adjoining Edmonton on the south It is served by the L.N.E.R and the London Passenger Transport board. Pop (1951) 126,921. Area, 4.71 sq mi Its full name was Tottenham High Cross, from the cross near the centre of the district. The present structure was erected *c* 1600. Formerly Tottenham was noted for its "greens." In the centre of one stood the famous old elm trees called the "Seven Sisters," which were removed in 1840. The name is preserved in the Seven Sisters road. Bruce castle, on the site of the old mansion of the Bruces, but built probably by Sir William Compton in the early 16th century, was occupied by a boarding school founded by Mr (later Sir) Rowland Hill in 1827 on the system he instituted at Hazlewood, Birmingham. It became public property in 1892, the grounds are now used as a public park All Hallows church, Tottenham, was given by David, king of Scotland (*c.* 1126) to the canons of the church of Holy Trinity, London, and parts of the old building still remain. In the reign of Edward the Confessor the manor of Tottenham was held by Earl Waltheof, and passed later, by mar-

riage, to the royal family of Scotland, and so to Robert Bruce and his co-heirs Tottenham, which was incorporated in 1934, returns two members to parliament.

William Bedwell, the Arabic scholar, was vicar of Tottenham, and published in 1632 a *Briefe Descripton of the Towne of Tottenham*, in which he printed for the first time the burlesque poem, the "Turnament of Tottenham"

TOTTENVILLE, a community in the borough of Richmond (since 1898 a part of New York city, U.S.A.), is on the southern shore of Staten island in lower New York bay, about 20 mi S.W. of the south extremity of Manhattan island The "Billopp House," or "Conference House," there, was the scene of the conference, on Sept. 11, 1776, between Lord Howe, representing Lord North, and Benjamin Franklin, John Adams and Edward Rutledge, representing the Continental congress, with regard to the British offer of reconciliation This house, originally called the "Manor of Bentley," was built by Capt. Christopher Billopp (1638–1726), who, by circumnavigating Staten island in 24 hours, according to legend, made it part of New York State under a ruling by the Duke of York Actually, Staten island did not become part of New York state until legislation was passed in 1830. Nevertheless, Billopp was awarded a 1,163-ac. land grant—the present site of Tottenville Originally known as Bentley, the community was incorporated in 1894 as Tottenville in honour of the Totten family. The largest industry is smelting and refining



TOUCANS, FOUND ONLY IN THE WESTERN HEMISPHERE

TOUCAN, the Brazilian name for a bird of the family *Ramphastidae*, characterized by their huge but light beaks

The type of the family is *Ramphastes toco*, of Guiana and Brazil. The beak, 8in long and 3in high at the base, is deep orange with a large black spot near the tip. The eye is surrounded by a bare orange space; the plumage is black except for the white throat, edged beneath with red. The tail is nearly square. In many allied species, the bill is parti-coloured *R. vitellinus* inhabits Trinidad, but all the remaining members of the family are confined to the mainland, where they do not extend north of Mexico. In the Andes, they reach an elevation of 10,000ft.

TOUCH, SENSE OF. In the environment of every animal, the solid, impenetrable objects with which it may collide play an important part Sensitiveness to touch, comparable to our own, is, therefore, generally developed. The manner in which an animal reacts to contact stimuli depends, principally, on the force of the contact. All such stimuli which exceed a certain degree act as repellants, and feeble, defenceless animals seek to escape from them. This is evident already in the simplest animals, such as the amoeba. It is sufficient to touch one of the protruded pseudopodia of an amoeba with a pointed, glass needle to bring about its immediate retraction. Already in many infusorians there are extraordinarily developed tactile cilia; if another animal comes into contact with them, it causes the infusorian to swim hastily away (fig 1).

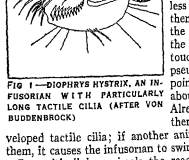


FIG 1.—DIOPHRYS HYSTRIX, AN INFUSORIAN WITH PARTICULARLY LONG TACTILE CILIA (AFTER VON BUDDENBROCK)

In multicellular animals the reaction to mechanical impulses differs very much, in accordance with the defensive powers of the individual. This is sufficiently well known in the higher animals. Defenceless animals, such as earthworms, or gasteropods, flee, or withdraw into their protective shells; on the other hand, those capable of defending themselves, such as the large Crustacea, cuttlefishes or sea-urchins meet the assault by active defensive movements. The example last mentioned is, perhaps, of sufficient interest for it to be discussed more particularly.

If we touch a sea-urchin on any part of its surface, one of three things happens In the first case, all the spines which are situated in the neighbourhood of the part stimulated bend towards it If some animal were the cause of the contact it would, thus, be grievously stung by the sharp spines, and put to flight In the second case the pedicellariae come into action (fig 2).

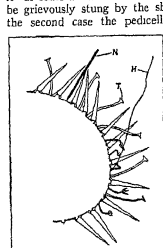


FIG 2.—SURFACE OF SEA-URCHIN UNDER MECHANICAL STIMULATION BY NEEDLE N AND HAIR H, T IS A TUBE-FOOT

These are pincers consisting of three small snapping blades on a pliant stalk. They turn towards the place whence the contact stimuli proceed, and wave their gaping jaws rapidly to and fro They bite firmly into the skin of the enemy, or into its hairs, and assist, either in putting it to flight, or in holding it fast and bringing it into contact with the tube-feet round the mouth, where it is consumed Lastly, in a third case, the whole sea-urchin moves in a direction calculated, if possible, to take it out of the sphere of the stimulus

The common crab, particularly the male, reacts to strong contact stimuli by assuming its very characteristic defensive attitude. It turns towards its opponent and presents its widely-opened pincers. If the enemy still continues to approach, it strikes at it with great force.

Some animals are able to assume an appearance of death when attacked The most pregnant examples of this are furnished by insects. The death-feigning reflex usually consists in the animal drawing in its legs, and remaining perfectly motionless, continuing thus even if maltreated in the most violent manner. In such a case, the assailant, a bird for example, thinks it is dealing with a dead thing instead of a food animal, and gives up the attack Insects such as these, which feign death, usually resemble very closely some inanimate object, such as a piece of wood or a twig. The stick-insects provide the best known examples of this.

As was mentioned at the beginning, the sense of touch often serves to prevent an animal dashing itself against hard objects when moving from place to place The whirligig beetle, *Gyrinus*, which we see skimming rapidly to and fro over the surface of the water in summer, bears eloquent witness to the degree of

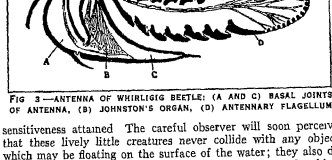


FIG 3.—ANTENNA OF WHIRLIGIG BEETLE: (A AND C) BASAL JOINTS OF ANTENNA, (B) JOHNSTON'S ORGAN, (D) ANTENNARY FLAGELLUM

sensitiveness attained The careful observer will soon perceive that these lively little creatures never collide with any object which may be floating on the surface of the water; they also do not run against one another, although, often, many may be skimming about in a restricted space. The sense organs which render this possible are situated in the feelers, as Eggers has proved. The antennary flagella are borne free in the air; their amputation does not cause alterations in the animal's conduct. On the other hand, those capable of defending themselves, such as the large Crustacea, cuttlefishes or sea-urchins meet the assault by active defensive movements. The example last mentioned is, perhaps, It contains numerous sensory cells, bearing stylets, which are

grouped together in "Johnston's organ." With the assistance of these the animal perceives in some way the proximity of solid objects; it may, perhaps, react to the waves of water reflected to it by these objects.

Among vertebrates, bats are able to perform a, perhaps, even greater feat. As was known already to the naturalists of the 18th century, even blind bats are able to avoid all obstacles which may be placed in their path

An opposite condition to that discussed hitherto prevails in not a few cases in which the animal seeks to establish contact with a solid object, and is uneasy if it cannot do so. This phenomenon has been given a special name, and is known as "thigmotropism." In most animals the soles of the feet are usually placed in constant contact with solid bodies. The vigorous attempts at "righting" which are made by almost every animal if it falls upon its back, until it regains its feet once more, are due, in many cases, to the effort to bring the feet again into contact with solid bodies. This may be seen particularly well in insects If we put a caterpillar upon its back it immediately rights itself. If, however, we place between its feet a twig to which it can adhere, it remains peacefully upon its back, and even eats in this position. The following experiment is easily carried out, and shows thus very clearly A thread is gummed firmly on to the back of a fly, and is then attached to a stand, the feet of the insect being allowed to hang down free If, now, a small ball of paper is placed between them, the fly begins at once to run about upon it.

The normal running movement, therefore, follows contact of the feet with the solid object. In leeches, contact stimuli are of particular importance in locomotion. Uexkuell showed that in these animals a quite definite co-ordination exists between the action of the suckers and the contraction of the muscles of the body. When the leech is adhering by means of its posterior sucker, it stretches out its body at full length, searching thus for a suitable surface on which to fasten its anterior sucker. When the anterior sucker is attached, the posterior sucker relaxes its hold, and immediately a reflex contraction of the longitudinal muscles of the body takes place Both phases, taken together, give rise to the characteristic looping motion of the leech. (*See* fig. 4.) If, however, we throw the leech into water without giving

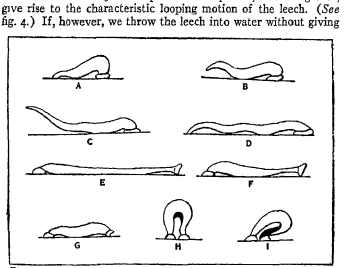


FIG. 4.—CRAWLING MOVEMENT OF A LEECH: (A–D) POSTERIOR SUCKER IS ATTACHED, AND THE WORM EXTENDED; (E–G) ANTERIOR SUCKER IS ATTACHED, POSTERIOR IS FREE, ANIMAL IS CONTRACTED, (H–I) RE-ATTACHMENT OF THE POSTERIOR SUCKER

it an opportunity of attaching itself by one of its two suckers, swimming movements at once take place.

Thigmotropism, however, appears also in quite another form. It was thought at first that many animals which are in the habit of dwelling in narrow tubes (such as many worms), or in crevices in wood, or under bark are led to seek out their hiding places through an aversion to light. The truth of the matter is that such an animal feels comfortable only if its body is in contact, as much as possible, on all sides, with solid surfaces. Thigmotropic worms will also creep into glass tubes, and some insects hide between glass slides, in spite of being fully exposed to daylight when in these retreats. Under natural conditions, the thigmotropic animal thus avoids the covetous eyes of its enemies, since in nature there are no transparent solid objects

Sensitiveness to mechanical stimuli has a very important use in the sense which in higher animals makes them aware of the relative position of the parts of the body. To the majority of human beings it certainly appears quite as a matter of course that they are able to take hold of their noses with their hands Science teaches, however, that this is possible only through stimulation of numerous sensory cells in the skin, which are pulled or pressed when the arm or the hand is moved. If the skin is narcotized, the power of touching any particular part of the body is lost.

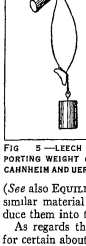


FIG 5.—LEECH SUPPORTING WEIGHT (AFTER CAHNHEIM AND UERKÜLL)

It is of interest that some of the lower animals, particularly arthropods, possess a similar sense Insects and Crustacea show this in the very vigorous way in which they clean the limbs and the body, making use of legs specialized for this purpose. The precision with which the decapod Crustacea, after moulting, place fresh statoliths in their statocysts is astonishing. (*See* also EQUILIBRIUM, SENSE OF.) They seize grains of sand, or similar material in their delicate pincers, and are able to introduce them into the statocyst through its minute opening.

As regards the lower animals, we do not yet know anything for certain about the localization of the sensory cells which function in these movements In Crustacea, this faculty is distributed apparently among sensory hairs in the region of the joints; in insects we know that there are free nerve endings in the skin of the joints.

To the mechanical sense belongs also the sense of "strength" When a man lifts a weight, he notices exactly if it is heavy or light, and, according to this sensation, he regulates the amount of energy to be expended. The leech shows that a similar sense is present also in the lower animals. It has been mentioned already that this animal contracts when the anterior sucker is attached and the posterior sucker is free. When the animal is in this position we can force it to lift fairly heavy weights, which, under certain circumstances, it will support for hours together. (*See* fig 5.) If we cautiously hold up the weight with one hand, the worm experiences a sensation of considerable relief, and alters the impulse it sends to its muscles This is clearly proved by the fact that, as soon as we withdraw our hand again, the worm is drawn out by the weight which it formerly had supported

Stimulation of the Nervous System by Mechanical Influences.—Every organism, in order to be able to move vigorously, requires constant stimulation from without. To man this statement does not appear very credible, but it can occasionally be proved quite clearly in the lower animals In the article on EQUILIBRIUM, SENSE OF, the statocysts of the lower organisms, which usually act as balancing organs, are described. It has been generally proved by experience, that the animals fall into an enduring state of debility after these statocysts have been removed by an operation. They are no longer able to make powerful movements; we can express mathematically the amount of diminution in the gripping power of the chelae of a crustacean caused by the removal of the statocyst. It is not yet determined for certain how this connection between the statocysts and the muscular strength is to be explained. Apparently, the mechanical stimulation of the sensory cells of the statocyst by the statoliths affects the central nervous system of the animal, thus, as we may say, rousing it into activity in a somewhat similar manner to that in which coffee stimulates a tired man.

Flies furnish a particularly remarkable instance of this. In these insects, the posterior wings are transformed into oscillating clubs or "halteres," which, during flight, move simultaneously with the wings, with great rapidity (figs 6a, 6b). If these

clubs are removed or stuck down firmly, the insect is no longer capable of flight. It can neither rise from the ground nor maintain itself in the air. It appears from this that the active movement of the halteres is essential. Formerly, it was thought that the halteres were a kind of balancing organs, and it was believed that the fly lost its power of balance after they had been removed This, however, is excluded by the extremely minute size of the

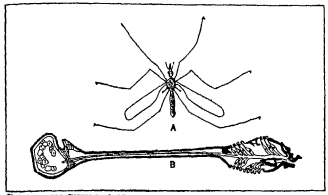


FIG. 6.—(A) TIPULA, A CRANE-FLY (DADDY-LONG-LEGS) SHOWING HALTERESES BEHIND THE WINGS, (B) LONGITUDINAL SECTION THROUGH A HALTERE, SHOWING SENSE ORGAN AT THE BASE (AFTER PFLUGSTEDT)

halteres. Now, however, numerous sensory cells affected by mechanical stimuli have been found on the basis of the halteres These are so arranged that they must be vigorously stimulated by the movement of the halteres, which, apparently, has this stimulation as its object. We may assume that this affects the nervous system of the fly in a similar way as stimulation of the statocyst affects crustaceans. The fly is able to send the necessary impulses to the muscles of flight only if this constant stimulation is present.

Wilde has recently discovered a similar, and, considered as a whole, certainly still very problematical contrivance in the Brazilian locust, *Rhspipterix chopardi*. This insect bears sense organs on the under side of its hind legs; if these are put out of action by being stuck down, the insect is prevented from springing and flying.

Structure of Tactile Organs.—There is not very much to be said on the subject of the anatomy of the sensory cells which serve for the transmission of mechanical stimuli It has been mentioned already that, even among unicellular animals (infusoria) tactile cilia are occasionally to be found (*See* fig. 1.) In multicellular animals there are frequently found, projecting from the surface of the body, groups of cells bearing small hairs like cilia, which are usually considered to be tactile organs (fig. 7 and 8). Several of these organs from the skin of different kinds of Echinoderms are shown in fig. 7. In fig. 8 is represented a "sensilla" from the skin of the leech. In yet other cases we find what are called free nerve-endings (fig 9), the nerve cells, which are deeply situated beneath the skin, sending one or many fine processes up to the outer surface. Unfortunately, in no case can it be proved definitely that the groups of sensory cells mentioned really serve for the perception of mechanical stimuli The only way in which this might be determined, namely by removing the organs by an operation and experimenting with the animals thus treated, is not practicable, owing to the large number of the organs, which usually are distributed over the whole surface of the skin. This difficulty of proof occurs also when dealing with arthropods, in which the tactile organs exhibit an astonishing

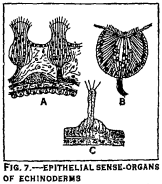


FIG. 7.—EPITHELIAL SENSE-ORGANS OF ECHINODERMS
(A) Ophurold, transverse section through the wall of an ambulacral foot; (B) Sea-cucumber, epithelial sense-organ from a tentacle; (C) Sensory papilla from an ambulacral foot of a feather-star

diversity The rule that the cuticle is particularly thin where the sensory cells are situated (*see* fig. 10) applies to all these creatures (insects, crustaceans, spiders). When a sensory cell is quite separated from the exterior by a layer of chitin, it is impossible that it can perceive chemical stimuli, and we may assume, with some degree of probability, that it is an organ for the perception of mechanical stimuli.

Among Crustacea the most general form in which these occur is the sensory hair, in insects we find in addition sensory cones

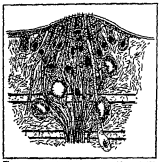


FIG 8.—SENSILLA FROM THE SKIN OF A LEECH WITH OPTIC CELLS, AND APPARENTLY TACTILE CELLS (AFTER HACHLOFF)

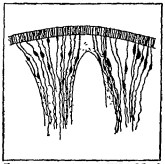


FIG 9.—ANTERIOR END OF A SHORT HORN OF A SLUG (ARION), SHOWING FREE NERVE ENDINGS (AFTER RETZIUS)

(fig. 10 B), sensory pits (10 C), cup-shaped sense organs (fig. 10 D), and so forth In insects only there is found also a particular kind of sense organ, the chordotonal organs In form they are like a cord stretched between two flat surfaces of the body wall, and, doubtless, function when these surfaces are displaced in any way The following parts may be distinguished in them:—the sensory cell with the proximal enveloping cell, the distal enveloping cell (cap cell) which connects the peculiar stylet (scolopala) with the hypodermis, and, lastly, the ligament which spans the whole apparatus Such organs are found singly or in groups on the body and extremities of insects. The organs which most resemble them are "Johnston's organs" in the feelers. (*See* fig. 4.)

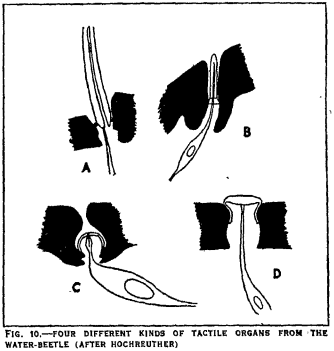


FIG. 10.—FOUR DIFFERENT KINDS OF TACTILE ORGANS FROM THE WATER-BEETLE (AFTER HOCHREUTHER)

In the auditory organs of insects the chordotonal organs certainly receive the sound waves; what purpose they serve in Johnston's organ, or in the simpler organs, is not yet known.

The Sense of Temperature.—Since heat, as is well known, consists in a mechanical vibration of molecules, the sense of tem-

perature, also, must be included in the mechanical sense. It goes without saying that the higher animals possess a sense of temperature which is very similar to that of human beings. It is of greater interest to prove its presence in the lower animals. The simplest method of deciding whether an animal reacts to heat stimuli is by the use of the temperature organ. This consists of a narrow box, about a meter in length, the bottom of which is

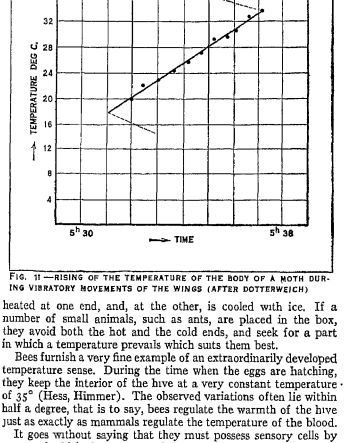


FIG. 11.—RISING OF THE TEMPERATURE OF THE BODY OF A MOTH DURING VIBRATORY MOVEMENTS OF THE WINGS (AFTER DOTTERWEICH)

heated at one end, and, at the other, is cooled with ice. If a number of small animals, such as ants, are placed in the box, they avoid both the hot and the cold ends, and seek for a part in which a temperature prevails which suits them best.

Bees furnish a very fine example of an extraordinarily developed temperature sense. During the time when the eggs are hatching, they keep the interior of the hive at a very constant temperature of 35° (Hess, Himmer). The observed variations often lie within half a degree, that is to say, bees regulate the warmth of the hive just as exactly as mammals regulate the temperature of the blood.

It goes without saying that they must possess sensory cells by means of which they perceive heat. They raise the temperature of the hive apparently by muscular movements; over-heating they counteract by carrying in water and allowing it to evaporate.

Nocturnal *Lepidoptera* regulate the temperature of the body before flying As a result of the heat produced by muscular activity, they attain, during flight, a temperature of about 36–40°. Before they fly off, they make very rapid, vibratory movements with their wings, buzzing or whirring This, as Dotterweich has recently proved, is simply to raise the temperature of the body. As soon as the flight temperature is reached, they fly off. Fig. 11 represents, graphically, the raising of the body temperature during this vibration. Very little is known of heat perception in the rest of the Invertebrata. (W. v. Bud.)

For the sensory function of touch in man *see* Skin, Sensory Functions of

TOUCH-ME-NOT, any plant of the genus *Impatiens*, family Balsamnaceae, so called from the fact that the fruits are extremely explosive, the valves rolling up inwards and scattering the seeds when touched. The genus includes about 350 species, found in tropical and north temperate regions, and especially abundant in the mountains of India and Ceylon. A few are cultivated ornamental flowers. Some American species are known as jewelweed. (*See* Impatiens.)

TOUL, a garrison town of northeastern France, in the department of Meurthe-et-Moselle, 21 mi W of Nancy on the Eastern railway. The population in 1936 was 12,979. Toul (*Tullum*) was originally capital of the Leuci, in the Belgic confederation, and acquired great importance under the Romans. It was evangelized by St Mansuy in the 4th century, and became one of the leading sees of northeast Gaul. After being sacked successively by Goths, Burgundians, Vandals and Huns, Toul was conquered by the Franks in 450. Under the Merovingians it was governed by counts, assisted by elective officers The bishops became sovereign counts in the 10th century, holding only of the emperor, and for 300 years (13th to 16th centuries) the citizens maintained a long struggle against them Together with Verdun and Metz, the town and its domain formed the territory of the Trois-Evêchés. Toul was forced to yield for a time to the count of Vaudémont in the 12th century, and twice to the duke of Lorraine in the 15th. Charles V made a solemn entry into the town in 1544, but in 1545 it placed itself under the perpetual protection of the kings of France Henry II took possession of the Trois-Evêchés in 1552, but the territory was not officially incorporated with France till 1648. Henry IV was received in state in 1603, and in 1637 the parlement of Metz was transferred to Toul. In 1700 Vauban rebuilt the fortifications of the town In 1790 the bishopric was suppressed and the diocese united to that of Nancy Toul capitulated in 1870

The church of St Étienne, which was formerly a cathedral, has a choir and transept of the 13th century; the nave and aisles are of the 14th, and the fine façade of the last half of the 15th. There are two western towers The two large lateral chapels of the nave are in the Renaissance style South of the church there is a fine cloister of the end of the 13th century which was much damaged at the Revolution. The church of St. Gengoult, chiefly late 13th- or early 14th-century, has a façade of the 15th century and a 16th-century cloister in Flamboyant Gothic The *hôtel de ville* occupies a building of the 18th century, once the episcopal palace. Toul is the seat of a sub-prefect. The industries include the manufacture of porcelain; trade is in wine and brandy.

TOULON, a seaport and first-class fortress and naval station of France, department of Var, capital of the arrondissement of Toulon, on the Mediterranean, 42 m. E.S.E. of Marseilles. Pop (1936) 146,420 The Roman Telo Martius is supposed to have stood near the *lazaretto*. The town was successively sacked by Goths, Burgundians, Franks and Saracens. Until conquered by Charles of Anjou in 1259, it was under lords of its own, and entered into alliance with the republics of Marseilles and Arles. St. Louis, and especially Louis XII and Francis I strengthened its fortifications. It was seized by the emperor Charles V in 1524 and 1536. Henry IV founded there a naval arsenal which was further strengthened by Richelieu, and Vauban made the new dock, a new enceinte, and several forts and batteries.

The bay, which opens to the east, has two divisions, the Grande Rade and the Petite Rade; it is sheltered on the north and west by high hills, closed on the south by the peninsula of capes Sicié and Cépet, and protected on the east by a huge breakwater. The forts of St. Marguerite, of Cap Brun, of Lamalgue and of St. Louis to the north, and the battery of the signal station to the south, the battery of Le Salut to the east, and the forts of Balaguier and L'Aiguillette to the west protect the entrance. The bay of La Seyne lies west of the Petite Rade, and is defended by the forts of Six-Fours, Napoléon (formerly Ft. Caire), and Malbousquet, and the batteries of Les Arènes and Les Gaus. To the north of Toulon rise the defensive works of Mt. Faron and Ft. Rouge to the east the forts of Artigues and St. Catherine, to the northeast the formidable fort of Coudon, and to the south-east that of Colle Noire, respectively dominating the highway into Italy and the valley of Hyères with the Bay of Carqueiranne. The modern quarter lies to the north of the old town. The chief buildings are the former cathedral of St. Marie Majeure, the church of St. Louis, the naval and military hospital, a naval school of medicine, a school of hydrography, and large barracks The imports are corn, wood, coal, hemp and salt provisions; the exports are salt, figs, raisins, almonds, oranges, cloth, bauxite ore, cork, soap and oils. The principal industries, apart from the arsenal, are shipbuilding, fishing and wine making. The interesting buildings and gardens of the hospital of St. Mandrier stand on the peninsula of

Cape Cépet, and near them is the *lazaretto*. Toulon is the seat of a sub-prefect, of a chamber of commerce, a board of trade-arbitrators and of a permanent maritime tribunal

Toulon is the most important of the French dockyards, and is the headquarters of the Mediterranean fleet. The arsenal, which was created by Louis XIV, lies on the north side of the Petite Rade. This is approached from the Grande Rade by passages at the north and south ends of a long breakwater which extends from the direction of Le Mourillon towards the Cépet peninsula. Outside in the Petite Rade is a splendid protected anchorage for a great fleet, the whole being commanded by many forts and batteries. There are four great basins approached from the Petite Rade—the Vieille Darse, to the east, on the side of Le Mourillon; the Darse Vauban, next to it; and the Darse de Castigneau and the Darse Missiessy, farther to the west. Shipbuilding and its accessory trades are carried on at Toulon. (H. J. F.)

The Battle of Toulon (1744).—This battle was fought off the port from which it takes its name on February 11, 1744. An allied Franco-Spanish fleet of 28 ships was in harbour, commanded by M. de Court, and was being watched by a British fleet of similar size under Admiral Mathews.

England and Spain had been at war since 1739, but England and France, though on opposite sides, had not yet actually declared war on one another. Spain was employed at this time in sending troops to North Italy for an attack on Austria's Italian possessions, and France was helping her by placing Toulon at her disposal and also by providing about two-thirds of this fleet which was to convoy them.

Mathews felt he would be justified in attacking the French as well as the Spaniards, should the former's proffered assistance with their Mediterranean fleet materialize. The combined fleet put out of Toulon on February 9, and to Mathews' surprise, made off on a southerly course. If he were to follow them, he would uncover Toulon and the transports would slip out; on the other hand, if he waited for the transports, the enemy's fleet would not be brought to action. The English admiral decided in these circumstances to go after the fleet and bring it to action quickly, and then to double back and intercept the transports. He himself was commanding the centre, Lestock, the second-in-command, the rear, and Rowley the van.

According to the fighting instructions of the day, it was Mathews' duty first, if possible, to obtain the windward position This he did Then, before he bore down on the enemy to what distance he considered suitable, he was so to arrange his line that the ends would be conterminous with those of the enemy, so that, when parallel battle was finally joined, each ship would be opposed to the corresponding ship in the enemy's line. Clearly, however, Mathews' plan was hardly compatible with such instructions. If he was to wait until his whole line was covering the allies before attacking, he was the less likely to be back off Toulon in time to deal with the transports. Consequently, when Rowley's squadron was opposite the allied centre, and his own opposite the allied rear, Mathews signalled the attack. He was further influenced to this course by the fact that the British rear was far behind and to the east, owing, so its commander said, to variable breezes and adverse currents: in this connection, however, it must be noted that there was bad blood between Lestock and Mathews. Previous to the attack, Mathews had been flying the signal for the line—obviously applicable to Lestock—but when the commander-in-chief flew also the signal for battle, clearly meaning that Lestock should come up and take on the unengaged allied van before it should get about to assist the centre and rear, the second-in-command hove to and did nothing, on the grounds that Mathews was already filling his place opposite the enemy's rear and that consequently there was nothing for him to do.

The remainder of the British fleet was also puzzled at being ordered to attack before the whole enemy line was covered. The centre bore down on the enemy eventually, but in considerable confusion. Some of Rowley's squadron likewise attacked, but they were fearful of being doubled by the unoccupied allied van, and the leading ships correctly beat to windward to prevent this. Eventually M. de Court, realizing that the Spaniards who formed his rear were hard pressed, ordered his whole fleet about, and as the fresh ships came into action, Mathews' broke off the battle. The only prize was the "Poder," taken by Captain Hawke.

A record number of courts-martial followed. Lestock was acquitted on the technical grounds indicated above, but Mathews was sentenced to dismissal from the service. He had, with such ships as supported him properly, fought energetically, but was dismissed because, in trying to force a decision in difficult circumstances, he had trespassed against the fighting instructions of his day. Thanks to such measures and other reforms Great Britain's sea power was greatly increased.

The Siege of Toulon (1792).—In 1792 the royalists of the town sought the support of the English-Spanish fleet cruising in the neighbourhood under Vice-admiral Samuel Hood (*q.v.*). The Convention (*q.v.*) having replied by outlawing the town, the inhabitants opened their harbour to the English. The army of the republic at the end of Aug. 1793 laid siege to the town, and on this occasion Napoleon Bonaparte first made his name as a military expert. The forts commanding the town having been taken on Dec. 17 the English ships retired after setting fire to the arsenal and destroying a large part of the French fleet. Under the Directory Toulon became the most important French military port on the Mediterranean; here Napoleon organized the Egyptian campaign. (*See* NAPOLEON I)

(G. A. R. C; J. G. B.; X.)

World War II.—The Franco-German armistice of 1940 left the French fleet in the hands of the Vichy government, and at the time of the Anglo-American invasion of North Africa on Nov. 8, 1942, the greater part of this fleet was stationed at the Toulon naval base. On Nov. 11 Hitler abrogated the terms of the armistice and ordered his forces to take over the unoccupied part of France, and on Nov. 27 his troops occupied Toulon and attempted to seize the French fleet.

The French were prepared for such a move, however, and under the command of Adm Jean de la Borde scuttled or otherwise sabotaged the majority of their warships. Of more than 60 ships aggregating about 225,000 tons, only about 25,000 tons of smaller vessels remained intact.

TOULOUSE, a city of southwestern France, capital of the department of Haute-Garonne, 443 mi. S.W. of Paris by the Orléans railway, and 159 mi. S.E. of Bordeaux by the Southern railway. Pop (1936), 185,401. Toulouse stands on the right bank of the Garonne, which here describes a curve round which the city extends in the form of a crescent. On the left bank is the low-lying suburb of St. Cyprien. The river is spanned by three bridges—that of St. Pierre to the north, that of St. Michel to the south, and the Pont Neuf in the centre; the last, a fine structure of seven arches. East and north of the city runs the Canal du Midi, which here joins the lateral canal of the Garonne.

The church of St. Sernin or Saturnin, whom legend represents as the first preacher of the gospel in Toulouse, where he was perhaps martyred about the middle of the 3rd century, has an 11th century choir, and is the largest Romanesque basilica in existence, being 375 ft. from east to west and 210 ft. in extreme breadth. The nave (12th and 13th centuries) has double aisles. The choir (11th and 12th centuries) ends in an apse, or rather chevet, surrounded by a range of columns, marking off an aisle, which in its turn opens into five chapels. Against the northern wall is an ancient *table d'autel*, which an 11th century inscription declares to have belonged to St. Sernin. In the crypts are many relics, which, however, were robbed of their gold and silver shrines during the Revolution. On the south there is a fine outer porch in the Renaissance style. The church was restored in the 19th century. The cathedral, dedicated to St. Stephen, has an 11th century nave and a 13th century choir, restored, the axis of which is not in a line with that of the nave. It is surrounded by 17 chapels

The western gate is flanked by a huge square tower. Over this gate there is a beautiful 13th century rose-window. The city contains other interesting old churches.

The principal secular buildings are the *capitole*, with a long

Ionic façade built 1750–60, and the museum The law courts stand on the site of the old Château Narbonais, once the residence of the counts of Toulouse and later the seat of the parlement of Toulouse. Toulouse is singularly rich in mansions of the 16th and 17th centuries, notably the Hôtel Bernuy, a fine Renaissance building and the Hôtel d'Assézat of the same period The Maison de Pierre has an elaborate stone façade of 1612.

Toulouse is the seat of an archbishopric, of a court of appeal, a court of assizes and of a prefect. It is also the headquarters of the 17th army corps and centre of an educational division (*académie*). There are tribunals of first instance and of commerce, a board of trade arbitrators and a chamber of commerce. The educational institutions include faculties of law, medicine and pharmacy, science and letters, a Catholic institute with faculties of theology and letters, schools of veterinary science, fine arts and industrial sciences and music and an agricultural institute. Toulouse, the principal commercial and industrial centre of Languedoc, has important markets for horses, wine, grain, flowers, leather, oil and farm produce. Its numerous industrial establishments include the national tobacco factory.

History.—Tolosa does not seem to have been a place of great importance during the early centuries of the Roman rule in Gaul, though in 106 B.C. the pillage of its temple by Q. S. Cepio, afterwards routed by the Cimbri, gave rise to the famous Latin proverb *habet aurum Tolosanum*, in allusion to ill-gotten gains. It possessed a circus and an amphitheatre, but its most remarkable remains are to be found on the heights of Old Toulouse (*vetus Tolosa*) some 6 or 7 m. to the east, where huge accumulations of broken pottery and fragments of an old earthen wall mark the site of an ancient settlement. The numerous coins that have been discovered on the same spot do not date back farther than the 2nd century B.C., and seem to indicate the position of a Roman trading centre then beginning to occupy the Gallic hill-fortress that, in earlier days, had been the stronghold of the native tribes dwelling on the river bank. Tolosa does not seem to have been a Roman colony; but its importance must have increased greatly towards the middle of the 4th century. It is entered in more than one itinerary dating from about this time; and Ausonius alludes to it in terms implying that it then had a large population. In 419 it was made the capital of his kingdom by Wallia, king of the Visigoths, and under his successors it was the centre of the great Visigothic kingdom. On the defeat of Alaric II. (507) Toulouse fell into the hands of Clovis, who carried away the royal treasures. Under the rule of the Merovingian kings Toulouse seems to have remained the greatest city of southern Gaul. It figures prominently in the pages of Gregory of Tours and Sidonius Apollinaris. About 628 Dagobert erected South Aquitaine into a kingdom for his brother Charibert, who chose Toulouse as his capital. For the next 80 years its history is obscure, till we reach the days of Charles Martel, when it was besieged by Sema, the leader of the Saracens from Spain (*c.* 715–720), but delivered by Eudes, "princeps Aquitaniae." Its real history recommences in 780 or 781, when Charlemagne appointed his little son Louis king of Aquitaine, with Toulouse for his chief city.

During the minority of the young king his tutor Chorson ruled at Toulouse with the title of duke or count. Being deposed at the Council of Worms (790), he was succeeded by William Courtnez, the traditional hero of southern France, who in 806 retired to his newly founded monastery at Gellone, where he died in 812. In the troubles of the century Toulouse suffered in common with the rest of western Europe. It was besieged by Charles the Bald in 844, and taken four years later by the Normans, who in 848 had sailed up the Garonne as far as its walls. About 852 Raymond I., count of Quercy, succeeded his brother Fridolo as count of Rouergue and Toulouse; it is from this noble that all the later counts of Toulouse trace their descent.

Dating from the 11th century the counts of Toulouse were the greatest lords in southern France. Raymond IV., the crusader, assumed the formal titles of marquis of Provence, duke of Narbonne and count of Toulouse. While Raymond was away in the Holy Land, Toulouse was seized by William IX., duke of Aquitaine, who claimed the city in right of his wife Philippa, the daughter of William IV, but was unable to hold it long (1098–1100). The rule of Raymond's son and successor Bertrand, also a crusader, was disturbed by the ambition of William IX. and his grand-daughter Eleanor, who prevailed upon her husband Louis VII. to support her claims to Toulouse by war. On her divorce from Louis and her marriage with Henry II., Eleanor's claims passed on to this monarch, who at last forced Raymond V. to do him homage for Toulouse. Raymond V., the patron of the troubadours, died in 1194, and was succeeded by his son Raymond VI., under whose rule Languedoc was desolated by the crusaders of Simon de Montfort, who occupied Toulouse in 1215, but lost his life in besieging the city in 1218. Raymond VII., the son of Raymond VI. and Joan of England, succeeded his father in 1222, and died in 1249, leaving an only daughter Joan, married to Alfonso the brother of Louis IX. On the death of Alfonso and Joan in 1271 the vast inheritance of the counts of Toulouse lapsed to the Crown. From the middle of the 12th century the people of Toulouse seem to have begun to free themselves from the most oppressive feudal dues. An act of Alphonse Jourdain (1141) exempts them from the tax on salt and wine, and in 1152 we have traces of a "commune consilium Tolosae" making police ordinances in its own name "with the advice of Lord Raymond, count of Toulouse, duke of Narbonne, and marquis of Provence."

The parlement of Toulouse was established in 1443 and was for Languedoc and southern France what the parlement of Paris was for the north. During the religious wars of the 16th century the Protestants of the town made two unsuccessful attempts to hand it over to the prince de Condé. After St Bartholomew's Day (1572) 300 of the party were massacred. Towards the end of the 16th century, during the wars of the League, the parlement was split up into three different sections, sitting respectively at Carcassonne or Béziers, at Castle Sarrasin and at Toulouse. The three were reunited in 1596. Under Francis I. it began to persecute heretics, and in 1619 rendered itself notorious by burning the philosopher Vanini. The University of Toulouse owes its origin to the action of Gregory IX., who in 1229 bound Raymond VII. to maintain four masters to teach theology and eight others for canon law, grammar and the liberal arts. Civil law and medicine were taught only a few years later. The famous "Floral Games" of Toulouse, in which the poets of Languedoc contended (May 1–3) for the prize of the golden amaranth and other gold or silver flowers, given at the expense of the city, were instituted in 1323–24. The *Académie des Jeux Floraux* still awards these prizes for compositions in poetry and prose.

See L. Ariste and L. Brand, *Histoire populaire de Toulouse depuis les origines jusqu'à ce jour* (Toulouse, 1898). (X.)

Battle of Toulouse, 1814.—Marshal Soult, retreating eastwards after a series of defeats (*see* PENINSULAR WAR), took shelter within the defences of Toulouse. The town lies on the right (east) bank of the Garonne, with a suburb, St. Cyprien, in the re-entrant angle on the left bank. In 1814 it was surrounded by fortified walls, St. Cyprien having also an outer line of earthworks. On the right bank the defences were: (1) the walls; (2) the Languedoc canal, which covers the north and east sides; (3) the ridge of Calvinet, east of the canal; (4) the river Hers, east of Calvinet and about two miles distant from the town. Wellington's plan was for Beresford's corps to attack the southern end of Calvinet ridge by way of the Caraman and Lavaur roads, while Freire's Spaniards advanced down the Albi road, captured the outlying Pujade hill, and attacked the Great Redoubt at the northern end of the ridge; to keep the defenders fully employed Hill was to demonstrate against St. Cyprien on the left bank, and Picton and Alten's Light Division against the northern defences of the town. Soult's dispositions were as follows: Maransin's division held St. Cyprien; Travot's division occupied the ramparts and the eastern stretch of the canal; Darricau's division was along its northern stretch from the Albi road to the Garonne. On the Calvinet ridge, Taupin was responsible for the southern end, including the La Sypière redoubts, Harpisse for Mas des Augustins, Villatte for the Great Redoubt, while Darmagnac covered the Albi road. Each army numbered something under 40,000; but it must be remembered that the French *moral* at this

time was at a very low ebb At 9 A.M. on April 10, 1814, Hill attacked St. Cyprien and during the course of the morning occupied the outer line of defences, the 3rd and Light Divisions closed up to the northern stretch of the canal and Freire gained the Pujade hill with little opposition. Wellington's plan necessitated Beresford's marching southwards three miles up the valley of the Hers, straight across the enemy's front and under direct fire of his guns. The going was so heavy that it was noon before he reached the Caraman road, his men nearly exhausted and his guns stuck in the mud miles behind. In spite of this he formed his corps for the attack, 6th Division on the right, 4th on the left, each in three lines. Meanwhile Freire, impatient for glory, launched a premature attack down the Albi road After some initial success he was counter-attacked by Darmagnac and driven back with severe losses Beresford now began his advance and quickly drove Taupin's division from La Sypière, but reinforcements from the town enabled the French to form a new line in front of the canal, connecting with Mas des Augustins Beresford paused to rest his men and wait for his guns, whereupon Picton, contrary to orders, hurled his division against the fortified canal bridges near the Garonne, and was repulsed with heavy loss. Wellington now ordered Beresford and Freire to renew their attacks upon the Calvinet redoubts Freire was again repulsed, but the 6th Division, after heavy and fluctuating fighting, won possession of Mas des Augustins and the neighbouring works. Upon this Soult withdrew from the remainder of the ridge and when night fell the French were behind the canal, except for two bridgeheads at its southern end. Wellington spent the 11th bringing up ammunition supplies, but during that night Soult, fearful of being shut up in Toulouse, evacuated the town and took the road for Carcasonne. The Allies lost 4,400 men, 1,800 being Spaniards; the French little more than 2,000. Vain losses, for Napoleon had abdicated a week previously. (H. L A.-F.)

TOUNGOO or TAUNG-NGU, a town and district in the Tenasserim division of Burma. The town is situated on the right bank of the river Sittang, 166 m. N. of Rangoon by rail Pop (1931) 23,223. From the 14th to the 16th century Toungoo was the capital of an independent kingdom The district has an area of 6,456 sq mi.; pop. (1941) 474,858. The main Rangoon-Mandalay railway is the chief means of communication. The rainfall is between 60 and 90 inches Rice is the staple crop, there are some plantations of rubber Forests cover more than 5,000 sq.m , of which large areas have been reserved, yielding a large revenue.

TOURACOU, the name of certain birds belonging to the plantain eaters (*Musophagidae*). The term is often extended to cover the whole family, which is exclusively African.

The plantain-eaters proper comprise the genus *Musophaga*. They are birds the size of a crow, with the horny base of the bill prolonged backwards over the forehead. The plumage is purple, with the top of the head and primaries deep crimson and, in *M. violacea*, a white eye-streak.

The Touracous number some 15 species. The white-crested Touracou (*Turacus albicristatus*) inhabits Cape Colony and Natal. *T persa,* from Guinea, is distinguished from the last by the purple, instead of green, wing coverts and tail The slate-brown grey Touracou (*Schizorrhis concolor*) inhabits Natal.

TOURAINE, a French province, bounded on the north by Orléanais, west by Anjou and Maine, south by Poitou and east by Berry, and corresponding approximately to the modern department of Indre-et-Loire. Touraine took its name from the *Turones,* the tribe by which it was inhabited at the time of Caesar's conquest of Gaul. The capital city, Caesarodunum, was made by Valentinian the metropolis of the 3rd Lyonnaise, which included roughly the later provinces of Touraine, Brittany, Maine and Anjou. The ecclesiastical province of Tours was apparently created during the episcopate of St. Martin (*fl.* 375–400), who founded the abbey of Marmoutier, near Tours, and whose tomb in the city became a celebrated shrine. Tours was included in the territory of the Visigoths, but the Tourangeans refused to adopt the Arian heresy of their conquerors, and easily accepted the conquest of the province by Clovis (*c.* 507). The possession of Touraine was constantly in dispute between different Merovingian princes, and the province enjoyed no settled peace until the reign of Charlemagne. He established Alcuin as abbot of St. Martin of Tours, under whom the school of Tours became one of the chief seats of learning in Gaul. From Merovingian times, the administration of Touraine was entrusted to counts appointed by the Crown. The office became hereditary in 940 or 941 with Theobald the Old. His son Odo I was attacked by Fulk the Black, count of Anjou, and despoiled of part of his territory. His grandson Theobald III., who refused homage to Henry I, king of France, in 1044, was entirely dispossessed by Geoffrey Martel of Anjou (d. 1060) and the county of Touraine remained under the domination of the counts of Anjou (*q.v.*) until 1204. Philip Augustus appointed William des Roches hereditary seneschal in 1204, but the dignity was ceded to the Crown in 1312 Touraine was granted from time to time to princes of the blood as an appanage of the Crown of France In 1328 it was held by Jeanne of Burgundy, queen of France, by Philip, duke of Orleans, in 1344; and in 1360 it was made a peerage duchy on behalf of Philip the Bold, afterwards duke of Burgundy. Charles VII. bestowed the duchy successively on his wife Mary of Anjou, on Archibald Douglas and on Louis III. of Anjou. It was the dower of Mary Stuart as the widow of Francis II. The last duke of Touraine was Francis, duke of Alençon (d. 1584). Plessis-les-Tours had been the favourite residence of Louis XI., who granted many privileges to the town of Tours, and increased its prosperity by the establishment of the silk-weaving industry. The reformed religion numbered many adherents in Touraine, who suffered in the massacres following on the conspiracy of Amboise. Many Huguenots emigrated after the massacre of St. Bartholomew, and after the revocation of the Edict of Nantes the silk industry, which had been mainly in the hands of the Huguenots, was almost destroyed. This migration was one of the prime causes of the extreme poverty of the province in the next century.

See the quarterly publication of the *Mémoires* of the *Société archéologique de Touraine* (1842, etc) which includes a *Dictionnaire géographique, historique et biographique* (6 vols., 1878–84), by J. X. Carré de Busserolle. There are histories of Touraine and its monuments by Chalmel (4 vols. 1828), by S. Bellanger (1845), by Bourrassé (1858). *See* also Dupin de Saint André, *Hist. du protestantisme en Touraine* (1885), T. A. Cook, *Old Touraine* (1892).

TOURCOING (tōōr-kwăn), a town of northern France in the department of Nord, less than a mile from the Belgian frontier, and 8 mi. N.N.E. of Lille on the railway to Ghent. Pop. (1936) 77,156. Famed since the 12th century for its woollen manufactures, Tourcoing was fortified by the Flemings in 1477, when Louis XI of France disputed the inheritance of Charles the Bold with Mary of Burgundy but in the same year was taken and pillaged by the French. In 1794 the Republican army, under Moreau and Souham, gained a decisive victory there over the Austrians. Tourcoing is practically one with Roubaix to the south, being united thereto by a tramway and a branch of the Canal de Roubaix. The public institutions comprise a tribunal of commerce, a board of trade arbitrators, a chamber of commerce, an exchange and a conditioning house for textiles. Together with Roubaix, Tourcoing ranks as one of the chief textile centres of France Its chief industry is the combing, spinning and twisting of wool, spinning of cotton and the manufacture of all kinds of woollen, cotton and silk goods, notably carpets To these industries must be added those of dyeing, the manufacture of hosiery, of textile machinery and of soap.

TOURING CAR. A term widely used to describe an automobile of open body type with a folding top, removable side curtains, and two fixed seats. Open cars, including the roadster (*q v.*) have been largely displaced in public popularity by closed models. In 1936, 99·6% of the passenger cars manufactured in the United States were of the latter type. (*See* SEDAN.)

TOURMALINE, a mineral of interest from several points of view, but of no commercial value, except occasionally when used as a gem-stone. The name is from the Cingalese *toramalli,* brown gem-stones having come from Ceylon early in the 18th century. The mineral is of interest chemically on account of its complex composition, containing, perhaps, a greater variety of chemical elements than any other mineral, and these are present

in very variable proportions. Many attempts have been made to arrive at a general formula to express the composition The one now generally accepted is that of S L Penfield and H W Foote (1899), who regarded the several varieties of tourmaline as salts of a hypothetical alumino-borosilicic acid $H_2Al_2(BOH)_2Si_4O_{18}$ Here hydrogen is partly, but not wholly, replaced by aluminium, ferric and ferrous iron, chromium, manganese, magnesium, calcium, sodium, potassium, lithium, etc , and fluorine is usually also present in small amounts. Rather than a single species, tourmaline thus represents an extensive series of isomorphous minerals, but the sub-division into species is not practicable According to the predominance of certain elements, a chemical distinction has been made between iron-tourmaline, magnesium-tourmaline and alkali-tourmaline.

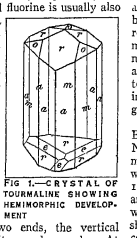


FIG 1.—CRYSTAL OF TOURMALINE SHOWING HEMIMORPHIC DEVELOPMENT

All crystals of tourmaline belong to the ditrigonal pyramidal (hemimorphic-hemihedral) class of the rhombohedral system, and no variation can be detected in the interfacial angles corresponding with the wide range in chemical composition. The crystals are of interest in showing a different development of faces at the two ends, the vertical trigonal axis, or principal axis, being unitermnal or polar. At the upper end in fig 1 are two trigonal pyramids r and o, and at the lower end the trigonal pyramids r and e. The crystals are usually prismatic in habit with one hexagonal prism a and a trigonal prism m, and between the two there may be several ditrigonal prisms each of six faces. All these prism faces are deeply striated or furrowed parallel to the vertical axis, so much so that the cross-section is usually triangular with curving convex sides. This characteristic feature enables the mineral to be readily distinguished from others of similar appearance.

Another interesting feature of tourmaline is shown in the pyro-electrical properties, which are intimately related to the hemimorphic or polar development of the crystals mentioned above. When a crystal is slightly warmed, one end becomes charged with positive electricity and the other end acquires a negative charge. On cooling these charges are reversed. This is well shown by dusting a cooling crystal over with a mixture of red-lead and sulphur, when the yellow sulphur is attracted to the positively charged end and the red lead to the negatively charged end. A faceted gem-stone of tourmaline may be tested in this way. Tourmaline also shows the related phenomenon of piezoelectricity. When a plate cut perpendicular to the principal axis is subjected to variations of pressure it develops positive and negative charges on the two surfaces. This property can be made use of for detecting small variations in pressure, as in depth-sounding apparatus.

The optical properties are also of exceptional interest. A ray of light entering a crystal of tourmaline is split up into two rays; one, the ordinary ray, vibrating perpendicular to the principal axis, and the other, the extraordinary ray, vibrating parallel to this axis. Coloured crystals are very strongly dichroic, the ordinary ray being almost completely absorbed Plates cut parallel to the principal axis of the crystal, therefore, allow only the extraordinary ray to pass through, and if two such plates are placed in crossed position the light is entirely cut out. A pair of such plates form a very simple polarizing apparatus known as tourmaline tongs The crystals are optically uniaxial and negative, and the refractive indices vary with the chemical composition, for the ordinary ray $\omega = 1{\cdot}6315$–$1{\cdot}6854$, and for the extraordinary ray $\epsilon = 1{\cdot}6123$–$1{\cdot}6515$ for sodium-light. The specific gravity shows a corresponding range from 3·0 to 3·2. The hardness is 7·5.

In general appearance, tourmaline is extremely variable. It may be quite colourless and water-clear, black and opaque, or various shades of red, yellow, brown, green or blue. Some crystals show very strikingly bands of different colours. The coloured varieties when clear and of good quality are cut as gem-stones under the names rubellite or "Siberian ruby," "Brazilian emerald," indicolite, etc. In addition to well-formed crystals, the mineral may take the form of rounded triangular rods or fine needles, which are often aggregated in bundles or radiating groups, or it may form compact granular masses. A common form, especially in the Cornish tin mines, is as bundles of black needles, this form being known as *schorl* (German, *Schorl*).

Tourmaline generally occurs in connection with granitic rocks, and it is often an indication of the presence of tin-ore. It would appear to have originated in most cases by the interaction of boron-bearing emanations from the granite magma on the surrounding rocks and minerals The best crystals are found in pegmatite veins and in metamorphic limestones in contact with granite masses. Being resistant to weathering processes the mineral accumulates in detrital deposits and in sedimentary rocks. Gem tourmaline comes from the gem-gravels of Ceylon and is quarried in pegmatite veins in the Ural mountains, California and Madagascar. (L J S)

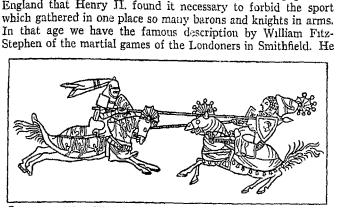
TOURNAI (Flemish *Doornik*), city, province of Hainaut, Belgium, on the Scheldt Pop. (1930) 35,290. The cathedral of Notre-Dame dates from 1030, the nave is Romanesque of the middle of the 12th century, with much pointed work The transept was added in the 13th century The first choir was burned down in 1213, but was rebuilt in 1242 at the same time as the transept, and is a superb specimen of pointed Gothic. There are five towers with spires. There are several old pictures of merit, and the shrine of St Eleuthère, the first bishop of Tournai in the 6th century, is a remarkable product of the silversmith's art The belfry on the Grand Place, the oldest in Belgium, was built in 1187, partly reconstructed in 1391 and finally restored and endowed with a steeple in 1853. The church of St. Quentin in the same square as the belfry is almost as ancient as Notre-Dame In the church of St. Brice is the tomb of Childeric discovered in 1653. Among the relics were three hundred small golden models of bees These were removed to Paris, and when Napoleon was crowned emperor a century and a half later he chose Childeric's bees for the decoration of his coronation mantle. In this manner the bee became associated with the Napoleonic legend just as the lilies were with the Bourbons The Pont des Trous over the Scheldt, with towers at each end, was built in 1290, and some old houses still in occupation date back to the 13th century On the Grand Place is the fine statue of Christine de Lalaing, princess d'Epinoy, who defended Tournai against Parma in 1581. Tournai is engaged in cement working, the making of hosiery, and spinning, weaving and tanning

The actual site was occupied under Julius Caesar and called *civitas Nerviorum* or *castrum Turnacum*. In the reign of Augustus, Agrippa fixed the newly mixed colony of Suevi and Menapii at Tournai. In the 5th century the Franks seized Tournai, and Merovaeus made it the capital of his dynasty. This it remained until the subdivision of the Frank monarchy among the sons of Clovis. When feudal possessions, instead of being purely personal, were vested in the families of the holder after the death of Charlemagne, Tournai was specially assigned to Baldwin of the Iron Arm by Charles the Bald, whose daughter Judith he had abducted, on receiving the hereditary title of count of Flanders. During the Burgundian period it was the residence of Margaret of York, widow of Charles the Bold; and the pretender Perkin Warbeck, whom she championed, if not born there, was the reputed son of a Jew of Tournai. In the early 16th century Tournai was an English possession for a few years and Henry VIII. sold it to Francis I It did not long remain French, for in 1521 the count of Nassau, Charles V's general, took it for Spain. Part of Tournai was destroyed in May 1940 during the German invasion.

TOURNAMENT or **TOURNEY.** Of the mediaeval definitions of the tournament given by Du Cange (*Glossarium, s v.* "Tourneamentum"), the best is that of Roger of Hoveden, who described tournaments as "military exercises carried out, not in the spirit of hostility (*nullo interveniente odio*), but solely for practice and the display of prowess (*pro solo exercitio, atque ostentatione virium*)." It apparently originated in France, and more than one chronicler records the violent death, in 1066, of a French baron, Geoffroi de Preulli, who, according to the testimony of his contemporaries, "invented tournaments." In England, at least, the

tournament was counted a French fashion, Matthew Paris calling it *conflictus gallicus*.

By the 12th century the tournament notwithstanding the condemnation of the Council of the Lateran, had grown so popular in England that Henry II. found it necessary to forbid the sport which gathered in one place so many barons and knights in arms. In that age we have the famous description by William Fitz-Stephen of the martial games of the Londoners in Smithfield. He



ENGLISH KNIGHTS TILTING WITH LANCES IN A TOURNAMENT FROM THE LOUTERELL PSALTER, AN ILLUSTRATED MANUSCRIPT OF THE 14TH CENTURY

tells how on Sundays in Lent a noble train of young men would take the field well mounted, rushing out of the city with spear and shield to ape the feats of war. Divided into parties, one body would retreat, while another pursued striving to unhorse them. The younger lads, he says, bore javelins disarmed of their steel, by which we may know that the weapon of the elders was the headed lance. William of Newbury tells us how the young knights, balked of their favourite sport by the royal mandate, would pass over sea to win glory in foreign lists Richard I. relaxed his father's order, granting licences for tournaments, and Jocelin of Brakelond has a long story of the great company of cavaliers who held a tournament between Thetford and Bury St. Edmund's in defiance of the abbot. From that time onward unlicensed tourneying was treated as an offence against the Crown, which exacted heavy fees from all taking part in them even when a licence had been obtained.

In 1299 life and limb were declared to be forfeit in the case of those who should arrange a tourney without royal licence, and offenders were to be seized with horse and harness As the tournament became an occasion for pageantry and feasting, new reason was given for restraint: a simple knight might beggar himself over a sport which risked costly horses and carried him far afield Jousters travelled from land to land, offering and accepting challenges. Thus Edward I., before coming to the throne, led 80 knights to a tournament on the Continent. Before the jousts at Windsor on St George's day in 1344 heralds published in France, Scotland, Burgundy, Hainault, Flanders, Brabant and the domains of the emperor the king's offer of safe conduct for competitors. At the weddings of princes and magnates and at the crowning of kings the knights gathered to the joustings, which had become as much a part of such high ceremonies as the banquet and the minstrelsy.

Regulations.—About 1292 a "Statute of Arms for Tournaments" enacted new laws. Swords with points were not to be used, nor pointed daggers, nor club nor mace. None was to raise up a fallen knight but his own appointed squires, clad in his device The squire who offended was to lose horse and arms and lie three years in gaol. Disputes were to be settled by a court of honour of princes and earls. That such rules were needful had been shown at Rochester in 1251, where foreign knights were beaten by the English and so despitefully treated that they fled to the city for refuge. On their way the strangers were faced by another company of knights who handled them roughly and spoiled them, thrashing them with staves in revenge for the doings at a Brackley tournament. Even as early as the 13th century some of these tournaments were mere pageants of horsemen. For the Jousts of Peace held at Windsor Park in 1278 the sword-blades were of whalebone and parchment, silvered; the helms were of boiled leather and the shields of light timber. But the game could make rough sport. Many a tournament had its tale of killed and wounded in the chronicle books. We read how Roger of Lemburn struck Arnold de Montigny dead with a lance thrust under the helm. The first of the Montagu earls of Salisbury died of hurts taken at a Windsor jousting, and in those same lists at Windsor the earl's grandson Sir William Montagu was killed by his own father. William Longespee in 1256 was so bruised that he never recovered his strength, and he is among many of whom the like is written; injuries were often caused when dismounted adversaries continued the combat on foot. Blunted or "rebated" lance-points came early into use, and by the 14th century the coronall or cronell head was often fitted in place of the point. After 1400 the armourers began to devise harness with defences specially wrought for service in the lists But the joust lost its chief perils with the invention of the tilt, which, as its name imports, was at first a cloth stretched along the length of the lists. The cloth became a stout barrier of timber, and in the early 16th century the knight ran his course at little risk Locked up in steel harness, reinforced with the grand-guard and the other jousting pieces, he charged along one side of this barrier, seeing little more through the pierced sight-holes of the helm than the head and shoulders of his adversary. His bridle arm was on the tilt-side, and thus the blunted lance struck at an angle upon the polished plates. Mishaps might befall. At the close of the famous tournament which formed part of the rejoicings for the peace of Cateau-Cambresis in 1559 Henry II of France died from the stroke of Gabriel de Montgomeri, who failed to cast up in time the truncheon of his splintered lance. The result of this tragedy was a considerable diminution in the popularity of the tournament. But the 16th century tournament was, in the main, a bloodless meeting, as befitted a spectacle arranged as much for the delectation of women as of men. Prizes, usually consisting of arms and armour, rich robes and great silver vessels were at the close presented to the victors by the Lady of the Tournament.

Pageantry.—In the 15th century the tournament had the aspect of a pageant. The great meeting at Bruges, when the jousting of the Knights of the Fleece was part of the pageant of the Golden Tree, the Giant and the Dwarf, may stand as a magnificent example of many such gay gatherings. When Henry VIII. was scattering his father's treasure the pageant had become an elaborate masque For two days after the crowning of the king at Westminster, Henry and his queen viewed from the galleries of a fantastic palace set up beside the tilt-yard a play in which deer were pulled down by greyhounds in a paled park, in which the Lady Diana and the Lady Pallas came forward, embowered in moving castles, to present the champions. Such costly shows fell out of fashion after the death of Henry VIII.; and in England the tournament remained, until the end, a martial sport. In France it degenerated to the carrousel, which became an unmartial display.

The tournament was, from the first, held to be a sport for men of noble birth, and on the Continent, where nobility was more exactly defined than in England, the lists were jealously closed to all combatants but those of the privileged class. In the German lands, questions as to the purity of the strain of a candidate for admission to a noble chapter were often settled by appeal to the fact that this or that ancestor had taken part in a tournament. Konrad Grünenberg's famous heraldic manuscript shows us the *Helmschau* that came before the German tournament of the 15th century—the squires carrying each his master's crested helm, and a little scutcheon of arms hanging from it, to the hall where the king of arms stands among the ladies and judges each blazon.

The Eglinton Tournament.—An attempt to revive the tourney was made at Eglinton castle, Ayrshire, in 1839. The inception of the idea was due to Archibald, 13th Earl of Eglinton, who found an ideal setting for his tournament in the grounds of Eglinton castle On Aug. 28, 1839, the lists were dressed in the park Each knight, with his esquires and attendants, had a separate pavilion The lists were splendidly decorated and richly hung, and temporary adornments of Westminster Abbey at the then recent coronation were again used At Lord Eglinton's request many of the ladies wore the costume of the 14th and 15th centuries The marquess of Londonderry was "King of the Tournament" and Lady Seymour, afterwards duchess of Somerset, was "Queen of Love and Beauty." The official list contained the names of 15 knights:—The earl of Eglinton, the marquess of Waterford, the

earl of Craven, the earl of Cassilis, Viscount Alford, Viscount Glenlyon, the hon. Capt. Gage, the hon. Mr. Jermingham, Capt Fairlie, Sir Frederick Johnstone, Sir Francis Hopkins, Capt Beresford, Charles Lamb, C Boothby and Mr. Lechmere. They were in armour and carried lances The crown of victory was bestowed upon Lord Eglinton. The second day there was a series of mimic tilts on foot and under cover between Prince Louis Napoleon, afterwards Napoleon III , and Charles Lamb, both of whom were in armour. On the third day there was a series of "tourneys" in which eight knights, armed with swords, were engaged A good description of the Eglinton tournament will be found in Chapters 59 and 60 of Disraeli's famous novel, *Endymion*

When Prince Humbert, afterwards Humbert I., King of Italy, was married at Turin in 1868 to Princess Margherita of Savoy, the festivities included a tournament. The Royal Naval and Military Tournament, held annually in London after 1880, but discontinued during World War II, consists of a series of displays of skill in arms, but differs widely from the mediaeval tourney.

TOURNEUR, CYRIL (*c.* 1575–1626), English dramatist, was perhaps the son of Captain Richard Turnor, water-bailiff and subsequently lieutenant-governor of Brill in the Netherlands. Cyril Tourneur also served in the Low Countries, for in 1613 there is a record made of payment to him for carrying letters to Brussels. He enjoyed a pension from the government of the United Provinces, possibly by way of compensation for a post held before Brill was handed over to the Dutch in 1616. In 1625 he was appointed by Sir Edward Cecil, whose father had been a former governor of Brill, to be secretary to the council of war This appointment was cancelled by Buckingham, but Tourneur sailed in Cecil's company to Cadiz On the return voyage from the disastrous expedition he was put ashore at Kinsale with other sick men, and died in Ireland on Feb. 28, 1626.

Tourneur's fame rests on two plays, *The Revenger's Tragedy* (pr. 1607) and *The Atheist's Tragedy* (pr. 1611). Of these Swinburne, in an article contributed to the 9th ed. of the *Encyclopædia Britannica*, wrote as follows:

"The singular power, the singular originality and the singular limitation of his genius are all equally obvious in *The Atheist's Tragedy*, a dramatic poem no less crude and puerile and violent in action and evolution than simple and noble and natural in expression and in style. The executive faculty of the author is in the metrical parts of his first play so imperfect as to suggest either incompetence or perversity in the workman; in *The Revenger's Tragedy* it is so magnificent, so simple, impeccable and sublime that the finest passages of this play can be compared only with the noblest examples of tragic dialogue or monologue ever existent in English or in Greek. There is no trace of imitation or derivation from an alien source in the genius of this poet. . . . As a playwright, his method was almost crude and rude in the headlong straightforwardness of its energetic simplicity; as an artist in character, his interest was intense but narrow, his power magnificent but confined; as a dramatic poet, the force of his genius is great enough to ensure him an enduring place among the foremost of the followers of Shakespeare."

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The Revenger's Tragedy was printed in Dodsley's *Old Plays* (vol. iv., 1744, 1780 and 1825), and in *Ancient British Drama* (1810, vol. ii.). The best edition of Tourneur's works is *The Plays and Poems of Cyril Tourneur, edited with Critical Introduction and Notes*, by J. Churton Collins (1878). See also the two plays printed with the masterpieces of Webster, with an introduction by J. A. Symonds, in the "Mermaid Series" (1888 and 1903). No particulars of Tourneur's life were available until the facts given above were abstracted by Mr. Gordon Goodwin from the *Calendar of State Papers* ("Domestic Series," 1628–1629, 1629–1631, 1631–1633) and printed in the *Academy* (May 9, 1891). A critical study of the relation of *The Atheist's Tragedy* to *Hamlet* and other revenge-plays is given in Professor A. H. Thorndike's "Hamlet and Contemporary Revenge Plays" (*Publ. of the Mod Lang. Assoc.*, Baltimore, 1902). For the influence of Marston on Tourneur *see* E E Stoll, *John Webster* . . . (1905, Boston, Massachusetts), pp. 105–116.

TOURNON, a town of south-western France, capital of an arrondissement in the department of Ardèche, on the right bank of the Rhône, 58 mi. S. of Lyons by rail. Pop. (1936) 4,657. Tournon preserves a gateway of the 15th century and other remains of fortifications and an old castle used as town hall, courthouse and containing a Gothic chapel The church of St. Julian dates chiefly from the 14th century. Tournon had its own counts as early as the reign of Louis I

TOURS, a town of France, capital of the department of Indre-et-Loire, 145 mi. S.W. of Paris by rail. Pop. (1936) 83,753.

Tours (*see* TOURAINE), under the Gauls the capital of the Turones or Turons, originally stood on the right bank of the Loire, a little above the village of St. Symphorien At first called *Altionos*, the town was afterwards known as *Caesarodunum* The Romans removed the town from the hill where it originally stood to the left bank of the river.

Tours became Christian about 250 through the preaching of Gatien, who founded the bishopric. The first cathedral was built 100 years later by St. Litorius. The bishopric became an archbishopric when Gratian made Tours the capital of Lugdunensis Tertia, though the bishops did not adopt the title of archbishop till the 9th century. In the 5th century the official name of Caesarodunum was changed to *Civitas Turonorum*. St. Martin, the apostle of the Gauls, was bishop of Tours in the 4th century

Affiliated to the Armorican confederation in 435, the town fell to the Visigoths in 473. It became part of the Frankish dominions under Clovis At the end of the 6th century the bishopric was held by St. Gregory of Tours. Tours grew rapidly in prosperity under the Merovingians, but abuse of the right of sanctuary led to great disorder. Charlemagne re-established discipline in the disorganized monastery and set over it the learned Alcuin, who established one of the oldest public schools of philosophy and theology. The arts flourished at Tours in the middle ages and the town was the centre of the Poitevin Romanesque school of architecture. The abbey was made into a collegiate church in the 11th century, and was for a time affiliated to Cluny, but soon came under the direct rule of Rome, and for long had bishops of its own The suburb in which the monastery was situated became important under the name of Martinopolis The Normans pillaged it in 853 and 903. Walls were erected from 906 to 910, and the name was changed to that of Châteauneuf.

In the 14th century Tours was united to Châteauneuf within a common wall, of which a round tower, the Tour de Guise, remains, and both towns were put under the same administration. The numerous and long-continued visits of Charles VII, Louis XI, who established the silk industry, and Charles VIII during the 15th century favoured commerce and industry. In 1562 Tours suffered from the violence of both Protestants and Catholics.

In the 17th and 18th centuries it was the capital of the government of Touraine. Its manufactures, of which silk weaving was the chief, suffered from the revocation of the Edict of Nantes (1685). In 1772 its mint, whence were issued the "livres" of Tours, was suppressed. During the Revolution the town formed a base of operations of the Republicans against the Vendeans.

Tours lies on a flat tongue of land between Loire and Cher just above their junction. The right bank of the Loire is bordered by hills at the foot of which lie St. Cyr and St. Symphorien. The river is crossed by two suspension bridges.

St Gatien, the cathedral of Tours, dates from the 12th to the 16th centuries. The lower portions of the west towers belong to the 12th century, the choir to the 13th century; the transept and east bays of the nave to the 14th; the remaining bays, a cloister on the north, and the façade, decorated in the Flamboyant style, to the 15th and 16th centuries, the upper part of the towers being in the Renaissance style of the 16th century In the choir there is fine 13th century stained glass. The 16th century tomb of the children of Charles VIII., is attributed to the brothers Juste. The square tower of the church of St. Julien is Romanesque, the rest being in the early Gothic style of the 13th century, with

the exception of two apses added in the 16th century. Two towers and a Renaissance cloister are the chief remains of the celebrated basilica of St. Martin Two other churches are Notre-Dame la Riche, originally built in the 13th century, rebuilt in the 16th, and magnificently restored in the 19th century, and St. Saturnin of the 15th century. Of the old houses of Tours the hôtel Gouin and that wrongly known as the house of Tristan l'Hermite (both of the 15th century) are the best known. Tours has a valuable library, including among its mss a gospel of the 8th century on which the kings of France took oath as honorary canons of the church of St Martin Balzac was a native of Tours Tours is the seat of an archbishop, a prefect, and a court of assizes, before World War II headquarters of the 9th army corps, and has tribunals of first instance and of commerce, a board of trade-arbitrators and a chamber of commerce.

There are silk factories and important printing works, steel works, iron and tin foundries and factories for automobiles, machinery, oil, cement, stained glass, boots and shoes, porcelain and other goods. A considerable trade is carried on in the wine of the district and in brandy, dried fruits and confectionery.

BATTLE OF TOURS

The battle of Tours (A D 732), sometimes called the battle of Poitiers, marks the turning point in the northern advance of the Moors, the victory of the Franks checked once and for all the expansion of Islam in western Europe. In 711 the Arabs had crossed the Straits of Gibraltar and conquered the weak Visigothic kingdom of Spain; a few years later they crossed the Pyrenees, and in 720 captured Narbonne, which became the base for their further progress into Gaul, where the wealth of the churches and monasteries offered a powerful inducement. The plan of extending their power to the north was rendered more possible by the political rivalry which subsisted between the dukes of Aquitaine and the Merovingian Mayors of the Palace. However, in 720, the year in which the Arab attacks began in earnest, Eudo, duke of Aquitaine, had made his peace with Charles Martel, and was therefore free to deal with the impending danger In 721 he relieved Toulouse, which was being besieged, and won a decisive victory over the Arabs. But after a short respite the attack was renewed in 725. A strong army crossed the eastern Pyrenees, captured Carcassonne and Nîmes, and occupied the greater part of the province of Septimania. In the same year they made a raid into Burgundy and destroyed the city of Autun. Internal dissensions among the Arabs themselves, the incessant hostility between the Ma'ddites and the Yemenites, prevented them, however, from following up these successes; and it was not until the appointment in 731 of the popular and energetic governor of the Yemenite party, 'Abd-ar-Rahmān, that the offensive was resumed. The situation in Gaul was favourable for the enterprise, for war had once more broken out between Eudo and Charles. With a large army 'Abd-ar-Rahmān crossed the Pyrenees and captured and burned Bordeaux Eudo, who hastened to check his advance, was defeated, with the loss of the greater part of his army, between the Garonne and the Dordogne. The Arabs pressed forward, plundering as they went, along the line of the Roman road which ran northward from Bordeaux through Poitiers to Orléans At Poitiers they destroyed the basilica of St. Hilary; their next objective was Tours, whither they were attracted by the immense riches of the famous church of St. Martin But before they reached it they were met by Charles, to whom Eudo, despite his previous hostility, had fled for assistance after his defeat.

Charles, at the head of a large army, engaged with the enemy south of Tours, perhaps at the little town of Cenon, near the junction of the Clain and the Vienne, and not far north of Old Poitiers (*see* the inset map in Spruner-Menke, *Hand-Atlas*, Plate 29). For seven days the two armies stood facing each other. Then on a Saturday in October the serious fighting began. Charles had taken up a defensive position in close formation It was the moral and physical superiority of the Teutonic race over the Muslims that won the day. The light Arab cavalry broke before the "immovable wall" of Frankish soldiers who stood, we are told, firm "as a rock of ice" (Isidorus Pacensis). They were hurled back with heavy loss; 'Abd-ar-Rahmān himself was killed on the field. Fighting continued till nightfall; and when, on the next morning, the Franks prepared to resume the battle, they found the Arab tents deserted. The Arab losses were very severe.

The battle of Tours is commonly regarded as one of the decisive battles of the world's history. In a sense this is true. It dealt a decisive check to the advance of the Arabs into Gaul. It removed an imminent peril, a constant menace. But there were causes other than Charles's victory which in part account for the cessation of the Arab advance. The revolt of the Berbers in North Africa was as decisive a factor as the battle of Tours in putting an end to the advance of the Arabs into western Europe.

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TOURVILLE, ANNE-HILARION DE COTENTIN

(OR COSTANTIN), COMTE DE (1642–1701), French admiral and marshal of France, was the son of César de Cotentin, or Costantin, who held offices in the household of the king and of the prince of Condé. Destined by his family to enter the Order of Malta, he served for eleven years with the galleys of the Order against the Barbary pirates. In 1667 he was incorporated in the corps of officers of the French Royal navy and in 1689 he left the Order. In the French navy he served in the Mediterranean for some years. In 1690, Tourville commanded the "Page" (50), in the squadron of the comte d'Estrées (1624–1707) sent to cooperate with the duke of York against the Dutch. He was present at the battle of Solebay (June 7, 1672), and in the action on the coast of Holland in the following year, when Prince Rupert commanded the English fleet. When England withdrew from the alliance, the scene of the naval war was transferred to the Mediterranean, where Holland was co-operating with the Spaniards. Tourville served under Abraham Duquesne in his battles with De Ruyter By this time he was known as one of the best officers in the service of King Louis XIV. By 1689 he had been promoted lieutenant-général des armées navales, and was named vice-admiral du Levant or of the East In June of that year he became commander-in-chief of the French naval forces in the war against England and her continental allies.

From this time till the failure of his resources compelled King Louis XIV. to withdraw his fleets from the sea, Tourville continued to command the naval war in the Channel and the Atlantic. His conduct and example during this period were the source of the system of manoeuvring to gain an advantage by some method other than plain fighting. In 1690 he had an opportunity which might well have tempted the most cautious, and he missed it out of sheer care to keep his fleet safe against all conceivable chances, aided perhaps by a pedantic taste for formal, orderly movement. He was opposed in the channel by the allies, who had only fifty-six ships, while his own force was from seventy to eighty sail strong He was feebly attacked by Admiral Arthur Herbert, earl of Torrington, off Beachy Head on July 10. The Dutch ships in the van were surrounded. The allies retreated in disorder, and Tourville followed in "line of battle" which limited his speed of pursuit to that of his slowest ship. In 1692 the Mediterranean fleet having failed to join him, he was faced by a vastly superior force of the allies. The French king had prepared a military force to invade England, and Tourville was expected to prepare the way. He made a resolute attack on the centre of the allies on May 29, off Cape Barfleur, and drew off before he was surrounded This action, with the pursuit of the following days, made up what is called "the battle of La Hogue." His flagship the "Soleil Royale" and fifteen other ships were cut off and destroyed. In 1693 he was again at sea with a great fleet, and had a chance to capture the Smyrna convoy off Gibraltar. Again he kept his fleet in battle order, and a large part of the convoy escaped. Tourville was made Marshal of France in 1693. He died in Paris in

TOUSSAINT L'OUVERTURE (or LOUVERTURE), **PIERRE-DOMINIQUE** (*c.* 1746–1803), one of the liberators of Haiti, claimed to be descended from an African chief. His first surname Breda was afterwards changed to L'Ouverture in token of his valour in causing a gap in the ranks of the enemy. He obtained his master's confidence and was made superintendent of the other negroes on the plantation After the insurrection of 1791 he joined the insurgents and acted as physician to the forces. His rapid rise aroused the jealousy of Jean François, who caused his arrest on the ground of his partiality to the whites. He was liberated by the rival insurgent chief Baissou, and a partisan war ensued, but after the death of Baissou he placed himself under the orders of Jean François. Subsequently he joined the Spaniards, but, when the French government ratified the act declaring the freedom of the slaves, he came to the aid of the French In 1796 he was named commander in chief of the armies of St. Domingo, but, having raised and disciplined a powerful army of Negroes, he made himself master of the whole country, renounced the authority of France, and announced himself "the Buonaparte of St Domingo" He was captured by the French and died in the prison of Joux, near Besançon, on April 7, 1803.

See Toussaint l'Ouverture's own *Mémoires*, with a life by Saint Remy (1850); Gragnon-Lacoste, *Toussaint Louverture* (1887), Schœlcher, *Vie de Toussaint Louverture* (1889); and J. R. Beard, *Life of Toussaint Louverture* (1853).

TOUT, THOMAS FREDERICK (1855–1929), British historian, was born in London on Sept. 28, 1855, and educated at St. Olave's school, Southwark, and at Balliol college, Oxford. In 1881 he was appointed professor of history at St David's college, Lampeter, and from 1890 to 1925, held a similar appointment at Manchester university. He was a fellow of Pembroke college, Oxford, from 1883 to 1890. He took a prominent part in the work of various historical societies and educational committees, and in 1911 was elected fellow of the British Academy. In 1925 he was elected president of the Royal Historical Society, and from 1927 to 1928 was messenger lecturer at Cornell university. He died in London on Oct. 23, 1929.

His works include *History of England for Schools* (with Prof. York Powell), vol. iii. (1890); vol. ii. (1898); *The Empire and the Papacy* (1898). He was first editor with H. Johnstone of *Select Trials of the Judges and Mmisters, 1289–92* (Camden Series, *Royal Hist Soc.*, 1906); and has written *Chapters in the Administrative History of Mediaeval England* (vols. i. and ii., 1920); *France and England, their Relations in the Middle Age and Now* (1922); and many school text books and articles in historical reviews.

TOVEY, SIR DONALD FRANCIS (1875–1940), English pianist, composer and writer on music, was born on July 17, 1875, at Eton, where his father, the Rev. Duncan Charles Tovey, was a master. He was trained as a pianist by Sophie Weiss. In 1900 he definitely took up music as a career and began to give recitals, in which his own compositions were included, in London and on the Continent. From 1914–1940 he was Reid professor of music at Edinburgh university. The Reid orchestral concerts, which he conducted, owe their existence to his initiative. He contributed a large number of articles to the present edition of the *Encyclopædia Britannica*.

The orchestral compositions include a symphony in D, performed at Aix-la-Chapelle in 1913, a pianoforte concerto in A, prelude and entr'actes for Maeterlinck's *Aglavaine et Sélysette* (for string orchestra), and an opera, *The Bride of Dionysus* to R. C. Trevelyan's text. In chamber music he wrote two sonatas for violin alone; a sonata for two violoncellos; a pianoforte trio and a quintet; a trio in C minor for pianoforte, clarinet and horn; two string quartets; variations on a theme by Gluck for flute and strings. He also wrote three anthems and 25 rounds for equal voices He was knighted in 1935.

TOWER, the term given to a lofty building originally designed for defence, hence, any structure whose height is its most important dimension, whether isolated or forming part of another building. The two earliest uses of lofty buildings were military and religious; in the one case constructed to give a raised platform from which a defending force could advantageously discharge missiles upon an attacking force, at the same time remaining protected from it; in the other case, always in connection with sun, moon or star worship, apparently in the effort to raise the worshipper or the priest as near heaven as possible.

Military.—The Mesopotamian peoples seem to have built the first highly developed masonry towered fortifications. Thus on a tablet in the lap of the famous statue of Gudea, the king of Lagash (*c.* 2700 B.C.), now in the Louvre, there is a representation of a fort with towers and gates The Egyptians used towers less frequently, but certain remains exist in which the Asian type appears and the palace pavilion of Amenhotep at Medinet Abu has projecting towers of Assyrian type. The Greek world made a less definite use of towers. In Roman times, however, towers formed an integral part of every developed fortification, and were especially important on the city walls, as can be seen in many examples, especially at Pompeii and in the wall of Aurelian at Rome. In Constantinople successive emperors merely followed Roman tradition and the existing ruins of the walls originally built by Theodosius reveal many analogies to similar Roman work, with their boldly projecting, square, battlemented towers Towers with curved fronts are also occasionally found, especially in connection with gates.

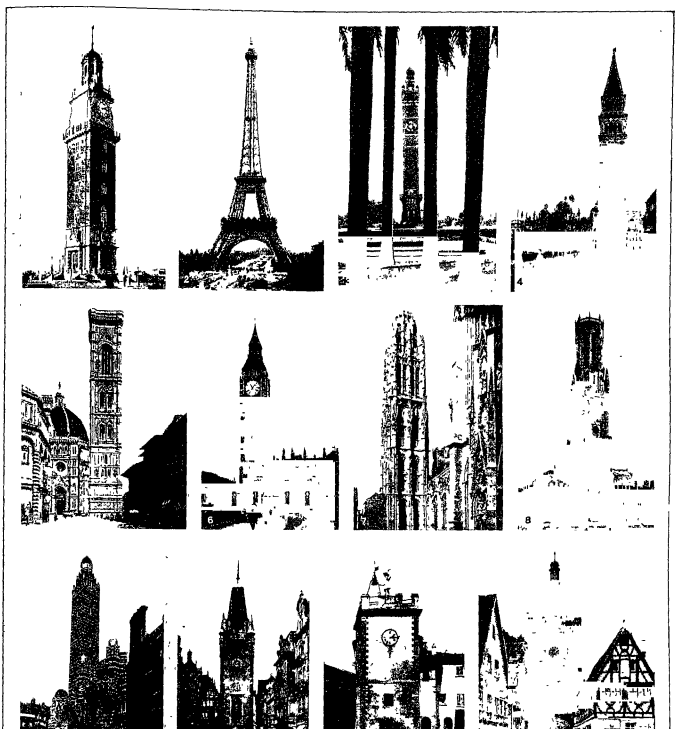
In the mediaeval period, from the 13th century on, the military tower received its greatest development, which found expression in such city walls as those of Aigues Mortes and Carcassonne, both dating largely from the latter part of the 13th century; and in such châteaux as Coucy (13th century) or Pierrefonds (15th century). The greatest development of the defensive tower was through its use as the keep (*q.v.*) or donjon (*q.v.*), such as the mediaeval White Tower of the Tower of London (11th century) or the famous round tower of Coucy. It is probably from this use of the tower as a keep that the word occurs often in house names in England, such as Houghton Tower. Meanwhile, in many important towns in mediaeval Italy noble families each tried to have its own tower as a place of refuge in time of factional strife. These towers were extremely high and often isolated, with only a small entrance and a few small openings.

In the Near East, the great towers of the fortifications built on either side of the Bosporus at Rumeli Hissar and Anatol Hissar, during the siege of the city (middle 15th century) are still landmarks. In China great masonry towers crown each gate of a city wall, topped with garrison buildings that give much additional height; towers of a simpler and strangely European type form the most conspicuous features of the famous Great Wall of China.

With the appearance of firearms, and particularly of large cannon, the use of towers as fortifications practically vanished. (*See* FORTIFICATION.)

Religious.—Towers built for religious purposes appear in an early developed form in the Chaldean ziggurats (*q.v.*)—the great stepped pyramids, with stairs or inclined planes connecting the levels, and an open terrace with an altar or a shrine at the top, which were attached to nearly every Chaldean and Assyrian temple. Similar high buildings, the so-called pyramids, were frequently associated with temples in ancient Mexico and Central America. The early Persians seem also to have used raised platforms on small towers in connection with their fire worship In the classic world towers do not appear as important religious buildings, and it was not until the 8th century, and probably with the wide introduction of bells that they came to be associated with churches. (*See* CAMPANILE.)

By the end of the 11th century the use of church towers was almost universal. In France the earliest examples are placed at the crossing of nave and transepts, often taking the form of a lantern in several stages or levels, with a pyramidal top. In England, on the other hand, a position at the west end of the nave had become common during the Saxon period, as at Earl's Barton and Barnack. In the Norman period central towers became usual as well as towers flanking the main entrance Particularly picturesque were the grouped towers common in the Rhineland as in the 12th century churches of Mainz and Speyer. Romanesque tower design was generally simple. Shallow corner buttresses were occasionally found, but the main effect was gained by a



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CLOCK AND OTHER TOWERS

1 The English Clock Tower in Buenos Aires. That city has many towers and monuments honouring the countries represented in its population
2. Eiffel Tower, Paris, France, built for the Paris exhibition of 1889 It is 984 feet in height
3. The Husainabad Clock Tower in Lucknow, India, viewed through stately palms The Hindu tank of the original Royal Palace is near its base
4 Piazza of St Mark, Venice, Italy, with the Cathedral and Campanile
5. The Campanile, or Giotto's Tower, at Florence, Italy
6 Clock Tower of the Houses of Parliament in London which contains the famous "Big Ben" bell
7. Tour de Beurre at Rouen Cathedral, so named because funds for its building were given in return for permission to eat butter in Lent
8 The Belfry, Bruges, Belgium
9. Tower of Westminster Cathedral
10. Martinsthor Gate at the end of the Kaiserstrasse in Freiburg-im-Breisgau, Germany
11. Ancient clock tower at Montepulciano, Italy, showing the bell and the figure which strikes the hour
12 The Siebers Tower, one of the numerous picturesque gate towers in Rothenburg, Bavaria, and one of the most interesting pieces of mediaeval architecture in the town. An old wine house is shown at the right of the tower

to gain admission into London, and threatened by the approach of Edward the young duke of York from the west of England, was compelled to fall back northward. York having been proclaimed as Edward IV., followed them up into Yorkshire, and on the 27th his leading troops surprised the passage of the Aire at Ferrybridge. The Lancastrians were encamped at Towton, some miles away, covering Tadcaster and York, but a force under Lord Clifford was promptly sent out, recaptured Ferrybridge by surprise, and cut to pieces the Yorkist garrison. About the same time, however, Edward's van, under Lord Fauconberg, an experienced soldier, crossed the Aire higher up, and Clifford was compelled to retire. He was closely pressed, and at Dintingdale, within a few furlongs of his own camps, was cut off and killed with nearly all his men Edward's main body was now close at hand, and the Lancastrians drew up on their chosen battlefield early on the 29th. This field was an elevated plateau, with steep slopes, between the present Great North Road and the river Cock, cut in two by a depression called Towton Dale. On opposite sides of this depression stood the two armies, that of York facing north, their opponents southward. Both lines of battle were very dense. On a front of little more than a thousand yards the Lancastrian party had nearly 60,000 men. Edward's force (less than 50,000) was not all present, the rear "battle" under Norfolk being still distant. Snow and sleet blew in the faces of the Lancastrians and covered the field of battle. The skilful Fauconberg used this advantage to the utmost. Aided by the wind, his archers discharged flights of arrows against the enemy, who replied blindly and feebly, hampered by snow and wind. The Yorkists withdrew until the enemy had exhausted their quivers, and then advanced afresh Their arrows soon stung the Lancastrians into a wild and disorderly charge. Suffering severe losses the latter closed with Edward's line of battle. No quarter was given by either party, and on the narrow front the numerical superiority of the Lancastrians counted for little. The long, doubtful and sanguinary struggle was only decided by the arrival of Norfolk's corps, which charged the enemy in flank. Driven backwards and inwards, the Lancastrians were in a desperate position, for their only way of escape to Tadcaster crossed the swollen waters of the Cock by a single narrow and difficult ford, and when, after a stubborn struggle, they finally broke and fled, they were slaughtered in thousands as they tried to cross. At the close of the day the defeated army had ceased to exist. 25,000 Lancastrian and 8,000 Yorkist dead were buried in and about Towton

See R Brooke, *Visits to English Battlefields* (London, 1857); C. R. B Barrett, *Battles and Battlefields of England* (London, 1896); H. B. George, *Battles of English History* (London, 1895).

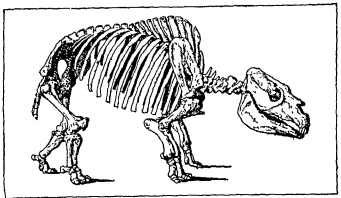
TOXICOLOGY, the name of that branch of science which deals with poisons, their effects and antidotes, etc. (*See* POISON and MEDICAL JURISPRUDENCE.)

TOXIN: *see* DIPHTHERIA; SCARLET FEVER; MEDICAL RESEARCH.

TOXODONTIA or NOTOUNGULATA, an extinct order of South American hoofed, herbivorous mammals. Members of this group and of the Litopterna (*q.v.*) were the typical herbivores of South America throughout most of the Age of Mammals. They were extremely numerous and so varied that it is difficult to give any diagnostic characters common to all of them, although all can be traced back to the same small, primitive ancestors in the Palaeocene and there is no doubt that they are truly related. Developing in isolation during the long period when South America was an island continent, they gave rise to forms superficially resembling various different animals of the northern hemisphere, to which they are not really related, an example of evolutionary convergence on a large scale.

The toxodonts, strictly speaking, suborder Toxodonta, were the most abundant members of the order The oldest and most primitive toxodonts, some of them no bigger than cats and largely generalized in structure, soon split into several different lines. One of these culminated in the Miocene in *Homalodotherium*, an anomalous herbivore with large claws on the feet, analogous to the northern Chalicotheres (*see* ANCYLOPODA). Another line, well represented by fossils of many different ages, led to the genus *Toxodon*, of Pleistocene age, as large as a recent rhinoceros and remotely similar in appearance, but hornless.

The typotheres, suborder Typotheria, were smaller than the toxodonts, many of them about the size of rabbits although the Pleistocene *Mesotherium* (often called "*Typotherium*") reached the size of a sheep. Like the rodents, the typotheres developed gnawing incisor teeth and long-rooted or continuously growing grinding teeth. They were very like some rodents in appearance



THE SKELETON OF TOXODON. AFTER A CAST IN THE AMERICAN MUSEUM OF NATURAL HISTORY

and doubtless also in habits, although they were true notoungulates and this is another example of convergence, not blood relationship The hegetotheres, suborder Hegetotheria, closely resemble the typotheres, with which they were long confused, but they represent a different line of evolution.

The other suborder of Notoungulata, the Notioprogonia, is known only from the Palaeocene and Eocene and includes the smallest and most primitive types of notoungulates. Although notoungulates are otherwise confined to South America, one genus of notioprogonians (*Arctostylops*) has been found in the Eocene of Wyoming to one in the Palaeocene of Mongolia, but this suborder, too, is most abundant in Patagonia. At the end of the Tertiary, South America was invaded by more progressive herbivores from the north. The native Notoungulata and Litopterna were unable to compete successfully and became extinct.

See W. B. Scott, *A History of Land Mammals in the Western Hemisphere*, revised edition (1937). (G. G. S.)

TOY, CRAWFORD HOWELL (1836–1919), American Hebrew scholar, was born in Norfolk, Va., on March 23, 1836. He graduated at the University of Virginia in 1856, completed in one year the three-year course at the Southern Baptist theological seminary, served in the Confederate army, studied at the University of Berlin in 1866–68 and taught in various southern educational institutions. His resignation from the seminary in which he had studied was accepted in 1879 because of his sympathy with Darwin's views on evolution and his belief that in spite of their divine inspiration there were obvious human errors in the Scriptures which, however, concerned the shell, not the kernel, of religious truth After a brief period with the *Independent* he went to Harvard as professor of Hebrew and Oriental languages and until 1903 Dexter lecturer on biblical literature. He became professor emeritus in 1909 and died in Cambridge, May 12, 1919. He was the author of *History of the Religion of Israel* (1882), *Quotations from the Old Testament in the New Testament* (1884), *Judaism and Christianity* (1890), *Introduction to the History of Religions* (1913) and of various critical and exegetical works.

See sketches in the *American Journal of Semitic Languages and Literature* (vol XXXVI., Oct. 1919) and the *Harvard Theological Review* (vol. XIII., Jan. 1920).

TOY, a child's plaything; also a trifle, a worthless, petty ornament. a gew-gaw, a bauble. Children's toys and playthings survive from the most remote periods, though many so-called diminutive objects made and used by primitive man, sometimes classified as playthings, may have been workmen's models, votive offerings or sepulchral objects. A large number of wooden, earthenware, stone or metal dolls remain with which the children of

ancient Egypt once played, thus in the British Museum collection there is a flat painted wooden doll with strings of mud-beads representing the hair, a bronze woman doll bearing a pot on her head, an earthenware doll carrying and nursing a child, some have movable jointed arms. There are also many toy animals, such as a painted wooden calf, a porcelain elephant with a rider; this once had movable legs, which have disappeared. Balls are found made of leather stuffed with hair, chopped straw and other material, and also of blue porcelain or papyrus. Jointed dolls, moved by strings, were evidently favourite playthings of the Greek and Roman children, and small models of furniture, chairs, tables, sets of jugs painted with scenes of children's life survive from both Greek and Roman times Balls, tops, rattles and the implements of numerous games, still favourites in all countries and every age, remain to show how little the amusements of children have changed. (*See* also DOLLS; TOP.)

TOYNBEE, ARNOLD (1852–1883), English social reformer and economist, second son of Joseph Toynbee (1815–1866), a distinguished surgeon, was born in London on Aug 23, 1852. He had originally intended to enter the army, but ill health and a growing love of books changed his plans, and he settled down to read for the bar. Here again the same causes produced a change of purpose, and he entered as a student at Pembroke College, Oxford. Two years later he removed to Balliol college, where, after taking his degree, he was appointed lecturer and tutor to students preparing for the Indian civil service. He devoted himself to the study of economics and economic history. He was a practical social reformer, taking part in much public work and delivering lectures in the large industrial centres on economic problems. He overtaxed his strength, and after lecturing in London in January 1883 he had a complete break-down, and died of inflammation of the brain at Wimbledon on March 9.

Toynbee had a striking influence on his contemporaries, not merely through his intellectual powers, but by his strength of character, love of truth and ardent and active zeal for the public good. He was the author of some fragmentary pieces, published under the title of *The Industrial Revolution* (1884). Toynbee's interest in the poor and his anxiety to be personally acquainted with them led to his close association with the district of Whitechapel in London, where Canon Barnett (*q.v.*) was at that time vicar—an association which was commemorated after his death by the social settlement of Toynbee Hall, the first of many institutions for social betterment. (*See* SOCIAL SETTLEMENTS.)

See F. C. Montague's *Arnold Toynbee* (Johns Hopkins University Studies, 1889); Lord Milner's *Arnold Toynbee: a Reminiscence* (1901); and L. L. Price's *Short History of Political Economy in England* for a criticism of Toynbee as an economist; also a new edition of his *Lectures on the Industrial Revolution* (1919), with preface by Lord Milner.

TOYNBEE, PAGET (1855–1932), English philologist and critic, was born at Wimbledon on Jan. 20, 1855, and educated at Haileybury and at Balliol college, Oxford. From 1878 he acted for 14 years as private tutor, afterwards making a name for himself as a Dante scholar. He has also published and edited a number of works relating to Horace Walpole.

His publications include *Specimens of Old French, with Notes and Glossary* (1892); *Life of Dante* (1900; 4th enlarged ed., 1910); *Dante Studies and Researches* (1902); *Chronological List of English Translations from Dante, from Chaucer to the Present Day* (1906); *Dante in English Literature from Chaucer to Cary* (2 vols., 1909); *Critical Texts of Letters of Dante* (1915–19, amended text and translation, 1920); *Dante Studies* (1921); *Horace Walpole's Journal of the Printing Office at Strawberry Hill* (1923); *Horace Walpole's Reminiscences* (1924), etc.

TOYNBEE HALL. Founded in London by Canon Barnett, then rector of St. Jude's Whitechapel in 1884, and named after Arnold Toynbee, a brilliant economist and co-worker whose death shortly before had been hastened by his zeal for social reform, Toynbee Hall, the pioneer university settlement, inaugurated an important movement (*see* SOCIAL SETTLEMENTS). In the earlier years of his ministrations at St. Jude's, Barnett had succeeded in creating interest at Oxford and Cambridge in the problems of East London and had brought to Whitechapel a considerable number of undergraduates to spend their holidays with him and learn about social conditions. The connection which was established in this way prepared the universities for the suggestion of a closer union between them and the East End and Barnett's plan to found a settlement that is, a house of residence for university undergraduates who might wish to live in an industrial area, was at once warmly supported With money collected mainly at Oxford he was able to purchase and reconstruct premises next door to St. Jude's which had been used for the purposes of an industrial school and with the help of a band of "settlers" to commence activities which left an enduring mark on the social history of the period. Mainly these activities were concerned with the collection of social data, with social experimentation, and with the amelioration of social and industrial conditions; but Barnett's underlying aim was to bring the generosity and learning of the young and the universities into effective relation with the industrial population so that both communities might come in time to serve ideals of citizenship and neighbourliness

The War involved the closing of the hostels (Balliol house and Wadham house) which Barnett had founded for working men students at Toynbee Hall and in other ways suspended the operations of the settlement. Since 1919 however most of its customary activities have been resumed and its work as a "popular university" has been extended An important feature of its annual programme is now a large "American Summer School" which is attended by about 100 preachers, educationalists and social workers from the United States, selected because of their interest in the international aspect of social and economic problems.

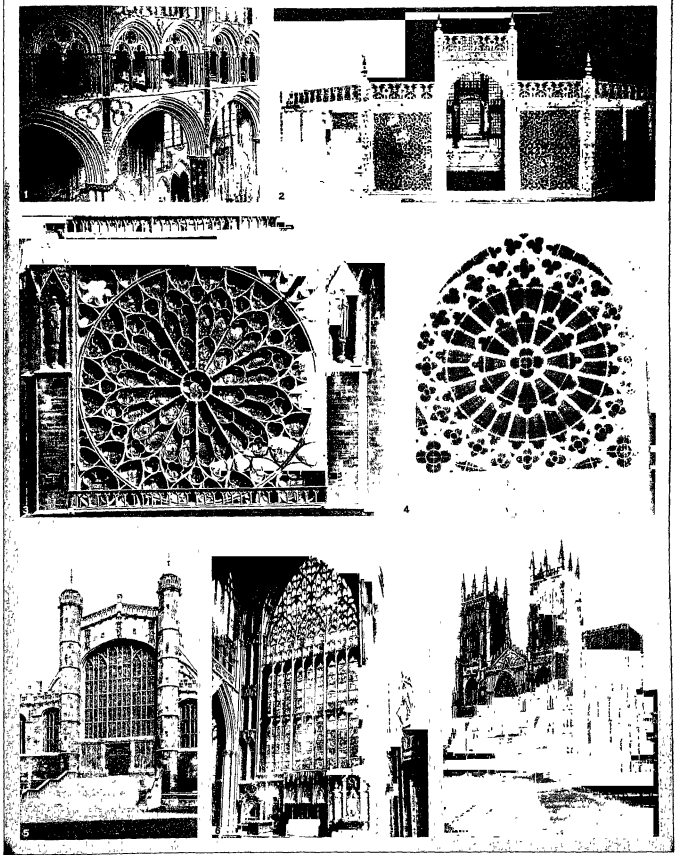
(J. J. M.)

TOZZI, FEDERIGO (1883–1920), Italian novelist, was born at Siena on Jan 1, 1883, the son of an innkeeper His childhood and early youth are described in *Con gli occhi chiusi* (1919). His father died in 1908, and Tozzi married the same year, and *Il Podere* (1921) is a record of his experiences at this time. He learnt Latin and studied old Tuscan, his first book being an *Antologa d'antichi scrittori senesi* (1913). *Tre Croci* (1920) translated into English as *Three Crosses* (1921), the only one of his novels which is not autobiographical, is considered his finest work. He died in Rome on March 21, 1920, before he was able to reap the fame which the success of his latest work brought him.

TRACERY, the term given in architecture to the upright curving or intersecting bars or ribs, used in a window or other opening to give beauty and variety to its silhouette. The term is also applied to similar forms used in relief, as wall decoration (sometimes called wall-tracery), and hence, figuratively, of any intricate line pattern. The word is often restricted to the elaborate system of window decoration, with its derivative forms, developed in Europe during the Gothic period, but it may, with equal validity, be applied to the pierced marble screens common in the Mogul work of India, or to the pierced plaster windows of Persia, Turkey, Syria and Egypt.

The origin of European tracery is confused. Pierced marble screens, with the openings glazed, were used occasionally in Byzantine work. The Byzantines also used, commonly, groups of two, three or even more narrow, arched windows, placed close together, under a single, large, relieving arch above. In this they were followed by most of the Romanesque styles. In such groups, the supports between the adjacent openings of each group usually consisted of single colonnettes, hence the arches over them were thin and shallow; and the tympanum, or section of wall supported by them and filling the space between them and the great enclosing or relieving arch over the whole group, was necessarily thin also. Such windows are found in the greater number of Italian campaniles and Romanesque towers, as well as in many Romanesque triforium arcades. To decorate the tympanum, piercing was an obvious and simple method. The result was the germ of tracery

Plate Tracery is found in early Gothic work both in France and England. In its simplest forms the tympanum is pierced with a single opening, usually circular, but occasionally taking a four-lobed or quatrefoil form. The points between the lobes known as cusps (*q.v.*), later became an important element in



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EXAMPLES OF TRACERY

1. Geometric decorated English Gothic tracery: Angel Choir, Lincoln Cathedral, 1250–80. 2. Mogul pierced marble tracery: screen in the Taj Mahal, Agra, India, 1632. 3. Rayonnant French Gothic tracery: transept rose window, Notre Dame Cathedral, Paris, *c.* 1270. 4. Rayonnant French Gothic tracery: rose window from St. Nazaire, Carcassonne, France, beginning of the 14th century. 5. Perpendicular English Gothic tracery: west front, St. George's Chapel, Windsor, begun 1474. 6. Early Perpendicular English Gothic tracery: east window, York Minster, 1408. 7. Curvilinear Decorated English Gothic tracery: west front, York Minster, 1338

much Gothic ornament In time, greater elaboration was sought by increasing the number and complexity of the piercings, and thus both the size and beauty of the entire unit The climax of plate tracery appears in France in the group of magnificent windows of Chartres cathedral (1194–1212); and in England in the rose window at Lincoln cathedral (1220), known as the Dean's eye.

Bar Tracery.—As skill in stone cutting and desire for complexity increased, the area of the tympanum wall left solid grew continually smaller, finally leaving only thin bars of stone separating the adjacent openings. Moreover, in Notre Dame cathedral, Paris, certain small, interior, round windows constituting a sort of upper triforium in the original design, carried decorations of little inverted arches built of stone—a sort of rudimentary tracery About 1220 the next inevitable step in the development was taken, and a window was considered not as a group of lights carrying a little piece of pierced tympanum wall, but as a group of lights where arches are formed of a bar of stone similar in section to that of the mullion or support between them, with the space between these arches and the enclosing arch—the old tympanum—occupied by a pattern of similar stone bars In early work this pattern usually consists of a circle, sometimes cusped, tangent both to the enclosing arch and to the small arches of the lights below it The cusps are usually of the type known as "soffit cusping," cut on separate pieces of stone set into grooves in the inner faces of the circle.

French Rayonnant Tracery.—In France, bar tracery occurs in the rebuilt clerestorey of Notre Dame (between 1220 and 1230) in the simplest possible form, and in a more developed type, with cusps, in the apse chapels of Reims cathedral (prior to 1230) From about 1240 on it becomes common, rapidly increasing in lightness and complexity. In general, the pattern types are restricted. There are two, three or four lights. In two-light windows, a single cusped circle is the crowning feature In three-light windows three smaller cusped circles fill the space above. Four-light windows are formed of two two-light windows, with an additional cusped circle above. In France the spring of the arches of the lower lights is kept far below that of the enclosing arch, so that the crowning circle is large During the late 13th century, curved-sided triangles, and trefoil and quatrefoil forms, without enclosing circles, are occasionally used. In four-light windows, the central mullion is often made heavier than the side mullions, both in depth and width, and this additional size carried around the enclosing arches of the side pairs. This heavier bar will have a section or profile, part of which is a duplicate of the smaller bars or mullions Thus tracery of two planes and two moulding types is developed—one, that of the smaller bars, and the other, that of the larger Each moulding type plane is known as an "order," and such a window is said to have tracery of two orders. The climax of French Rayonnant tracery can be seen in S. Urbain at Troyes (1270), S. Chapelle in Paris (1246–48) and S Nazaire at Carcassonne (early 14th century). The rose windows (*q.v.*) of the style, such as those of Notre Dame at Paris (*c.* 1270), designed with radiating patterns using similar combinations of forms—arches, circles, cuspings, etc.—are perhaps the most remarkable traceried windows of the style During the later Rayonnant period, tracery forms came to be used decoratively, for wall surfaces, pinnacles, gables, etc. Especially noteworthy is the filling of the gables of porches, above the door arches, with tracery forms. At first this was done simply, with little piercing; later, as in the Portail des Libraires, at Rouen cathedral (*c.* 1280), the gable became a mere decorative screen of lace-like open tracery. French Rayonnant tracery was the controlling influence in all continental tracery outside Italy.

English Geometric Tracery.—Based on the same simple arch, circle and cusp forms as the French tracery, the English geometric tracery is infinitely richer and more varied The great east end and west windows of the cathedrals allowed the development of four-, six- or eight-light windows, designed in two or three orders, carefully systematized, like the east window of Lincoln cathedral (*c.* 1280), in eight lights, with three orders. But the greatest change was in single order windows of smaller size. In these the use of cusps without circles became common, and all sorts of star-shaped, triangular and other geometric forms occur.

English Curvilinear Tracery.—In the early years of the 14th century the English architects discovered that by the use of the ogee (*q.v.*) curve, or curve of double curvature, the occasional harsh angularities of the geometric style could be avoided, and wavy-lined tracery of great beauty produced. This gave rise to the so-called curvilinear tracery. Its simplest form is the reticulated, or network window in which the entire upper part is filled with a regular all-over pattern of waving bars, rhythmically tangent and then separating. But the introduction of the reverse curve set free the imagination of the designer, and an infinite number of varying types resulted, such as the rose window at Lincoln cathedral (1350), or the great west window at York (*c.* 1338).

Perpendicular Tracery.—By the end of the 3rd quarter of the 14th century a reaction had set in against this flowing curvature, and the 15th century saw the new style—the so-called perpendicular—triumphant. It was based on one controlling idea—verticality. Mullions were run through unbroken from bottom to top At intervals they were connected by horizontal bars running across the window, supported on little arches between the mullions, thus dividing the whole window into tiers of little arch-headed lights At the top there is great variety of treatment, but almost always the upper lights are smaller than those below; and there was frequent use of curved bars intersecting the verticals, and to some extent recalling the arched forms of the earlier styles This new feeling appears in the transept window of Gloucester cathedral as early as 1335, and in a more developed form in the east window of the choir, which fills the entire east end, about 1350. During the 15th century the lines become more and more rectangular and the window heads have flatter and flatter arches The climax of this development is reached in such enormous end windows as those of the King's College chapel, Cambridge, and St. George's chapel, Windsor (*c.* 1525).

Wall tracery of perpendicular character was widely used both for exterior and interior work during the 15th and early 16th centuries Great areas are sometimes filled with tiers of traceried panels, as in the Henry VII. chapel, Westminster Abbey (begun 1502) In some cases, where flint was common, a tracery of cut stone, filled in with dark flints, decorates church exteriors, as in Long Melford church and St. Laurence at Ipswich. Traceried forms are also the basis of much screen, stall and tomb design of the 15th century; rood screens are particularly rich. Tracery is also the basis of the decorative rib treatments of fan vaulting. (*See* FAN VAULT; VAULT)

French Flamboyant Tracery.—In the last years of the 14th century the reverse curve came into use in French tracery, probably as the direct result of English curvilinear models. The French, however, soon gave tracery of this kind an individual spirit. In the best Flamboyant work, such as the tracery of S Maclou, Rouen (begun 1432), and the west front of Rouen cathedral (begun 1481), all of the forms are shimmer and more flame-like than is usual in English work. Particularly interesting is the application of Flamboyant tracery to rose windows, like that of the south transept of Beauvais cathedral (1500–48), in which the radiating character of the earlier types is maintained, although combined with the reverse curve. Flamboyant tracery forms the chief decoration of many gorgeous choir stalls and screens. The screen at Albi (*c.* 1500) has tracery of unbelievable lace-like delicacy in its canopies, as well as larger patterns covering wall surfaces; the wood choir stalls of Amiens (1508–19) are even more delicate and the tracery is of the utmost richness and intricacy. Noteworthy, also, is the application of Flamboyant tracery forms to exterior detail, as in the porch of S. Maclou, Rouen, and the west front of S. Wulfran at Abbeville (1480).

Italian Tracery.—Due to the Italian lack of understanding of Gothic structural principles, tracery never achieved in Italy the logical development of the north. The nearest approach to this is in the bands of tracery of Venetian palace windows, such as those of the Ca' d'Oro (1430), by G. and B Bon. Elsewhere, tracery was only understood as beautiful pattern, and much of it,

even when copying the forms of bar tracery, is pierced from large sheets of marble, as in the *triforium* of the cathedral at Lucca (*c.* 1400) and the cloister of S. Maria della Verita, at Viterbo

Tracery in the Orient.—The Mohammedan designers not only followed Byzantine precedent in using pierced marble screens for windows but also, by the development of a new technique, invented a characteristic type of tracery, which combined the functions played by both leading and stone tracery in western work. This technique consisted in filling the window area with a pierced sheet of cement, each piercing being filled with a piece of coloured glass Results of jewel-like intensity and brilliance were thus obtained, and being made of a plastic material, tracery of this type could have unlimited variety of pattern. The usual types found were basically floral, with the leaf shapes in glass, carefully arranged to give a sense of flow and growth Such cement tracery is found particularly in the later work of Cairo, such as the mosque of Barkouk (*c.* 1384) and in the imperial Turkish work, such as the brilliantly jewelled windows in the 17th century mosque of Suleiman, Constantinople. In India, where ventilation is required, rather than floods of light, a different type was developed, without glass, and in a richer material—carved and pierced marble Thus, in almost all of the great Mogul palaces, and in many of the tombs, large, pointed arch openings are filled with sheets of white marble, pierced in the most elaborate patterns, of the finest scale. The most delicate example of this pierced, marble tracery is that of the screen around the sarcophagi in the Taj Mahal (*q.v.*), at Agra (1632–47)

Modern Types.—Church architects of the 20th century, working, frequently, in a modernized Gothic style, found in tracery a congenial means of free expression. Both geometric and curvilinear forms furnished inspiration, but patterns of a freshness and individuality frequently quite different from the mediaeval custom were developed. Foliated ornament was frequently added to the tracery basis. A modern development is seen in the use of precast cement tiles, pierced in geometric patterns and glazed, built up into large windows, as in the church of Notre Dame at Raincy, Fr. (1924), by Perret Frères. (*See* GOTHIC ARCHITECTURE, INDIAN ARCHITECTURE) (T. F. H., X)

TRACHELIUM, in architecture the neck of the capital of the Doric and Ionic orders. In the Greek Doric capital it is the space between the annulets of the echinus and the grooves which marked the junction of the shaft and capital. In the Roman Doric and the Ionic orders the term is given to the interval between the lowest moulding of the capital and the top of the astragal and fillet (*See* also HYPOTRACHELIUM)

TRACHEOTOMY, the operation of opening the trachea or windpipe (*see* RESPIRATORY SYSTEM, ANATOMY OF) and inserting a tube to provide a means of breathing when the natural air-passage is obstructed above this level by injury, disease or foreign bodies

The operation is by no means easy when performed on a small child, for the windpipe is deeply placed among important structures. The chief anxiety is in connection with haemorrhage, for the vessels are large and generally overfull because of the impairment of the respiration Formerly, it was frequently performed in diphtheria (*q.v.*) but since the introduction of diphtheria antitoxin it has rarely become necessary.

TRACHIS, a city of ancient Greece, at the head of the Malian gulf in a small plain between the rivers Asopus and Melas, enclosed by Mt Oeta which there descends close to the sea and at the Trachinian Cliffs commanded the main road from Thessaly. The position was well adapted as an advanced post against invaders from the north, and furthermore guarded the road up the Asopus gorge into the Cephissus valley. Its citadel, Heracleia, was a subject of dispute between the Spartans and the Thebans at the end of the 5th century B.C. In Strabo's time the citadel alone was inhabited.

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TRACHOMA, from the Greek adjective *trachys* meaning rough, is a communicable, chronic, inflammatory disease of the conjunctiva, the delicate mucous membrane that lines the back of the eyelids and the front of the eyeball (*see* EYE, HUMAN. *Diseases of the Eye*). In addition to chronic conjunctival congestion, thickening and roughening of varying severity, trachoma causes scarring and opacification of the cornea and thereby impairs the vision. The disease is caused by a virus and communicated among humans by transfer of secretion from the eye of the affected person. This transfer may occur by direct hand-to-hand contact or indirectly through soiled handkerchiefs, towels or water in washbasins used indiscriminately by diseased and undiseased individuals. One of the oldest diseases known to man, trachoma is still prevalent in most countries of the near east and the far east. In the United States it was once endemic among the white rural population of certain parts of the south central states and among the American Indians, but has been brought under control by sustained intensive treatment and systematic improvement of living conditions and personal hygiene. (P. C. K.)

TRACHYTE (Gr τραχύς, rough), in petrology, a group of volcanic rocks which consist mainly of sanidine (or glassy orthoclase) felspar Very often they have minute irregular steam cavities which make the broken surfaces of specimens of these rocks rough and irregular, whence comes their name, which was first given by Haüy to certain rocks of this class from Auvergne, and long included quartz trachytes (now known as liparites and rhyolites) and oligoclase trachytes, which are now more properly assigned to andesites.

Mineral Composition.—The trachytes are often described as being the volcanic equivalents of the plutonic syenites. Their dominant mineral, sanidine felspar, very commonly occurs in two generations, *i.e.*, both as large well-shaped porphyritic crystals and in smaller imperfect rods or laths forming a finely crystalline ground mass. With this there is practically always a smaller amount of plagioclase, usually oligoclase; but the potash felspar (sanidine) often contains a considerable proportion of the soda felspar, and has rather the characteristics of anorthoclase or cryptoperthite than of pure sanidine.

Quartz is typically absent from the trachytes, but tridymite (which likewise consists of silica) is by no means uncommon in them. It is rarely in crystals large enough to be visible without the aid of the microscope, but in thin slides it may appear as small hexagonal plates, which overlap and form dense aggregates, they often cover the surfaces of the larger felspars or line the steam cavities of the rock, where they may be mingled with amorphous opal or fibrous chalcedony In the older trachytes secondary quartz is not rare, and probably sometimes results from the recrystallization of tridymite.

Of the ferromagnesian minerals present augite is the most common. It is usually pale green, and its small crystals are often very perfect in form Brown hornblende and biotite occur also, and are usually surrounded by black corrosion borders composed of magnetite and pyroxene. Sometimes the replacement is complete and no hornblende or biotite is left, though the outlines of the cluster of magnetite and augite may clearly indicate from which of these minerals it was derived Olivine is unusual, though found in some trachytes, like those of the Arso in Ischia. Basic varieties of plagioclase, such as labradorite, are known also as phenocrysts in some Italian trachytes. Dark brown varieties of augite and rhombic pyroxene (hypersthene or bronzite) have been observed but are not common. Apatite, zircon and magnetite are practically always present as unimportant accessory minerals.

The trachytes being very rich in potash felspar, necessarily contain considerable amounts of alkalis; in this character they approach the phonolites. Occasionally minerals of the felspathoid group, such as nepheline, sodalite and leucite, occur, and rocks of this kind are known as phonolitic trachytes. The soda-bearing amphiboles and pyroxenes so characteristic of the phonolites may also be found in some trachytes; thus aegirine or aegirine-augite forms outgrowths on diopside crystals, and riebeckite may be present in spongy growths among the felspars of the ground mass

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O
Riebeckite trachyte, Hohenberg, Berkum, Rhenish Prussia	66·06	16·46	2·25	1·10	0·19	0·79	6·81	5·52	0·62
Keratophyre, Hamulton Hill, Peebles, Scotland	64·38	16·98	4·04	.	0·28	1·98	7·57	4·30	1·64
Trachyte (Orthophyre), Garleton Hill, Haddington, Scotland	61·35	16·88	0·41	5·01	0·44	1·39	5·26	6·12	1·70
Trachyte, Monte Nuovo, Phlegraean Fields, near Naples, Italy	60·33	18·74	2·84	1·29	0·38	1·15	7·15	7·30	0·56
Trachyte, Algersdorf, Bohemia	64·60	18·39	.	3·44	0·49	1·73	4·61	6·46	0·24

(as in the trachyte of Berkum on the Rhine). Trachytic rocks are typically porphyritic, and some of the best-known examples, such as the trachyte of Drachenfels, show this character excellently, having large sanidine crystals of tabular form 1–2 in. in length scattered through their fine-grained ground mass.

Two types of ground mass are generally recognized. the trachytic, composed mainly of long, narrow, sub-parallel rods of sanidine, and the orthophyric, consisting of small, squarish or rectangular prisms of the same mineral. Sometimes granular augite or spongy riebeckite occurs in the ground mass, but as a rule this part of the rock is highly felspathic. Glassy forms of trachyte (obsidians) occur, as in Iceland, and pumiceous varieties are known (in Teneriffe and elsewhere), but as contrasted with the rhyolites, trachytes have a strong tendency to crystallize, and are rarely vitreous.

Distribution.—Trachytes are well represented among the Tertiary and Recent volcanic rocks of Europe. In Britain they occur in Skye as lava flows and as dikes or intrusions, but they are much more common on the Continent, as in the Rhine district and the Eifel, also in Auvergne, Bohemia and the Euganean Hills. In the neighbourhood of Rome, Naples and the island of Ischia trachytic lavas and tuffs are of common occurrence. In America trachytes are less frequent, but occur in S. Dakota (Black Hills). In Iceland, the Azores, Teneriffe and Ascension there are Recent trachytic lavas, and rocks of this kind occur also in New South Wales (Cambewarra range), East Africa, Madagascar, Aden, etc.

In England there are Permian trachytes in the Exeter district, and Carboniferous trachytes in many parts of the central valley of Scotland. The latter differ in no essential respect from their modern representatives in Italy and the Rhine valley, but their augite and biotite are often replaced by chlorite and other secondary products. Permian trachytes occur also in Thuringia and the Saar district.

Closely allied to the trachytes are the *Keratophyres*, which occur mainly in Palaeozoic strata in the Harz (Germany), in the Southern Uplands of Scotland, in Cornwall, *etc.* They are usually porphyritic and fluidal; and consist mainly of alkali felspar (anorthoclase principally, but also albite and orthoclase), with a small quantity of chlorite and iron oxides. Many of them are lavas, but others are probably dikes or thin intrusions. As the analyses given above will show, they differ from trachytes mainly in being richer in soda. (J. S. F.)

TRACK AND FIELD SPORTS, a term used in the United States for those sports called *athletic sports* in England. For a full description of these athletic events in England and further description of the national athletic bodies in the United States *see* ATHLETIC SPORTS and also the separate articles on each sport. The article below covers only the track and field sports in the United States. They include foot-racing upon the flat and over obstacles such as hurdles, hedges and water-jumps; jumping for distance and height either with or without the aid of pole or weights; and the propulsion through the air by the use of the arms and body of objects and weights (the weight being sometimes called a shot) for distance or height such as the discus, javelin and hammer. The first national athletic body formed in America was the Intercollegiate Association of Amateur Athletes of America. Founded in 1875 it had as its original members Amherst, Columbia, Cornell, Harvard, Princeton, Trinity, Union, Williams, Wesleyan and Yale. A month later these were joined by Dartmouth, Pennsylvania, College of the City of New York, Brown and Bowdoin. Sixty-three colleges and universities were members in 1943. The association holds two great annual championship meetings, the May outdoor meeting, instituted in 1876, and the March indoor meeting, inaugurated in 1922. In 1917, owing to World War I, no meeting was held. At the first meet, held at Saratoga in 1876, the following events were contested: 100-yd dash, quarter-, half-, one- and three-mile runs, one- and three-mile walk, 120-yd. hurdles, shot put, baseball throw, high jump and long jump Ten colleges were represented by 28 individual athletes. At the 67th annual track and field championship meeting, held at Randalls Island, New York city, in 1943, the events were the 100- and 220-yd. dashes, the 440-, 880-, one-, and two-mile runs, one-mile relay, the 100-yd and the 220-yd. hurdles, shot put, javelin throw, running high jump, pole vault, discus throw, running broad jump and hammer throw. A total of 734 athletes represented 38 colleges and universities. In the 23rd annual indoor meeting (1943), held at New York city, 275 athletes from 35 universities and colleges contested in the 60-yd. dash, 60-yd. hurdles, 600-yd , 1,000-yd., one-mile and two-mile runs, one-mile, two-mile relays, and broad jump, pole vault, high jump, shot put, and 35-lb. weight event. The heavier men, outclassed on the flat and in the jumps, were given another event on the introduction of the 35-lb. weight throw in 1922. The addition of the javelin and discus events to the programs since 1922 is ascribable to their inclusion in the schedules of the Olympic games.

Among record holders, Ben B. Eastman of Stanford university established a new world's record for the 440-yd. run, of 46.4 sec. in 1932 at the outdoor I.C.A.A A.A. meeting. This mark was equalled by Grover Klemmer, University of California, at the 1941 outdoor meeting. Frank C. Wykoff, University of Southern California established a new world's record for the 100-yd dash of 9.4 sec., at the 1930 outdoor meeting. This was equalled by Clyde H. Jeffrey of Stanford university at the 1940 outdoor meeting. University of California established a new world's record of 3 min. 9.4 sec. for the one-mile relay race at the 1941 outdoor meeting. A large proportion of the winners of points for the United States in the Olympic games have previously competed in the meetings of the I.C.A.A.A.A.

The Amateur Athletic Union (1888) assumes jurisdiction over track and field sports in the United States (*see* ATHLETIC SPORTS: *United States*). Its amateur definition, the competitor's qualification requirement (*see* AMATEUR), while rigid, is substantially the same as that of the I.C.A.A.A.A. The A A.U. holds annual national championship meets the schedules of which have been extended to include the javelin, discus and all-round events as affording opportunity for preparation for the Olympic games.

Certain college conferences and organizations also administer track and field competitions. The National Collegiate Association, which was originally organized primarily as an advisory body, has held (1943) twenty-two annual outdoor meetings. Its program is practically identical with that of the I.C.A A.A.A. as regards the nature of the events. The N.C.A.A. meeting at Chicago in 1943 was entered by 150 athletes from 32 colleges and universities. The association affords to colleges, particularly those of the middle west and south, an opportunity for track and field competition that would otherwise be lacking. Its meetings are open to all and occasionally a few of the athletes who have competed in the I.C.A.A.A.A. championships compete also in the meet of the N.C.A.A. The Intercollegiate conference ("Western conference" or "Big Ten") has conducted some 43 annual outdoor championship track and field meetings at the last of which the program was composed of the same events as the I.C.A A.A.A. outdoor and the N.C.A.A. schedules. Its record-holders have included such college athletes as Jesse Owens, Ohio State U.; William Bonthron, Princeton; Gregory Rice, Notre Dame; Alfred Blozis, Georgetown U. All of these conferences and associations have followed the I.C.A.A.A.A. in definition, purposes and schedules of events.

American Schoolboy Track and Field Sports.—Many college athletes have taken lively interest in the schoolboy sports of

their local residential communities Through this interest have grown up numerous organizations of public spirited citizens who co-operate with municipal authorities to provide playing space, equipment, training and competition in track and field sports for schoolboys and thus contribute to the national welfare The pioneer in this field is the Public School Athletic League of the City of New York, founded in 1903 In the greater city of New York, each year 500,000 boys are provided with some form of athletic competition, the majority being engaged in track and field sports More than 12,000,000 have been trained since the league's organization

The experiences of the I C.A.A.A.A with college youths and of the P S A L. of New York city with elementary and high schoolboys have provided a stimulus to the widespread development of track and field sports in the U S

Cities and villages, the nation over, are organizing schoolboys for track and field sports along the lines of the P.S.A L of New York city.

See ATHLETIC SPORTS, separate articles on the branches of track and field sports, and various team games.

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TRACTORS. The term "tractor" means any self-propelled vehicle (generally powered by an internal-combustion engine) which is capable of pulling loads on hard-surfaced terrain or on earth surfaces as typified by agricultural lands The word had been coined by 1890, when it first appeared on record in a patent issued on a "tractor or traction engine" invented by George H Harris of Chicago. But popular establishment of the name is generally set in the year 1906 and attributed to Charles W Hart and Charles H Parr of Charles City, Ia , who are credited with having built the first successful internal-combustion engine tractor and founding the gasoline tractor industry.

Power Farming.—In the middle of the 1890s the farmer of the United States, in performing his field operations, had to rely mainly on the use of a handful of lightly constructed horse-drawn machines such as a grass mower, a grain drill, grain binder, hay rake, peg-tooth harrow, and a one- or two-furrow plow. He laboured hard from early dawn to dusk to try to get his work done on time. He drove to market and to church in a wagon or buggy over dirt roads which were often axle deep in mud, and his social life was accordingly restricted

After that time, many changes took place that greatly altered his mode of life. Roads were hard-surfaced for all-weather use; autos, trucks, and best of all, tractors appeared. A revolution in agriculture took place, and the power farming era built around the gasoline tractor as the power unit was ushered in.



FIG. 1.—Ploughing with a 3-furrow plow. Tractor equipped with lug wheels for right work

This new mobile power source, which had its inception in the United States in the early 1890s, spread to all corners of the civilized world Soon tools to go with the tractor, enabling it to perform almost any farm operation, appeared Such work as seedbed preparation, planting, cultivating and harvesting could be done better, more rapidly and at lower cost than had ever been dreamed of in the use of the horse Operations could be performed on time with some degree of comfort and with less physical effort In the horse days of 1890 it took 9 man-hours to produce and harvest an acre of wheat, in 1940 about 4 man-hours were necessary when full advantage was taken of mechanical power and machinery. In 1890, too, it took 15 man-hours to produce and harvest an acre of corn, but in 1940 the mechanized farm did it in less than 5 man-hours. In the over-all picture in 1890, it took one agricultural worker to produce food for 8 people, whereas in 1940 one worker produced food for 16 people

What stimulated the coming of this economic revolution? It was largely the high cost and scarcity of labour. Increased food requirements in the face of labour shortage gave the movement impetus in World War I Still greater food requirements and still greater labour shortage emphasized the need of power farming in World War II.

World Production.—On Jan 1, 1944, there were approximately 2,000,000 tractors on farms in the United States Table I gives the tractor production in the United States by years (U.S bureau of census)

TABLE I.—*Tractor Production in the United States*

Year	Production	Year	Production
1910	4,500	1930	196,207
1912	11,400	1931	69,039
1914	10,900	1932, 33, and 34	(No census taken)
1916	29,070	1935	156,858
1918	132,697	1936	221,240
1920	203,300	1937	272,430
1922	99,602	1938	189,274
1924	116,838	1940	274,106
1925	167,553	1942	215,074
1926	178,074	1943	143,469
1928	171,469	1944	310,000

About 1930 Russia entered the tractor field and began building tractors at an accelerated pace, and by 1943 had placed some 25,000 on farms. Germany had speeded up its production and had set a goal of 300,000 to be on farms in 1940 Great Britain had a tractor population of about 55,000 in 1939 and by 1944 had 160,000. Table II shows the approximate number of tractors sold in Great Britain by years.

TABLE II.—*Tractors Sold in Great Britain*

Year	Imports	Total
1931	2,490	3,800
1932	2,853	4,100
1933	581	2,200
1934	1,567	4,000
1935	2,158	6,400
1936	1,608	7,000
1937	2,571	9,000
1938	2,262	5,000
1939	4,464	5,000
1940	4,348	5,000
1941	4,660	5,000

HISTORY OF DEVELOPMENT

The beginning of the use of self-propelled vehicles as a source of power in agricultural operations in the United States dates back to the middle of the 19th century. The steam engine had already been developed into a practical unit by Thomas Newcomen, James Watt and others. In those days the country's wide expanse of sparsely settled land suitable for the growing of a great variety of crops afforded unlimited opportunity for inventive genius to develop machinery and new sources of power Also, industries had opened up, which caused a labour shortage on the land, and there was an ever-increasing demand for grain for export, so that an urgent need developed for machinery and mechanical power. Work animals were inefficient for operating threshers and other belt machines, and sources of greater power were required. Hence manufacturers of threshers and other ma-













PHOTOGRAPHS, ACME

DISCUS THROW, SHOT PUT, POLE VAULT

1. Discus throw, showing position of arms and legs before the athlete releases the discus
2. Position at end of the discus throw
3. Athlete about to put the shot
4. Releasing the shot
5. Pole vaulter before releasing his grip on the pole as he prepares to clear the bar
6. Clearing the bar after letting go of the pole

TRACK AND FIELD SPORTS



PHOTOGRAPHS, ACME

JAVELIN THROW, RUNNING, HIGH JUMP

1. Javelin throwers in position
2. Athlete about to throw the javelin
3. Runners immediately after the starting gun has been fired for a 440-yd. race
4. Taking the first stride in a 100-metre race
5. Clearing the high hurdles
6. Excellent form in taking low hurdles
7. High jumper about to land after clearing the bar

chines undertook the production of portable steam engines.

One of the first of these, consisting of a horizontal boiler and engine mounted on a frame supported on wooden wheels, was produced in 1849, although in 1810 an attempt had been made in Great Britain to use steam power for plowing The next step was the conversion of the portable steam engine into a self-propelling traction engine, one of which was built in California in 1868 by a man named Standish and was called the Standish steam plow. It plowed 100 ac. as its first job. Other makes followed along One appearing in 1873, known as the Parvins steam plow, was probably the first American attempt at a track-laying machine The propelling unit or "endless chain of steel plates had feet shod with 2-in. plank." There was soon a large demand for self-propelling steam engines for hauling threshers from place to place, and farmers began buying them in considerable numbers. In England about 1850 the cable system of plowing had been developed and its use soon spread and extended to continental Europe, particularly France and Germany, as well as to the western United States for sugar-beet culture and to Hawaii for sugar-cane culture.

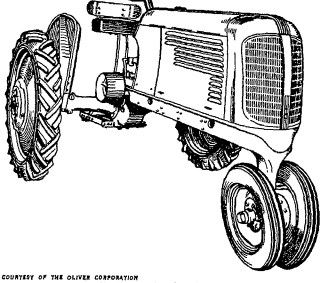
By 1910 the number of steam traction engines in the United States reached its peak, when there were about 72,000 on farms. Although these rigs were used considerably for drawbar work on level fields, their main use was as power plants to operate threshing machines. They were cumbersome, weighing as much as 35,000 to 40,000 lb., and required much attention

Internal-Combustion Engine Tractor.—A new development in the agricultural tractor, however, was under way, having started with the invention of the Otto internal-combustion engine in 1876. It was not long before many concerns entered the field to produce this type of engine and to convert it into a self-propelled machine. The first wheel-type gasoline tractor in the United States appeared in the early '90s and the first gasoline track-layer in 1904. John Froelich was responsible (1892) for one of the early wheel-type gasoline tractors appearing in the United States, although it is recorded that the Charter Gas Engine company built six gas tractors in 1889. In Great Britain one of the first oil-engined tractors was built in 1897 and was awarded a silver medal by the Royal Agricultural Society of England the same year.

By 1910, the same year steam traction engines were at their peak, there were approximately 56 companies manufacturing all sorts of internal-combustion engine tractors in the United States, and 10,000 tractors were on farms by the close of that year. Practically all of the tractor output up to about 1912 consisted of large equipment suitable for prairie plowing, some as large as 90 or 100 belt horsepower and capable of pulling 12- or 14-furrow plows. Many of these outfits weighed around 20,000 lb. and averaged about 450 lb. per belt horsepower as entered in the 1908 Winnipeg (Canada) trials (international tractor contests held annually 1908–13 inclusive to demonstrate the merits of tractors of that period). Under load they were capable of delivering only about half of the engine horsepower to the drawbar, the other half being used up in friction. Hence the rating 30/60 indicated 30 h.p at the drawbar, 60 h.p. at the belt. Their use was restricted to plowing and belt work, and probably did not average more than 200 hours per year.

Very shortly, however, the pendulum swung the other way and the gas tractor patterned after the steam traction engine design gave way to units of 20 or 30 belt horsepower and weighing only 5,000 to 10,000 lb. This resulted in an increase of tractor use from an average of 200 hours per year to one of from 300 to 400 hours

In 1913 the first frameless type of tractor was introduced. A U-shaped piece of boiler plate provided the backbone for the machine, crankcase and transmission housing. This general type of tractor, with refinements, and designed for straight-line assembly, became more or less the standard type of farm tractor during the next few years The boiler plate, however, was replaced by cast iron in later tractors, but the function was the same. This cast-iron base in general was supported in the conventional manner by four wheels—the rear two, drivers, and the front two, steering, and fitted on an axle of automobile type construction. Mounted side by side on this base were the twin two-cylinder horizontal or the four- or six-cylinder vertical engines, arranged either longitudinally or crosswise according to make. On some makes the cross-mounted engine provided for transmitting the power from the clutch and transmission, through roller chains and sprockets directly to the rear wheel axles. With the longitudinally-mounted engine, the power after leaving the clutch passed through the transmission and then through a worm and worm wheel, or bevel pinion and bevel gear, to drive the rear wheels. These engines, with speeds ranging from about 600 to



COURTESY OF THE OLIVER CORPORATION

Fig. 2.—A wheel-type tractor

1,200 r.p.m., were in most cases equipped with a gear-driven governor to maintain constant engine speed. Many were provided with either cold manifolding for use with gasoline as a fuel, or hot manifolding (intake pipe with jacket through which hot exhaust gases pass) and low compression ratio (about 4 to 1) for use with kerosene, furnace oil or distillate. Some were also furnished with both hot and cold manifolds so that either fuel could be used by throwing a damper. Still others which were designed with high-compression ratios (5 or 6 to 1) suitable for burning gasoline, made use of water injection when burning kerosene, to prevent detonation.

Tests and Standards.—By 1916 the practicability of the tractor had been well established and during that year 100 companies in the United States produced 30,000 tractors. Because of the large number of makes and types of tractors and the fact that many were impracticable and were frequently unloaded on the unsuspecting farmer, the state of Nebraska in 1919 passed a "bill to provide official tests for gas, gasoline, kerosene, distillate or other liquid fuel traction engines in the state of Nebraska and to compel the maintenance of adequate service stations for same." The first official test was completed on April 4, 1920. The Nebraska tests became significant not only in Nebraska and the nation as a whole, but in many foreign countries as well. Up to about Jan. 1, 1942, when the tests were suspended, 378 complete tests had been run on different models and types of various makes of tractors. Soon after the Nebraska tests were set up, similar testing was inaugurated in Great Britain, Germany and Sweden In 1919 and 1920 two tractor trials were held at Lincoln, England, the first under the auspices of the Society of Motor Manufacturers and Traders and the second under the Royal Agricultural society.

Tractors in Europe.—While this development was going on in the United States, tractors were shipped to Europe and much enthusiasm developed there This was greatly accentuated in

1914 when World War I started and additional thousands were shipped across the Atlantic In Great Britain the two-tractor steam cable system was modified to make use of the internal-combustion engine, and track and wheel types were developed both in Great Britain and in continental Europe.

The French government in 1920 paid a bonus of 25% on the purchase price of tractors of domestic manufacture and 10% on tractors of foreign manufacturers French engineers paid particular attention to tractors in a narrow design for use in vineyards

Tractor development and application in Europe received a severe setback about the time of the world-wide business depression of 1921, chiefly owing to the high cost of the fuel. To reduce fuel cost a number of compression-ignition type engines (diesel and hot-bulb) were brought out, including a few British makes, a Swedish make, two German and one Dutch, these tractors using heavy liquid fuels

In France, efforts to reduce the fuel cost of tractors were directed along other lines, the machines being fitted with gas generators operating on charcoal or prepared solid fuels. Most of the tractors exhibited at the Paris Agricultural Show in 1928 had such generators and for the next 10 or 12 years manufacturers exhibited a number of models of such equipment. These units consisted essentially of a sheet steel cylinder or generator for producing the gas, and other sheet metal units such as a cooler for cooling the gas, a scrubber for removing tar, grit, etc , and a receiver to hold the gas as generated. The German government in 1927 initiated a scheme for extending credit to farmers for the purchase of (German-built) tractors. The soviet government during the period 1925–27 bought thousands of tractors from leading U.S. firms.

All-Purpose Tractor.—By about 1918 the so-called all-purpose tractor began appearing in the United States in numbers. These tractors not only could plow, but with suitable attachments could plant row crops, harvest them, spray or dust them for pest control, and, in the case of corn, harvest it. They differed, however, from the conventional tractor in that they had either a single front wheel, or two front wheels close together, to permit travelling between rows; the two rear or drive wheels were adjustable as to tread, ranging, according to make and size, from about 44 in. to around 90 in., to accommodate different row spacings of crops The clearance between the ground and the axle ranged from 20 to 24 in. With the use of the power take-off already developed and appearing on tractors in 1922, the small (6-ft or smaller) combine appearing in 1935 could be operated without the use of the auxiliary engine commonly used on the larger combines. With the use of the mechanical power lift developed about the same time for raising pulled or mounted machines off the ground, four methods of applying tractor power were available—belt pulley, drawbar, power take-off and power lift.

Rubber Tires.—With the advent in the United States about 1932 of rubber tires for tractors, and their adaptation to field machines, higher speeds were possible and, accordingly, smaller field units. (It is recorded that first use of rubber on tractor wheels in the United States was made in 1871 when it was fastened to plates attached to the rear wheels of a steam tractor for hauling on the road.) A 5- or 6-ft combine and tractor, both equipped with rubber tires, could be operated at speeds of 4 or 5 m p h., and under favourable field conditions could do the same amount of work as an 8- or 10-ft combine on steel wheels working at about 3 m p h. Also, the cushioning effect of the rubber tires provided more comfort for the operator Repair bills were less because of the lessened vibration and wear, and fuel economy was improved due to reduced rolling resistance

TABLE III.—*Comparative Rolling Resistance of Tractors when Equipped with Steel Wheels and Lugs and with Low-Pressure Pneumatic Tires*

Wheel	Tractive surface	Speed Miles per hour	Horsepower to move tractor
Steel	Sod	2	5 1
Rubber-tired	,,	2	1 6
Steel	,,	3	7 7
Rubber-tired	,,	3	2 4
Steel	,,	4	10.2
Rubber-tired	,,	4	3 2
Steel	Plowed ground	2	6.5
Rubber-tired	,, ,,	2	2 5
Steel	,, ,,	3	9 8
Rubber-tired	,, ,,	3	3 3
Steel	,, ,,	3½	12.4
Rubber-tired	,, ,,	3½	6 2

Source Ohio Agricultural Experiment Station *Bulletin* 526

TABLE IV.—*Performance Data of a Typical Tractor Equipped with Steel and Rubber-Tired Wheels*

Wheels	Drawbar h p	Drawbar pull	Miles per hour	% Slip	Gear
Rubber	17 15	3,136	2 05	18.01	Low
Steel	19 77	3,041	2 52	8 00	Low
Rubber	22 48	2,732	3 10	13 91	Intermediate
Steel	21 16	2,071	3 83	4 25	Intermediate
Rubber	24 16	2,017	4 49	8 12	High
Steel	20 13	1,480	5 16	4 03	High
Rubber	20 10*†	1,640	4 60	2 87	High
Steel	17 67*†	1,727	3 84	0 28	Intermediate

Source The Nebraska Tractor Tests, 1920–1940, *Bulletin* 330

*Operated at rated load (85% of maximum), others at maximum load.
†9 58 horsepower hours per gal (U S)
18 13 horsepower hours per gal. (U S)
Weight of rubber-tired tractor as tested 4,534 lb , and with steel tires 3,165 lb

Use of pneumatic tires for tractors in the United States rapidly increased each year to about 1940 when approximately 90% of the wheel tractors left the factories on rubber tires. To improve traction under severe conditions, cast-iron weights are usually provided for mounting at the hub of the rear wheels Also, the tires may be filled with water to furnish additional weight. Chains similar to automobile skid chains are sometimes used to prevent undue shippage on wet soils. Occasionally special nonskid lugs are available. One of several types made in Great Britain—the retractable strake—consists of a series of lugs or strakes mounted on the side of each rear wheel in such a way that they may be made manually to project or retract as field conditions warrant

It was in the early 1930s that the old system of rating the belt and drawbar horsepower of wheel tractors was changed to the number of 14-in plow bottoms the tractor would pull under average conditions

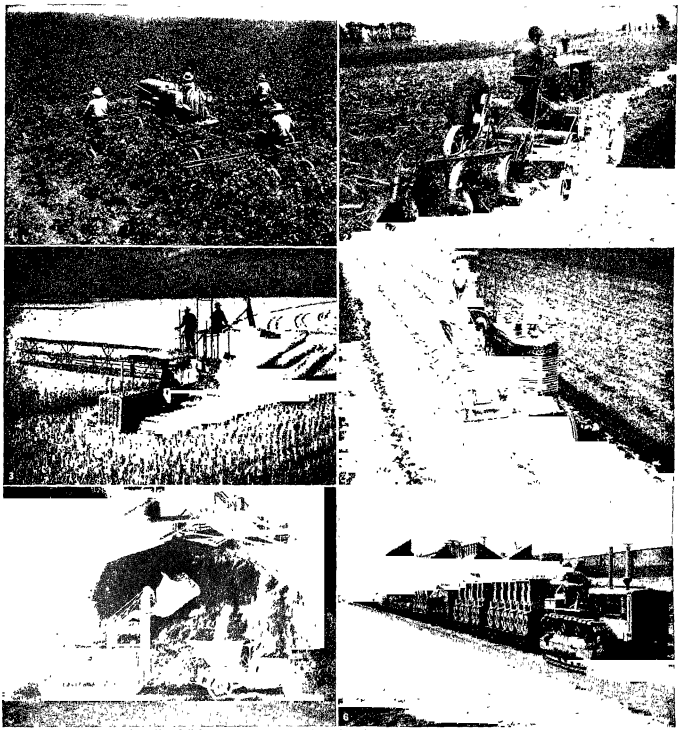
Fuels.—Up to 1930, internal-combustion tractor engine design was greatly influenced by the type of fuel used and efforts toward engine improvements were directed along two independent lines: (1) designing for the use of the more highly refined fuels in the Otto cycle engine already mentioned, and (2) designing for the use of the lower grades of crude oils in the diesel engine. The diesel engine, which had been investigated in the United States for a number of years, proved its worth, and one "crawler" tractor manufacturer in 1931 began producing a tractor powered by its own diesel engine. The diesel cycle differs from the Otto cycle in that it depends upon high compression (350 to 550 lb) for generating sufficient heat (1,000° F with 500 lb. pressure) to ignite the charge, in contrast to the low compression (about 90 lb for gasoline) used in the Otto cycle.

Because of the high compression, hand cranking a diesel engine is impossible. So other methods for starting must be used, such as an auxiliary two-cylinder gasoline engine using a bendix pinion (similar to electric auto starter) for meshing with the teeth of the flywheel to turn the engine over; or a heavy-duty electric starting motor operated by a storage battery similar to that used in starting automobile engines; or a built-in gasoline engine. In this last method the compression is released automatically, spark is supplied, and the outfit runs as a gas engine until it has turned a predetermined number of operations, as set by the operator, when it automatically shifts to diesel operation

While the initial cost of diesel-powered tractors proved to be considerably more than tractors powered with engines using lighter fuel, its higher economy seemed to justify its adoption, particularly if the tractor could be used more than 1,000 to 1,200 hours annually. Low-grade fuel has a price advantage over other fuels and the fire hazards in handling it are much less

The diesel type of power unit by 1944 had been furnished on three or four of the well-known makes of crawler (track-laying) tractors in the United States and several in Great Britain and continental Europe. One application of diesel power worthy of note was that of the giant English gyrotiller. This consisted of a

TRACTORS

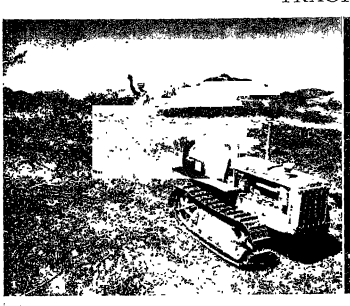


BY COURTESY OF (1, 3, 5, 6) CATERPILLAR TRACTOR CO.; (2, 4) INTERNATIONAL HARVESTER COMPANY

TRACTORS IN AGRICULTURE AND INDUSTRY

1. Diesel tractor pulling three cultivators which cultivate nine rows of cotton in one strip
2. All-purpose tractor drawing three-furrow plough
3. A tractor-pulled combine which covers 3½-4ac per hour
4. Small tractor which permits unobstructed forward view
5. Shovel mounted on tractor loading nitrate into dump truck
6. Tractor hauling castings on industrial railway

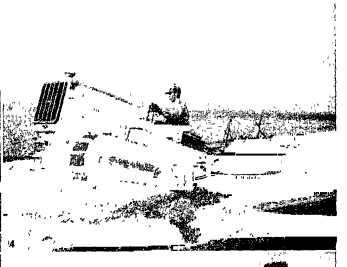
TRACTORS



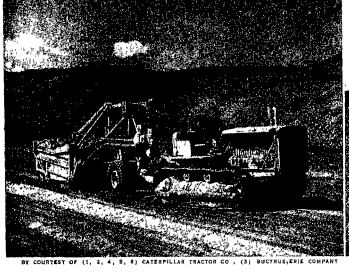




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4





BY COURTESY OF (1, 2, 4, 5, 6) CATERPILLAR TRACTOR CO., (3) BUCYRUS-ERIE COMPANY

VARIOUS USES OF TRACTORS IN THE UNITED STATES

1. Uprooting trees and scrub oak preparatory to tilling a creek and building a flood-control dam
2. Tractor hauling wagons in tandem at site of an excavating project
3. A bulldozer, tractor equipped with heavy blade to excavate and transport soil by pushing it
4. Levelling ground for irrigation, with rotary scraper pulled by tractor
5. Tractor and "carry-all" moving earth in highway construction
6. Tractor-pulled equipment for laying telephone cable 30in underground

60 h.p. tractor equipped with conventional steering wheels in front and short tracks behind for traction Supported in a frame hinged at the back were two tillage assemblies with long curved blades vertically mounted which revolved toward each other and assisted in propelling the whole machine forward. These knives stirred up the soil at a maximum depth of about 18 in.

Small Units and Improvements.—About 1938 the so-called streamlined or one-plow tractor appeared, with supplementary equipment, and opportunity was afforded for the small or family-sized farm to compete on an equal basis with larger farms. This tractor is also useful in large-scale farming as it can perform tasks uneconomical for larger tractors These small tractors consist of the ordinary unit frame construction However, some are designed with wheels having approximately the same tread in front as in the rear, both being adjustable to fit various row-crop spacings; others are of the tricycle type with only the rear wheels adjustable for tread Some of the models have the engine mounted at one side of the centre, while others use a narrow engine mounting narrowing in width toward the front to permit unobstructed vision of the ground in front helpful in cultivating. These tractors, available also in two-plow and sometimes three-plow sizes, have been largely developed for mounting on rubber tires. They have three or four speeds forward, the high gear frequently permitting a speed of 20 m p h , which is usually used for hauling on the road or in travelling from field to field. A high speed of 10 m.p.h , however, is more common

Another type of tractor which has been increasing in importance is the garden tractor which has been manufactured at the rate of about 9,000 annually in the United States and to a considerable extent in Great Britain. This type of unit fits into the program of the truck gardener, factory worker, or the man who has only a few acres under cultivation and where the use of a horse would not be practical. These are walking units of from 1 to 5 or 6 h.p., and, according to make, are fitted to pull a 6- or 7-in. plow; or they are riding units capable of developing up to 10 h p. and pulling a 10- or 12-in. plow. Additional equipment such as cultivating attachments, seeders, reciprocating mowers and small sprayers are available for use with these tractors.

One tractor of American make appearing on the market about 1940 has a unique combination hitch and hydraulic device whereby a plow, for instance, can be altered in plowing depth or raised out of the ground for transport simply by manipulating a small lever (finger-tip control) This mechanism was developed by Harry Ferguson and consists essentially of an enclosed power-driven oil pump; ram cylinder into which oil is pumped to raise the implement and from which the oil is drained to lower the implement; control valves manipulated by the control lever; piston, connecting rod, hydraulic lift shaft and suitable linkages to transmit the motion from the piston to the attached tool This unit acts also as its own safety device to prevent damage to the plow when striking a stone, stump or other obstruction In such a case the sudden impact produced causes the upper or compression link to thrust against and compress the master control spring, thereby actuating the hydraulic system and causing some of the weight to be removed from the rear wheels The wheels then spin and the pull against the obstruction practically ceases.

Several field machines have been developed to attach to this tractor and make use of its hydraulic system. One of these is a two-wheel trailer for which the hitch is so arranged that a proportion of the weight is transferred just in front of the rear axle, thereby adding more weight to the rear tractor wheels and increasing the tractive capacity. About 1940 other makes of tractor appeared with hydraulic, vacuum or compressed air devices for lifting or regulating attached implements, all with a view to easing the task of the operator.

To facilitate their maintenance and operation many tractors are provided with removable cylinder sleeves which may be replaced in case of excessive wear or damage without having to remove the cylinder block; with variable governor throttle control which automatically maintains the engine speed desired; automobile-type electric starter and lights; adjustable radiator shutter for use in cold weather; air cleaner, usually of the oil bath type and oil filter with replaceable elements.

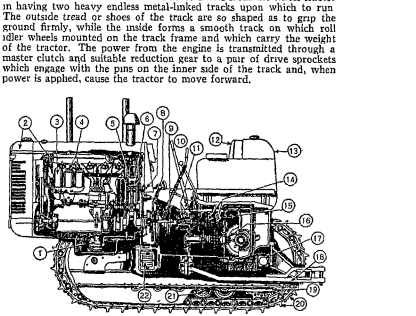
Where full use is made of these improvements 750 to 1,000 hours' annual use of a tractor is not unusual. Also, they make for longer life, higher efficiencies and better fuel economies. It is not uncommon for a tractor to deliver more than 75% to 80% of its horsepower at the drawbar, or perform belt work with a fuel consumption around one-half pound per horsepower hour at rated load.

In order that farmers may hook up machines and tractors not originally designed to work together, certain dimensions of the hitches and power take-off assemblies have been standardized This permits, for instance, a power take-off driven combine, binder or potato digger of one make to be attached to a tractor of another make—an arrangement which has heretofore not been possible except by makeshift hook-up, often dangerous

After 1941 the standard dimensions set up by the A S A E (American Society of Agricultural Engineers) were embodied in tractors and driven machines. For equipment of prior design, in so far as is feasible, ways have been worked out for conversion to these standards which, on the tractor, include the height of the drawbar (part projecting to rear, to which machines or implements are hitched) from the ground, which should be 12 to 15 in The power take-off shaft should be from 6 to 15 in. above the drawbar, and within 2 in to the right or left of the centre of the rear of the tractor. Looking down from above, the horizontal distance between the projecting end of the power take-off shaft and the point of the drawbar to which the machines are hitched should be 14 in

CRAWLER TRACTORS

The foregoing has dealt mainly with wheel-type tractors. Track-laying or crawler tractors have gone through a similar period of development and, as stated earlier, made a start with steam as the power source. The conventional crawler tractor differs from the wheel tractor in having two heavy endless metal-linked tracks upon which to run The outside tread or shoes of the track are so shaped as to grip the ground firmly, while the inside forms a smooth track on which roll idler wheels mounted on the track frame and which carry the weight of the tractor. The power from the engine is transmitted through a main clutch and suitable reduction gear to a pair of drive sprockets which engage with the pins on the inner side of the track and, when power is applied, cause the tractor to move forward.



COURTESY OF THE INTERNATIONAL HARVESTER CO.

Fig. 3.—Cross section of Diesel tractor. (1) Triple-gear oil pump. (2) Thermostat-controlled centrifugal pump cooling system. (3) Fuel filtering system. (4) Absorption-type oil filters. (5) Six-cylinder, valve-in-head, Diesel engine. (6) Removable cylinder sleeves. (7) 12-volt electric starter. (8) Single-plate, 17-in., over-centre-type engine clutch. (9) Clutch brake for fast gear shifting. (10) Controls. (11) Ball and roller bearings. (12) Upholstered, spring-cushioned seat (13) Sixty-gallon fuel tank. (14) Transmission with six forward and two reverse speeds. (15) Bearing caps. (16) Bevel pinion and gear in separate sealed compartment from steering clutches. (17) Pivot axle shaft. (18) Drawbar, equipped with wearing plates (19) Welded steel track frame. (20) Track shoes. (21) Lower rollers. (22) Saddle-mounted equalizer spring

Two different types of steering mechanisms are used. One makes use of two steering clutches, one for each track; if the steering clutch is released on one side, the track on that side slows up and the turn is made in that direction If a sharper turn is desired the clutch is not only released but a brake for that clutch is actuated and track movement on that side is practically stopped This type does not need a differential. The other type makes use of a differential with a brake band and drum on each side When the brake on one side is held, that side slows down and the machine turns in that direction The steering brakes, and consequently the steering are controlled by an automobile-type steering wheel.

Up to 1904, when the first gasoline track-type tractor in the United States was built, all tractors of this type were operated by steam; then

by 1910, tracklayers powered by internal-combustion engines began to appear on the market. Between 1910 and 1920 some seven companies were in this field. While crawlers were developed primarily for agricultural work such as pulling large combines and supplying power for farm operations in the northwest (United States), they proved useful for such purposes as road building, logging and oil field work. Later their use was extended to soil conservation activites, mainly as the source of power with which to build terraces to stop soil washing.

OPERATING COSTS

Unit factors involved in the cost of operating tractors are (1) original cost of tractor, which influences charges for depreciation, interest and taxes, (2) necessary operating outlays for fuel, oil, grease, servicing, repairs and tractor driver, (3) charge for use of shelter, (4) amount of annual use of tractor The following tabulation indicates cost factors for several up-to-date tractors

TABLE V —*Unit Factors of Cost of Operating Tractors*

Item	Tractor					
	A	B	C	D	E	F
First cost	$680	$750	$1,050	$1,000	$1,400	$2,850
Estimated life hours of work	10,000	10,000	10,000	10,000	10,000	12,000
Depreciation (per hour of use) (in cents)	7 3	7 5	10 5	10 0	14 0	15 4
Taxes per year (5% of average investment)	$2 90	$3 75	$5 25	$5 00	$7 00	$9 25
Interest per year (at 5% of average investment)	1 4 50	18 75	26 25	25 00	35 00	46 25
Fuel (requirements per hour) gallons	1 2	1 3	2 2	2 0	2 2	2 1
Cost of fuel (per hour of use, gasoline at 14 cents, diesel oil at 5 cents) (in cents)	17	18	31	28	31	11
Cylinder oil per hour of use (including renewing each 60 hours of use) quart	0 15	0 15	0 16	0 20	0 24	0 25
Cost of cylinder oil (per hour of use at 16 cents per quart) (in cents)	2 4	2 4	2 6	3 2	3 8	4 0
Cost of other oils and greases (per hour of use) (in cents)	1/	1/	1/	1	1	1
Repairs and parts (per hour of use) (in cents)	17 8	3 6	4 0	5 0	6 0	4 0
Servicing (per hour of use at tractor driver's wages) (in cents)	2 25	2 25	2 75	2 25	2 75	2 75
Driving (per hour of use) (in cents)	35	35	40	35	40	40
Shelter (per year)†	$1 50	$2 50	$2 75	$2 50	$2 75	$3 75

(A) 2-plow, 6-12*, wheel tractor, rubber-tired. (B) 2-plow, 10-25, wheel tractor, steel-tired (C) 3-plow, 20-30, wheel tractor, steel-tired (D) 15-25, 2-plow tractor (gasoline), caterpillar tread (E) 20-30, 3-plow tractor (gasoline), caterpillar tread (F) 25-35, 3-plow tractor (diesel), caterpillar tread

*Drawbar and full rating horsepower

†Including tires (5 8 cents an hour) †Shelter charge is based on use of implement shed, costing 30 cents per square foot so that the annual charge per square foot is

Depreciation at 4% of first cost	$0 0120
Upkeep at 1% of first cost	0 0030
Taxes at 3% of average investment	0 0030
Insurance at 1 1/2% of average investment	0 0023
	$0 0203

TABLE VI —*Summarized Cost of Operating Tractors*
(Based on 800 hours' annual use data as set forth in Table V)

Item	Tractor					
	A	B	C	D	E	F
Fuel	$136 00	$144 00	$218 00	$224 00	$218 00	$ 88 00
Cylinder oil	10 20	19 20	20 80	28 80	30 40	32 00
Other oils and greases	4 00	4 00	4 00	8 00	8 00	8 00
Repairs (including tires for "A")	62 40	28 80	32 00	40 00	48 00	32 00
Servicing	17 00	17 00	22 00	17 00	22 00	22 00
Interest	14 50	18 75	26 25	25 00	35 00	46 25
Taxes	2 90	3 75	5 25	5 00	7 00	9 25
Depreciation	58 40	60 00	84 00	80 00	112 00	123 20
Shelter	1 50	1 50	1 75	1 50	1 75	1 75
Total cost	$311 90	$207 00	$414 05	$426 10	$512 15	$369 45
Cost per hour						
Not including driver	$ 0 39	$ 0 27	$ 0 56	$ 0 53	$ 0 64	$ 0 46
Including driver	0 74	0 72	0 96	0 88	1 04	0 86

Source of Tables V and VI R L Adams, *Farm Management Crop Manual*, University of California Experiment Station Syllabus Series No 278 (1941)

TABLE VII —*Gasoline Consumption of Tractors Pulling Different Machines*

Operation	*Gallons (U S) gasoline per acre
Plowing	2 5 to 4 0
Row-crop cultivating	75 to 1 25
Discing	1 0 to 2 0
Harrowing	75 to 1 25
Grain binder	75 to 1 25
Combining	2 5 to 3 5
Grain drill	1 5 to 2 0
Corn planter	1 25 to 2 0
Potato planter	2 0 to 3 0
Hay loader	1 5 to 2 0

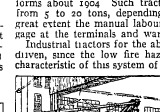
*1 U S gallon = 8 imperial gallon

Because of the critical liquid fuel situation brought on by World War II, Table VII was compiled to guide persons who had to arrive at some approximate figures on gasoline consumption for ration purposes. Figures are average from the work of various testers with different kinds of tractors on different kinds of soils (New Jersey Agricultural Experiment Station) (R. B. G)

INDUSTRIAL TRACTORS

These are machines designed for hauling trailer trucks over comparatively smooth surfaces such as railroad terminal and warehouse floors, steamship piers, etc They were developed from industrial trucks which began to replace hand trucks on steamship docks and railroad platforms about 1904 Such tractors would haul a trailer load ranging from 5 to 20 tons, depending upon the size, and so reduced to a great extent the manual labour required in handling freight and baggage at the terminals and warehouses

Industrial tractors for the above purposes generally were electrically driven, since the low fire hazard and the absence of exhaust gases characteristic of this system of drive recommended it for indoor work.



A POWER WINCH MOUNTED ON A TRACTOR

The wheel tread usually was around 30 in , and the wheelbase ranged from 40 to 48 in., while the wheels in most cases were 20 in in diameter and equipped with solid rubber tires Although the earliest industrial tractors were steered by the front wheels, and were driven by the rear wheels, later designs frequently were provided with a four-wheel drive and a four-wheel system of steering; the former to give a sufficient traction even on slippery oily or icy surfaces, and the latter to manoeuvre the trains more advantageously in restricted spaces

Four-wheel-drive tractors were usually equipped with four-wheel brakes, while made it possible to stop them quickly in an emergency. Speeds ranged from 6 to 8 m p h when light, and around 4 m p h. when loaded. On fairly smooth surfaces the trailer trucks required a drawbar pull of approximately 50 lb per ton. With the usual constructed the normal continuous drawbar pull obtainable was about 10% of the total weight of the tractor with battery. The weight of the battery amounted to 30% to 35% of the total tractor weight.

Generally the operator steered by means of a lever or tiller which folded out of the way when he left his seat Three speeds in both directions were obtained by means of a controller For safety purposes, the main switch, controller and brake were interlocked Before the tractor could be started a pedal had to be depressed When the operator withdrew his foot from the pedal the main switch opened and the brake was applied automatically This tended to prevent accidents, as the tractor would come to a stop if the driver were thrown from his seat The battery voltage used to drive the tractors was either 32 or 48 volts.

ROAD TRACTORS

The road tractor (or tractor truck, as it is often called in the United States) was developed from the truck It differs from the latter only in having a shorter wheelbase and in that, instead of being provided with a platform or other body for carrying loads, it is fitted with a bolster on the frame over its rear axle which carries the forward end of a semi-trailer through a fifth wheel Whereas in the conventional truck nearly all of the useful load is carried on the rear wheels, in a tractor trailer combination it can be equally divided between the rear wheels of the tractor and the two wheels of the trailer, so that a much greater load can be carried. Moreover, by far the most expensive part of the combination is the tractor, and this need not be kept idle during periods of loading and unloading, but can be kept busy all the time, providing a sufficient number of trailers is available. When the semi-trailer is being loaded or unloaded its forward end rests on jacks or folding supports with caster wheels Coupling of the semitrailer to the tractor is effected automatically by simply backing the tractor up to the trailer, and uncoupling is an equally simple operation Road tractors for hauling semitrailers have been built with electric steam and gasoline power plants (P M H.)

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TRACY, ANTOINE LOUIS CLAUDE DESTUTT,

COMTE DE (1754–1836), French philosopher, son of a distinguished soldier, was born in Bourbonnais on July 20, 1754 He

belonged to a noble family of Scotch descent, settled in France in the 15th century He studied at Strasbourg, entered the army, and when the Revolution broke took an active part in the provincial assembly of Bourbonnais He was elected a deputy of the nobility to the states-general, where he sat with his friend La Fayette. In the spring of 1792 he received the rank of *maréchal de camp* in command of the cavalry in the army of the north; but when the Left became predominant took indefinite leave. He settled at Auteuil, where, with Condorcet and Cabanis, he devoted himself to scientific studies Under the Terror he was imprisoned for nearly a year, during which he studied Condillac and Locke, and abandoned the natural sciences for philosophy As an associate of the Institute he wrote the papers which formed the first draft of his comprehensive work on ideology. The society of "ideologists" at Auteuil embraced, besides Cabanis and Tracy, Volney and Garat (1749–1833), professor in the National Institute. Destutt de Tracy died in Paris on March 9, 1836.

Destutt de Tracy was the last eminent representative of the sensualist school which Condillac (*q v.*) founded in France upon a one-sided interpretation of Locke. He pushed the sensualist principles of Condillac to their last consequences, being in full agreement with the materialistic views of Cabanis, though the attention of the latter was devoted more to the physiological, that of Tracy to the psychological or "ideological" side of man His ideology, he frankly stated, formed "a part of zoology," or, as we should say, of biology. The four faculties into which he divides the conscious life—perception, memory, judgment, will —are all varieties of sensation As a psychologist de Tracy deserves credit for his distinction between active and passive touch, which developed into the theory of the muscular sense. His account of the notion of external existence, as derived, not from pure sensation, but from the experience of action on the one hand and resistance on the other, may be compared with the account of Bain and later psychologists. His chief works are *Eléments d'idéologie* (1801–15; 2nd ed, 1824–25); *Commentaire sur l'Esprit des lois de Montesquieu* (1806; 5th ed , 1828, Eng trans., President Jefferson 1811); *Essai sur le génie et les ouvrages de Montesquieu* (1808).

See F Picavet, *Les Idéologues* chs. v. and vi (1891); V. Stepanowa, *Destutt de Tracy, eine historische psychologische studie* (Zürich, 1908).

TRADE. *See* COMMERCE; TRADE· WORLD STATISTICS; BALANCE OF PAYMENTS, FREE TRADE, PROTECTION; TARIFFS; TRADE ORGANIZATION, and also the sections dealing with trade and commerce under the various countries For the English Board of Trade, *see* GOVERNMENT DEPARTMENTS; for international trade congresses, *see* INTERNATIONAL TRADE ASSOCIATIONS AND CONGRESSES; for trade disputes, *see* STRIKES AND LOCKOUTS.

TRADE, PRIMITIVE. The importance of trade to primitive races is seldom realized. Exchange of goods among them is certainly limited in extent; often only specified classes of objects are allowed to change hands, and many commodities are exempt from such traffic, as the land of the clan or tribe. Nevertheless trade, *i.e.*, a regular series of acts of exchange, is a distinct feature in the life of primitive peoples, even the lowest, who live by hunting and collecting forest products The principle of reciprocal transfer of goods, of giving and taking, seems in fact to be deep-rooted in human nature.

Trade has two aspects, intra-communal, between members of the same community, and extra-communal, between members of different communities The latter is of more interest, especially since, by the widely accepted theory of Karl Bücher, those few primitive folk who have advanced beyond the pre-economic stage of existence are still in a state of closed household economy. Each little group is imagined as self-sufficient, its needs and products in equilibrium, and trade between them, being unnecessary, is therefore held to be absent More adequate study, however, shows that this idea is quite erroneous.

Types of Trade.—1. Most spectacular is the institution variously described as the *silent trade*, "dumb barter" (*Stummer Handel*) or depot trade (*Le Commerce par dépôts*). Mentioned by Herodotus, this method of exchange was practised by the Carthaginians in their traffic for gold with the African tribes beyond the Pillars of Hercules, and was noted by Fa Hien, Ibn Batuta and other early travellers In the most general form of procedure one party goes to the customary spot, lays down goods and retires into the bush or to a distance, giving as a signal a call or a gong-stroke. The other people then come, lay down what they consider to be articles of equivalent value, and retreat in their turn. The first party then comes back and if satisfied with the bargain removes the newly-deposited goods; if not, these are allowed to remain until suitable additions are made. The people of the second party then take away the original wares and the transaction is concluded. Neither party holds any communication with the other, beyond giving the customary signal, hence the name of "silent trade." This widespread institution is reported from such diverse regions as north Russia, Lapland, west Africa, Timor, Sumatra, India, Ceylon and north New Guinea. It is found especially where people of a fairly primitive type conduct habitual exchange with those of a somewhat higher culture. Thus the Akka pygmies obtain bananas in exchange for meat from neighbouring agricultural tribes, and the Veddah obtain iron implements from Singhalese smiths in return for game Elements of shyness and fear are obviously involved in this custom, which thus secures economic benefits for people who shun foreign contracts

2. In the *gift-exchange* the transaction takes the form of present and counter-present often between host and guest A good example is afforded by the Maori of New Zealand Exchange was conducted quite in the manner of gift-making; no bargaining upset the proceedings; such was not *tika* ("correct"). At the same time a very strict system of reciprocity was in force, by which the recipient of the gift was bound, as he valued his name and reputation, to make adequate repayment. This was expected by the donor Such was the idea of *utu*, equivalence, which ran through all Maori social life But the recipient usually tried, if possible, to give back greater value than he received, not through generosity, but since his own prestige would thereby be enhanced. Even where the exchange was primarily a matter of securing necessaries of life, as food or garments, the desire to obtain fame by being liberal strove with the wish to have the economic advantage. As Malinowski, Thurnwald, Radcliffe-Brown and Raymond Firth have shown, these are the twin psychological factors lying at the root of every exchange of gifts.

3. *Barter* consists in the direct transfer of goods against goods Unlike the gift exchange, it implies agreement as to rates, with the possibility of haggling over quantities and values A system of barter in certain commodities may co-exist with gift-exchange in others of greater social import, as in the Trobriands, where, as described by Dr Bronislaw Malinowski, the *Kula*, or exchange of valuable arm shells and necklaces is conducted along polite, strictly ceremonial lines, while the *gimwali*, the barter of fish for vegetables, is carried on with haggling as to size and quantity, and even acrimonious wrangling. Barter in abstract form is often supposed to be typical of primitive peoples. But very rarely in any native community is the rate of exchange for goods determined by purely economic considerations of supply and demand working on the principle of rational utility alone.

4 *Buying and Selling* avoids the awkwardness of barter by the use of some medium of exchange. Much of what is often described as "primitive money" is wrongly so termed, but in various parts of Africa, for instance, cloth, iron, cowrie shells and salt do act as true currency, as also, apparently, do coconuts in the Nicobar islands (*See* CURRENCY, PRIMITIVE.)

Occasions of trade on a large scale among primitive peoples are provided by expeditions and markets.

Trading Expeditions.—In some areas itinerant traders, as the Hausa hawkers in parts of Africa, play an important rôle in economic life. In others their place is taken by caravans, as those of the Arabs, regularly equipped and following recognized trade routes. Of great interest, again, as being accomplished by more primitive folk, are such group expeditions as those of the Dieri and other Central Australian tribes, who will travel on foot for 400–500 miles to procure red ochre and the *pituri* plant. Noteworthy also are the trading voyages, in unwieldly dug-out canoes,

of the people around the New Guinea coast, as the sailing trips of the Siassi of the North, the *hiri* of the Motu, in which pots are taken to the Papuan gulf and exchanged for sago, and the *Kula* of the Trobriands, the ceremonial exchange of valuable ornaments.

Primitive Markets are of varied kind and wide distribution. Their great home is Africa, but they have also been described from Guiana, old Mexico and Peru, Hawaii and various Melanesian areas. A typical example at either end of the scale will serve for illustration. The inhabitants of certain small islets off the coast of Malaita, Solomon islands, barter fish with those of the mainland for vegetables and pigs. Almost every day at times arranged beforehand with the bush natives, the islanders resort in their canoes to recognized places on the beach. The men then stand guard with spears, while the actual bartering is done by the women, who, thus covered, advance slowly towards one another, produce in hand. Disputes at these markets are rare, though at other times the island natives cannot venture ashore without risk. In parts of Africa this institution is more imposing. Among the Akikuyu of the East, markets in a thickly populated district are no more than ¾ m apart, and are of great importance in the life of the people. They occur very frequently in the week, but are so arranged as not to clash with others in the neighbourhood, so that a person may visit them all in turn. About 9 o'clock in the morning the paths begin to fill with natives carrying loads of corn, firewood, beer or iron to exchange, and between 11 and 1 business is at its height, the concourse numbering perhaps 4,000–5,000 people. Order is maintained by special officers and no weapons are allowed within the precincts. The main characteristics of a market as a mode of conducting trade are its set time and regular recurrence, the definite place of assembly and the regulations by which order is preserved.

Psychology of the Trading Process.—The motives behind primitive trade are many-sided. The central factor is undoubtedly the desire for rational gain, for securing objects of economic utility otherwise unprocurable owing to variations in natural conditions or specialized skill. But the psychological background is more complex than this. Trade is often carried on in articles charged with great social and ceremonial meaning, as in ornaments, but of no direct practical interest. Moreover, the desire for renown and prestige is often a prominent element in the exchange, while the transaction itself may assist in cementing social bonds.

The value of goods, too, is determined by a complex set of factors. Even in the case of things apparently desired merely for their practical utility there is not such an objective standard of valuation as obtains in modern society, *i.e.*, personal factors enter much into the exchange. The extent to which emotional elements lie at the root of value is shown in the case of such objects as *tiki* and other greenstone ornaments of the Maori, heirlooms of great wealth and the principal articles of ceremonial exchange. Their worth lies in their historical association with dead chiefs and ancestors of renown, in their sacredness and importance as symbols of the tribal greatness rather than in their practical use for adornment.

Theory of Primitive Trade.—The principal types of trade in primitive culture were once regarded as successive products in evolutionary development. Modern research, however, tries to study each particular system of trade in its own cultural setting. The primitive market in its various forms, for instance, cannot be understood if conceived simply as an evolutionary sequence from the customs of silent trade (Grierson) or as a development from previous hostile relations (Müller-Lyer) or as the result of a recurring assemblage of people for religious or ceremonial purposes (Ling Roth). It is explicable only as an institution *sui generis* which emerges in response to certain needs, and is conditioned by the natural situation and the social structure of the community which it serves. So also with primitive trade in general. It is more than a mere matter of economic trafficking on abstract principles of national advantage; it is a complex social mechanism linked to many aspects of native life. The true problem does not lie in theorizing about its historical or evolutionary origins but in disentangling the various social and psychological factors which together determine the form of the living institution.

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(R. F.)

TRADE: WORLD STATISTICS. The 16th, 17th and 18th Centuries.—The sea is the great highway of international commerce and it was the discovery of the Cape of Good Hope route to the East Indies and the discovery of America at the end of the 15th century which opened the world to commerce. Before that time the spices, sugar, silk and other luxuries of the East came into European hands only when they had filtered overland to the seaboards of the Mediterranean and Black seas. Thus the carrying trade of Europe was focused in the Mediterranean, and in the fifteenth century Venice had established herself as the great market and carrier of Europe. Statistics relating to these early times are far between and generally unreliable, but it is said that Venice, at the height of her glory in the 15th century, could dispose of 3,300 ships, 36,000 mariners and 16,000 dock hands. The number of the crew was in proportion to the burden, one man for every 10,000 lb. of capacity, so that the carrying capacity of the fleet may well have approached 150,000 tons. Complementary to the eastern trade route was the western route extending by sea to the ports of England and Flanders; thus Venetians exchanged the luxuries of the East for the wool and woollen cloth of the North. Further north, the carrying trade was largely in the hands of the Hanseatic League.

With the discovery of the Cape route to the Indies, the centre of trade shifted from the Mediterranean to the western seaboard of Europe. The Portuguese were bending all their energies to the development of the Indian sea-route and, by the end of the 15th century, the Dutch had established their supremacy in the carrying trade and Amsterdam had become the emporium of Europe.

As Sir Walter Raleigh showed in 1603 in his famous *Observations concerning the trade and commerce of England with the Dutch and other foreign nations*, it was largely owing to the development of their herring fishing industry, which trained both sailors and shipbuilders, that the Dutch were able to become the great carriers of Europe's trade. They maintained this position till the end of the 17th century when the wars in which they were involved, together with the economic development of England and France, destroyed their trade supremacy.

Sir William Petty in one of his essays on "Political Arithmetick," published in 1690 but written some years earlier, gives some interesting estimates of Europe's mercantile marine at that time. He wrote, "The value of the shipping of Europe, being about two Millions of Tons, I suppose the English have Five Hundred Thousand, the Dutch Nine Hundred Thousand, the French an Hundred Thousand, the Hamburgers, and the subjects of Denmark, Sweden, and the Town of Dantzick Two Hundred and Fifty Thousand, and Spain, Portugal, Italy, etc. Two Hundred and Fifty Thousand." Later in the same essay, he estimates the total value of the merchandise carried by Europe's shipping at £45,000,000 a year. Petty appears to have based his estimates of shipping on one seaman being required for every ten tons of shipping. He probably meant to include Scotland and Ireland with England but even so his figure of 500,000 tons appears to be on the high side. The first complete return of England's mercantile marine was obtained by the commissioners of customs in 1701–2, when it appeared that there belonged to all the ports of England and Wales 3,281 vessels, measuring (or rather supposed

to measure) 261,222 tons and carrying 27,196 men By 1760, on the eve of the industrial revolution, the number of vessels had grown to 6,105 of the reputed burden of 433,922 tons, while in addition there belonged to Scotland 976 vessels of 52,818 tons.

There is one exception to the general absence of real statistics of shipping in the age before the industrial revolution. From about the year 1429 all vessels passing the sound were liable to pay dues to Denmark and particulars of each ship passing, varying from time to time in their detail, were entered in the records Some of the earlier records are missing, but two volumes entitled *Tables de la Navigation et du Transport des Marchandises passant par le Sund, 1497–1660*, edited by Fröken Nina Bang, contain the available information. The figures naturally reflect the commercial progress of the countries bordering on the Baltic The first two years for which the records are extant are 1497 and 1503; averaging these two years, the number of vessels passing the sound (each vessel is counted both outward and inward) was 1,009, of which 712 were Dutch and most of the rest belonged to the Hanseatic towns. In the ten years 1538–47 the average number of ships a year was 1,442. The average annual number in each decade then rose steadily till the end of the 16th century, being 5,623 vessels per year in the years 1590–99. Then the numbers fell off again and in the period 1650–57 averaged only 3,015 per year. Throughout the period, with rare exceptions, more than half the vessels were Dutch (usually about two-thirds of them were Dutch). From 1536 to 1645 the Dutch vessels were shown according to their capacity—more than 100 lasts (a last is about 2 tons), 30–100 lasts, and less than 30 lasts. About 40% of the Dutch vessels were recorded as more than 100 lasts in the early years but thereafter the proportion so recorded fell off. About the year 1618, however, the regulations appear to have been tightened up and in the following decade about half the Dutch vessels were recorded as more than 100 lasts Thereafter the proportion of vessels of more than 100 lasts increased and accounted for about 90% of all vessels in the period 1640–45. Throughout the period the number of English and Scottish vessels rarely exceeded 10% of the total

In the century or so preceding the industrial revolution, the development of international trade was normal in degree, depending mainly on the increase of population and any cheapening in transport caused by improvements in the arts of navigation and shipbuilding. Nations were on the whole self-dependent for the means of livelihood of their people and international commerce consisted of the exchange of surplus products for luxuries from other lands. But with the industrial revolution all this was changed. First England and later other industrial countries became essentially dependent on external trade. Manufactures were made largely from imported materials and the industrial population tended to depend more and more on imported supplies of foodstuffs, both received in exchange for exports of manufactures. International trade increased at a tremendous rate. About the middle of the 19th century a further great stimulus was given to commerce by the cheapening and acceleration of transport through the development of the steamship and the railway.

As mentioned above, in 1760 the reputed burden of the vessels belonging to England and Wales was 434,000 tons. By the year 1800 the figure had grown to 1,467,000 tons, in spite of severe losses in the war with France. The tonnage of all vessels entering and clearing ports of Great Britain from or to foreign countries also increased about fourfold in this period of 40 years. On the other hand the wars practically destroyed the carrying trade of the Netherlands. For the number of vessels entering and leaving the Baltic in certain years *see* the following table.

Vessels Passing the Sound in Certain Years

Flags	1772	1791	1798
Dutch	2,745	1,736	None
British	1,894	3,720	3,313
Danish	972	1,304	1,825
Swedish	805	1,816	2,120
Prussian	316	430	1,691
Other flags	337	1,386	629
Total	6,680	10,452	9,508

Commerce of the United Kingdom, U.S., France and Germany to World War I.—In the foregoing sketch of the development of commerce up to the end of the 18th century, the carrying capacity of shipping has been the best guide. With the development of trade in highly manufactured and valuable articles occupying comparatively little space, shipping capacity becomes a less satisfactory measure; a ton of coal or of iron ore and of cotton piece-goods or machinery have values of quite different orders. About the same time figures of the total value of imports into and exports from the principal trading countries become available and, as late as 1880, about 75% by value of the goods passing in world trade were imports or exports of the United Kingdom, the United States, France and Germany.

In interpreting figures of value the effects of changes in the level of prices must be borne in mind. The following table shows the fluctuations in general prices in the United Kingdom at ten-yearly intervals between 1791 and 1911, as shown by Jevons' index numbers from 1791 to 1846 and Sauerbeck's index numbers from 1846 to 1911.

The average of the years 1867–77 is taken as 100 and the two series have been linked on the respective index numbers in the year 1846.

1791	107	1861	98
1801	168	1871	100
1811	164	1881	85
1821	113	1891	72
1831	99	1901	70
1841	102	1911	80
1851	75		

At the time of the revolutionary and Napoleonic wars, prices increased very greatly. After the wars, prices drifted downward on the whole till about 1850. In the next 25 years they moved upward reaching a high point (111) in 1873 but dropped back again in the last quarter of the century to about 30% below the datum line.

Prices then increased steadily till the outbreak of World War I. The effect of the war was, of course, to increase them very greatly.

The United Kingdom.—A systematic record of the official value of the imports into and exports from England from 1699 to 1778, the same for Great Britain from 1779 to 1800, and for the United Kingdom from 1801 to 1853 is given in *Custom Tariffs of the United Kingdom, 1800–1877* (1897). The official values were based on the old valuations laid down at the end of the 17th century. It follows that, while they may afford a basis for estimating the volume of trade from year to year, they give no correct idea of the value of the trade of each year at later prices. In 1798, however, an ad valorem convoy duty was imposed on domestic exports and this made it possible to ascertain the real current value of exports For imports and re-exports, it was not till 1854 that the old official values gave way to current values. Trade with Ireland is excluded from the following figures throughout

Around the year 1700 the official value of imports into England was about £5,500,000 and that of exports about £6,000,000. During the next 60 years the figures increased slowly but steadily and around 1760 were about £8,500,000 for imports and £13,000,000 for exports. From 1760 to 1785 imports continued to grow, exceeding £14,000,000 in the latter year, but exports remained stationary. In the next 15 years, however, both imports and exports about doubled.

From the beginning of the 19th century the figures relate to the United Kingdom and about the same time real values become available for exports of domestic produce and manufactures In the year 1805, the official value of the imports was £28,561,000 and that of the exports £31,064,000, of which £23,377,000 represented exports of domestic produce and manufacture and the remainder exports of imported merchandise; the real value, however, of the domestic exports was £38,077,000, *i.e.*, about 60% above the official value.

The volume of imports, so far as it can be judged on the basis of these official values, remained about steady from 1805 to 1822, doubled in the next 15 years and again about doubled in the following 15 years (up to 1853). The official values of British exports in this period have little significance beyond illustrating, by

comparison with the real values, the enormous decline in the prices of exports, caused partly by the general fall in prices and partly by *the effects* of the development of the factory system in cheapening manufacturing costs. While, as shown above, the real value in 1805 was more than 60% above the official value, by 1840 the real value was only half the official value; in other words export prices in 1840 were, on average, less than one-third of what they had been 35 years earlier. The real value of domestic exports was £36,966,000 in 1822, £47,381,000 as late as 1842 and then increased rapidly to £98,934,000 in 1853. The following table shows the real value of the domestic exports, and of the retained imports (*i.e.*, total imports less re-exports) in annual averages from 1855 to 1913, together with the population:

Annual averages	Retained imports	Domestic exports	Population
	Million £	Million £	Millions
1855–59	140·1	116·1	28·9
1860–64	193·8	138·4	29·2
1865–69	237·7	181·5	30·4
1870–74	290·6	234·8	31·9
1875–79	319·5	207·5	33·6
1880–84	343·8	234·3	35·2
1885–89	318·8	220·9	36·6
1890–94	357·1	234·4	38·0
1895–99	392·7	237·8	40·0
1900–04	466·1	282·8	41·9
		288·2*	
1905–09	522·1	377·3*	43·7
1910–13	612·0	474·2*	45·5

*Including value of exports of ships and boats (new) with their machinery recorded from 1899 only

Throughout the period shown in the table imports consistently exceeded exports in value. This difference was more than made up by *receipts* from such items as shipping earnings and returns from overseas investment.

Considering first domestic exports, there was a very rapid rate of progress up to 1872, when the figure of £256,000,000 was reached. In the next 25 years there was comparatively little increase in values, owing partly to increased competition from other countries, which were now manufacturing on a substantial scale, and partly to the fall in prices. Then followed a period of rapid expansion till 1913 when the figure was £525,000,000. In 1854, 90%, by value, of the domestic exports consisted of articles wholly or partly manufactured, while in 1913 the proportion of manufactured articles had fallen to 78% of the total. Exports of coal accounted for a considerable proportion of the remainder.

The course of retained imports was similar. Their value was £134,000,000 in 1854 and increased rapidly to £315,000,000 in 1873; then till 1895 progress was slow, the figure in that year being £356,000,000, but thereafter there was, on the whole, a rapid increase till 1913 when the figure of £659,000,000 was reached. Of the retained imports, only 15% in 1854 consisted of articles wholly or partly manufactured, but by 1913 the proportion had increased to 25%. The great bulk of the imports consisted of foodstuffs and raw materials of industry, raw materials predominating in the earlier years, and foodstuffs (including drink and tobacco) from about 1875.

In 1855–59 imports and exports per head of population averaged about £9 5s and by 1870–74 the figure had grown to about £16. As late as 1895–99 the figure was still about £16, but by 1910–13 it had increased to nearly £24.

The United States.—Figures of the value of imports and exports are available for the United States as far back as 1790. At that time the population was under 4,000,000 and being concentrated mainly on the seaboard, was more dependent on overseas trade than later when the internal resources of the continent were developed. This is reflected in the trade statistics. In the decade 1790–1800 *the value of* imports and exports together averaged $22 per head of population; and in the decade 1821–30 the value per head dropped to under $10. The value per head then gradually increased to about $25 in the period 1871–80. Thereafter there was a setback and progress was not resumed till the beginning of the present century. On the annual average of the years 1910–13, the imports and exports per head had increased to $39.

But while the external trade per head of population was comparatively small, the aggregate value of the trade increased enormously, owing to the rapid rate of the growth of population. In the decade 1790–1800, imports and exports together averaged annually $100,000,000; in 1821–30 the annual average was $142,000,000; and in 1841–50 it had increased to $244,000,000. The following table shows the value, both in dollars and sterling, of the domestic exports and the retained imports in five-year annual averages from 1850 to 1913, together with the population.

5-year annual averages	Retained imports		Domestic exports		Population
	Million dollars	Million £	Million dollars	Million £	Millions
1851–55	288·0	59·2	256·0	52.8	28·9
1856–60	356·6	74·8	208·7	44·0	32·7
1861–65	354·7	72·0	231·4	48·5	36·2
1866–70	550·8	113·2	468·1	96.2	40·6
1871–75	468.1	96·2	606·8	124·7	46·4
1876–80	681·7	140·1	804·8	165·4	52·5
1881–85	677·8	139·3	772·4	142·2	56·7
1890–94	701·7	164·7	858·7	184·7	63·1
1895–99	708·0	145·5	1,034·5	212·6	71.6
1900–04	905·1	186·0	1,422·4	292·3	79·0
1905–09	1,347·7	276·4	1,730·9	355·7	87·3
1910–13	1,664·5	333·8	2,109·5	433·5	94·6

Up to the year 1873 the value of imports exceeded that of exports, in spite of the fact that the United States authorities valued imports in the country of shipment and so excluded the freight and insurance charges from the recorded values. This excess of imports was mainly due to the fact that the United States was borrowing large amounts of capital from Great Britain for purposes of internal development; another reason is that the United States was still earning considerable sums from its mercantile marine, since the era of wooden ships, of which they had a large merchant navy, was not yet over. From 1873 to 1895 exports only slightly exceeded imports in value, but *in the next ten years* exports developed more rapidly than imports From 1905 to 1913 both imports and exports increased at about the same rate.

The following table shows the relative distribution of foodstuffs (crude or manufactured), raw materials for industry and articles wholly or partly manufactured among the total imports and domestic exports from 1860. In the 30 years before that date the changes were comparatively small.

Years ended June 30	Per cent of total imports			Per cent of domestic exports		
	Foodstuffs	Raw materials	Manufactures	Foodstuffs	Raw materials	Manufactures
1860	29·9	21·6	48·5	16·1	68·6	15·3
1870	34·4	13·0	52·6	24·6	50·8	18·6
1880	32·7	21·3	46·0	53·8	29·4	14·8
1890	33·3	22·8	44·0	42·2	38·6	20·2
1900	27·2	33·1	39·7	30·8	34·8	35·4
1910	21·0	37·1	41·9	22·6	33·6	44·8
1913	22·4	35·8	41·8	20·7	30·5	48·8

The above table brings out very clearly the growth in the relative importance of industry in the United States during the 50 years before World War I. Among imports, the relative importance of raw materials for industry increased threefold while the relative importance of manufactured articles declined by about one-third. On the export side the United States tended more and more to export manufactures instead of raw materials of industry. The high proportion of foodstuffs exported in the last quarter of the 19th century was mainly due to the rapid development of cereal cultivation. As the population and the standard of living steadily increased, the surplus available for export relatively declined, while at the same time the exports of manufactures increased.

France.—Satisfactory figures of French trade first became available in 1815. Up to and including 1846 standard official unit values (fixed in 1826 and applied retrospectively to the recorded quantities for earlier years) were used, so that the figures represent the volume of trade rather than its real value. The following table gives the figures at decennial intervals throughout this pe-

riod, together with the population:

Year	Imports for consumption	Domestic exports	Population
	Million £	Million £	Millions
1815	8 0	16 9	29.4
1825	16 0	22 8	31.4
1835	20.8	23 1	33 3
1845	34.2	33 9	35 2

Imports increased fourfold in the 30 years while exports doubled in volume In the same period the population increased by about 20%.

From 1847 onward, the official unit values were revised annually, so that the figures more nearly represented actual values The development of French trade from that date to World War I is shown in the following table:

Annual averages	Imports for home consumption	Exports of domestic produce	Population
	Million £	Million £	Millions
1850–54	40.3	31 8	35 9
1855–59	69 3	51 8	36 3
1860–64	91 9	96 1	37 4
1865–69	119.3	119.7	38.2
1870–74	136 1	134.4	36.7
1875–79	129 7	128 4	37 0
1880–84	190.0	138 1	37 7
1885–89	166 0	132 3	38 3
1890–94	168 8	136 8	38 2
1895–99	163 7	144 3	38 6
1900–04	189 1	168 6	39 1
1905–09	248 1	212 0	39 3
1910–13	318 0	259.0	39.6

Up till the Franco-Prussian War the value of imports was about equal to that of exports but thereafter the value of imports was consistently higher Imports increased rapidly in value up to 1880–84 and exports up to 1870–74 There followed a distinct check till the end of the century. This check was mainly due to the heavy fall in prices. In France prices fell by more than 40% between 1874 and 1896 when the lowest point was reached, while between 1896 and 1913 they increased by about 40% With rising prices, the value of imports practically doubled between 1895–99 and 1910–13 while the value of exports increased by 80%.

The growth in population was small in France. In 1825 imports and exports amounted to about 25s. per head; in 1850–54 the figure had about doubled and by 1870–74 it had increased to about £7.10s. per head. There was then little increase till the end of the 19th century, but by 1910–13 imports and exports had grown to nearly £15 per head.

The distribution of imports and exports according to the principal classes of goods is shown in the following table, at decennial and other intervals from 1850·

Year	Per cent of imports			Per cent of exports		
	Food	Raw materials	Manufactures	Food	Raw materials	Manufactures
1850	26 6	78 2	5 2	30 1		69 9
1860	20.8	76 1	3 1	37.3		62.7
1869	22.4	68 9	8.7	46 7		53 3
1880	39.0	49.1	11.9	23 4	23 5	53.1
1890	32.6	53 5	13.9	22 8	23 9	53 3
1900	17 4	64 6	18.0	18.7	26 4	54 9
1910	19 7	60.6	19 7	13 8	31.0	55 2
1913	21.0	58 7	19 7	12 2	27 0	60 8

Germany.—Not until the 19th century was the first attempt made to establish a co-ordinated commercial policy between the many independent states, large and small, which were to form in 1871 the German empire. The formation of the customs union between Prussia and certain north German states and between the Bavaria and Württemberg in 1828 was followed in 1834 by the amalgamation of the two unions and thereafter other states gradually came into the Zollverein. Before 1871, a bird's-eye view of the rate of development of Germany's oversea trade may best be gained from the shipping statistics of the port of Hamburg. The following table shows the number and tonnage of vessels entering Hamburg at decennial intervals from 1791 to 1871:

Year	Number	Tonnage
1791	1,504	
1801	2,177	
1811	(blockade)	
1821	2,008	161,066
1831	2,347	293,443
1841	3,164	377,804
1851	4,169	558,403
1861	5,219	903,470
1871	5,439	1,867,192

Progress was fairly slow in the period up to 1831, but thereafter the tonnage entering Hamburg increased at a rapid rate down to 1871. Forty years later, in 1911, the tonnage had increased to more than 13,000,000.

From 1872, the trade of the Zollverein practically represents the trade of the empire The following table shows the development of this trade, together with the population from 1872 to the outbreak of World War I:

Annual average	Imports for consumption	Domestic exports	Population
	Million £	Million £	Millions
1872–74	*	113 7	41.3
1875–79	*	132 3	42 1
1880–84	151 8	152.8	45 2
1885–89	159 0	151 0	47 3
1890–94	198 9	152.5	50 5
1895–99	232 8	181 3	53 8
1900–04	287 0	235 6	58 0
1905–09	394 3	324 0	62.2
1910–13	492 9	425 7	66 0

*Comparable figures not available

The general trend of both imports and exports was similar to that of the trade of the United Kingdom and France; a period of hesitancy in the last quarter of the 19th century, mainly due to the fall in prices, was followed by a period of rapid expansion of the value of trade in the early years of the present century, when prices were rising. In the '80s the values of imports and exports about balanced and thereafter the value of imports was distinctly higher than that of exports. Imports and exports together were about £6 15s. per head of population in 1880–84, about £7.15s. in 1895–99 and by 1910–13 had risen to nearly £14 per head.

Turning to the classes of goods imported, the following table shows the percentages of imports and of exports, classified as articles of food, raw materials, and manufactures.

Year	Per cent of Imports			Per cent of exports		
	Food	Raw materials	Manufactures	Food	Raw materials	Manufactures
1880	32 6	30 6	27 8	22 2	20 2	57 7
1890	33 5	42 9	23 6	14 2	21 3	64.5
1900	30 0	48.6	20 8	12 1	24 1	63.7
1910	27 6	52 2	20 2	10 0	23 4	66 6
1913	27 8	52 2	20.0	10 1	23 8	66 1

Such changes as occurred mostly took place before the end of the 19th century The growth in imports of raw materials of industry is the most significant feature on the import side Among exports, it will be seen that foodstuffs decreased in importance, while raw materials and manufactures increased It should be mentioned that the term "raw materials" in the German statistics includes considerable quantities of goods in a semimanufactured state (*e.g.*, pig-iron, steel, ingots, etc.).

The World's Trade 1860–1913.—In the preceding section, the progress of the external trade of the United Kingdom, the United States, France and Germany has been traced throughout the 19th century and up to the outbreak of World War I. The earliest authoritative figures of the value of the trade of the world as a whole go back to 1867–68 and were given (up to 1894) in Neumann-Spallart's *Übersichten der Weltwirtschaft* and, for the later years up to 1908, in Otto Hübner's *Geographisch-Statistische Tabellen*. The following figures (converted into sterling at 20 marks to the £) are taken from these publications. Imports and exports have been added together so that the value of the goods

actually passing in the trade is about half the figures shown. The figures for 1860 and 1865 are rough estimates.

Annual averages	£ millions	Sauerbeck's price index (1867–71=100)
1860	1,450	90
1865	1,750	101
1866–70	2,317	97
1872–73	2,888	110
1874–79	2,822	93
1880–84	3,283	83
1885–89	3,142	70
1890–94	3,508	69
1895–99	3,901	63
1900–04	4,791	71
1905–08	6,106	75

These figures cover the trade of 75 to 100 countries, the additions to the number of countries in later years do not seriously affect the table, because the trade of the new countries, when first included, was relatively small in value.

The gold value of the world's trade appears to have about doubled between 1860 and 1872–73, but part of this increase was due to rising prices. From 1872–73 till about 1895, when prices fell heavily, the gold value of the world's trade increased but slowly. Prices then rose again slowly till 1913, and the value of the world's trade rapidly increased.

It is of interest to compare the value of the trade of the four principal countries considered above with that of the value of the world's trade. For the year 1880, Neumann-Spallart's tables show the value of the trade (imports and exports together) of these four countries to be slightly more than 50% of the world's total Now, in considering alone the trade of these four countries, only those goods which pass *inter se* are duplicated in the total, while in the world total all goods are duplicated. Making the necessary adjustments for this duplication, it may be estimated that in 1880 about 75%, by value, of the goods passing in the trade of the world was imported into or exported from those four countries.

The following table shows the values of the imports into and exports from the principal countries of the world and each continent at ten-yearly intervals between 1874–75 and 1905 according to the above authorities. Figures for 1913, taken from the League of Nations publications and not comparable in all respects with the earlier figures, have been added.

Between 1874–75 and 1905 the gold value of the world's trade more than doubled and, allowing for the fall in prices, its volume probably about trebled. The trade of the United Kingdom and of France increased more slowly than the world's total trade, while that of Germany and the United States increased more rapidly. Among other European countries, the trade of the western countries shown increased far more rapidly than that of the eastern countries. In other parts of the world, remarkable rates of increase were shown by Japan and Argentina. Considering the proportions of the total attributable to each continent, Europe's share fell from 72% of the total in 1874–75 to 64% in 1905 and (according to the League of Nations figures) to 61% in 1913. On the other hand, the share of America increased from 15% of the total in 1874–75 to 19% in 1905 and to 21% in 1913; the share of Asia also increased from 8% of the total in 1874–75 to 11% in 1905 and 1913.

Figures in million £

Area	1874–75	1885	1895	1905	1913
United Kingdom*	656	584	657	914	1,186
Germany	300	290	353	719	1,091
France	496	387	287	380	607
Russia	148	157	128	170	303
Austria-Hungary	110	133	125	187	277
Netherlands	104	169	221	380	576
Belgium	96	102	124	219	328
Italy	91	96	90	153	244
Total Europe	1,976	2,077	2,305	3,587	5,137
United States	200	268	333	584	868
Canada†	42	42	57	86	216
Argentina	23	36	43	107	201
Total America	407	533	649	1,068	1,734
India‡	95	130	127	187	279
Japan	9	11	60	85	145
Total Asia	212	285	374	629	956
Australasia	84	120	104	125	202
Africa	61	70	123	215	335
World total	2,740	3,085	3,555	5,623	8,337

*The United Kingdom figures for 1874–75 relate to total imports and total exports; those for 1885–1905, to total imports and domestic exports, and those for 1913 to retained imports and domestic exports.
†British N America prior to 1905.
‡British E. Indies prior to 1895.

The commercial interchange of goods between countries was completely upset by World War I. The unsettled conditions prevailing immediately after that war—sharp variations in currency values, depreciated exchanges, frontier changes, etc.—render aggregate figures up to the end of 1923 of little value The following table shows the value of world imports and exports and price and quantum indexes (1929=100) for 1913 and 1924–38.

Year	Values in Millions of Old U S Gold Dollars*			Price index (1929=100)	Quantum index (1929=100)
	Imports	Exports	Total		
1913	21,034	19,564	40,598		
1924	28,978	27,850	56,828	100 4	75 7
1925	33,150	31,251	64,701	113 4	83 2
1926	32,117	29,929	62,037	108 1	85 2
1927	33,364	31,516	65,880	103 5	91 9
1928	34,052	32,728	67,380	103 2	95 2
1929	35,595	33,034	68,629	100	100
1930	29,075	26,477	55,552	87 1	93 0
1931	20,795	18,906	39,701	67 7	85 5
1932	13,968	12,885	26,853	52 4	74 6
1933	12,461	11,714	24,175	46 7	78 4
1934	13,081	11,333	24,414	45 5	78 2
1935	12,243	11,559	23,802	42 4	81 8
1936	13,142	12,581	25,723	43 7	85 8
1937	16,328	15,497	31,760	48 0	96 8
1938	14,370	13,417	27,730	45 5	88 8

*Dollars according to the "old" parity (23.22 gr. of fine gold).
Source League of Nations *Review of World Trade, 1937–38.*

Making allowances for changes in prices and multiplication of frontiers, it is probable that in 1924 the volume of international commerce was about 75% smaller than in 1913, that in 1925 it had increased to slightly above the 1913 volume, and that in 1926 it further increased to about 5% above the 1913 volume. International commerce continued to increase, reaching a high point in 1929, but dropped off greatly during the world depression in the early 1930s. By 1937 the volume of world trade had risen to 96 5% of the 1929 volume, but dropped again in 1938 to 89% of the 1929 level. The economic recovery in the United States had been one of the primary factors in the general improvement of world economic conditions and the increase in commercial activity which had brought the volume of trade in 1937 near the 1929 level. However, the slowdown in economic activity in the United States in the last quarter of that year and in the first half of 1938 had a depressing effect on world trade. Because the United States had become the world's greatest consumer of raw materials, changed economic conditions in that country had widespread effect on world trade. Other factors in the lower level of international trade in 1938 were the intensified efforts at self-sufficiency and the growing uncertainties in anticipation of war. The growth of armament activity prevented a steeper downturn in international trade.

Continental group	1913	1926–30	1931–35	1936	1937	1938
Imports						
North America*	11 5	13 7	12 2	13 9	13 9	10 0
Latin America†	7 3	7 4	6 0	6 7	7 1	7 5
Europe‡	63 2	56 1	60 3	56 4	55 9	57 3
Africa	3 8	4 6	5 9	6 5	6 3	6 4
Asia§	10 1	13 4	13 6	13 7	14 2	14 8
Oceania	2 4	2 8	2 0	2 8	2 7	3 1
Total	100 0	100 0	100 0	100 0	100 0	100 0
Exports						
North America*	14 8	19 3	15 7	16 3	17 0	17 8
Latin America†	8 6	9 3	9 4	10 2	10 3	9 3
Europe‡	58 5	48 5	51 0	46 2	45 7	47 0
Africa	4 4	4 5	6 5	7 6	7 9	6 6
Asia§	11 2	15 5	14 5	16 1	16 7	15 8
Oceania	2 5	2 9	3 0	3 6	3 4	3 5
Total	100 0	100 0	100 0	100 0	100 0	100 0

*Canada, Newfoundland, Greenland, St. Pierre and Miquelon and United States
†America other than North America.
‡Including U S S.R.
§Excluding U S.S.R.
Source Percentages computed from values shown in League of Nations *Review of World Trade, 1937–38.*

The above table shows the percentage distribution of the world's trade by continental groups for 1913 and 1926–38. The figures indicate a marked change in the relative importance of the continents over the period.

International Trade in the Years Immediately Following World War II.—A large number of countries stopped issuing trade statistics during World War II. Although many countries resumed publication of statistics after the termination of hostilities, the U.S.S.R. and several other eastern European countries continued to withhold their trade data from publication Estimates of world trade since World War II, therefore, are necessarily approximate.

The following table shows estimated values of world exports and indexes of quantum and unit value for 1946–48 compared with 1937–38.

Year	Value in millions of U S dollars*	Quantum Index	Unit value (price) index
1937	26,200	100	100
1938	24,000	93	94
1946	33,100	73	173
1947	48,500	90	208
1948	55,100	95	221

*Dollars as distinguished from "old gold dollars" in the similar table above
Source. United Nations *Summary of World Trade Statistics* (Jan 1, 1950).

For 1946, the first year following the close of hostilities, the value of total world exports was estimated at $33,000,000,000 and the volume (value adjusted for price changes) at 73% of the 1937 level The United States, exporting almost twice as much as in 1937, supplied about 30% of the total. For the world excluding the United States, the export quantum index (1937 = 100) for 1946 was 56.

In 1947 world exports rose to 90% of the 1937 volume; United States exports were more than two and one-half times their 1937 volume and constituted about one-third of the world total; the export volume for the rest of the world rose to 66% of the 1937 level World exports continued to expand in 1948 as the work of rehabilitation and reconstruction progressed and European and Asiatic countries raised production levels and increased their exports.

The following table shows the estimated values of world imports and world exports, by continental groups, for 1947–48 compared with 1937–38. Values are shown in millions of U.S dollars.

Continental group	1937	1938	1947	1948
Imports				
Northern North America	4,230	2,920	9,130	10,820
Latin America	2,030	1,910	6,130	6,000
Europe	13,560	14,220	24,180	28,530
Africa	1,840	1,660	4,120	5,260
Asia	4,020	4,100	6,600	7,230
Oceania	700	810	1,440	1,880
Total	29,000	25,600	52,400	61,100
Exports				
Northern North America	4,340	3,960	18,060	15,730
Latin America	2,560	1,990	6,360	7,370
Europe	11,080	10,880	15,290	20,300
Africa	1,380	1,100	2,730	3,190
Asia	5,050	4,190	4,540	5,070
Oceania	800	830	1,510	1,230
Total	26,200	22,900	48,500	55,100

Source· United Nations *Summary of World Trade Statistics* (Jan 1, 1950)

The proportion of world exports supplied by the United States in the years immediately following World War II indicates the degree of unbalance in international trade which resulted from the world conflict. Reduced means of financing, by the individual countries, of their abnormally large trade deficits with the United States rendered the situation extremely difficult. A large part of goods moving in international channels was financed by grants and loans. Although the high degree of dependence upon the United States as a source of supply diminished as production rates increased in other countries, trade deficits with the United States, though smaller in 1948 and 1949 than in 1947, were still large There was a widespread realignment of currencies in relation to the dollar in the fall of 1949, beginning with the devaluation of the pound sterling on Sept. 18, in consequence of the continuing dollar shortage.

Exchange and import controls were used intensively after the war to restrict imports from the United States and other hard-currency countries to commodities of highest essentiality and thus conserve dwindling dollar exchange reserves.

Inconvertibility of currencies led to increased resort by most countries to bilateral agreements and barter arrangements for the conduct of trade following World War II. However, advantages to be derived from the conduct of trade on a multilateral basis and free convertibility of currencies were widely recognized. Negotiations among 23 countries, beginning in April 1947, for the reduction of tariffs and other trade barriers, resulted in the framing of the General Agreement on Tariffs and Trade which by June 30, 1948, had been made provisionally effective by 22 of the countries. Provision was made for the accession of other countries to the General Agreement. Another accomplishment in that direction was the completion in March 1948 by the United Nations Conference on Trade and Employment of the Havana charter for the International Trade organization for submission to the various countries for acceptance. Significant progress was made in liberalization of trade controls, notably in western Europe where the European Payments union was set up in 1950 to facilitate payments However, following the invasion of South Korea in June 1950, the effects of growing international tension became increasingly apparent in trade policies and in the character and distribution of international trade.

(*See* also COMMERCE; EXPORTS; STATISTICS; TRADE ORGANIZATION.)

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TRADE BOARD, a term applied in Great Britain to one of a system of industrial wages boards established to fix legal minimum rates of payment for workers in certain industries under the Trade Boards acts of 1909 and 1918.

The principal Trade Boards act of 1909 was based on the minimum wage provisions contained in the Factory and Shops act of Victoria, Australia, passed in 1896. The Trade Boards act was the result of long and vigorous agitation for legal protection on behalf of the "sweated" women workers, particularly in the chain-making industry centred in Cradley Heath, and in the clothing trades of London and the great towns. Boards were first established in four trades set out in the act, namely, ready-made and wholesale bespoke tailoring; paper-box making; machine-made lace finishing and chain making. Before 1914 five new trades were added, making nine in all.

Each of these boards was composed of an equal number of representatives of employers and workers in the trade plus from one to three neutral persons, called "appointed" members designated to sit on each board in order that a deadlock might be avoided.

The bodies so constructed had two powers under the act of 1909: 1. A mandatory power to fix minimum rates of wages for time workers in the specified trades; 2. A discretionary power to

fix general minimum rates of wages for piece workers in a trade. Rates of both kinds were subject to confirmation by the Trade Board before becoming effective, and even then had to undergo the test of a six months' limited operation before they became obligatory upon all employers. The action of these early boards was very cautious and in general their effect upon wages of women workers was to raise the general level of rates to that of the firms which were already paying the highest or very nearly the highest in the trade. Rates fixed for men, on the other hand, fell, on the average, below the rate for all men in a trade though they were higher than rates for the average unskilled man.

Between 1912 and the signing of the Armistice in 1918 the principle of state wage regulation became widely recognized through extended legislation in Australia, the United States and Great Britain. The tendency of the early months of the war in England was to favour suspension of Trade Board activities, but that attitude was soon abandoned in the interests of efficiency. Then, in addition to the Coal Mines (Minimum Wage) act passed in 1912, came the Munitions of War acts of 1915, 1916 and 1917, the Corn Production act of 1917 and finally the Wages (Temporary Regulation) act of 1918, each of which provided for state control of wages in some form and thus strengthened the Trade Board idea. In line with the general movement toward state control and self-government in industry the second Whitley report in 1918 recommended to parliament the extension of the Trade Boards system to unorganized and spasmodically organized trades as a complement to the establishment of voluntary Whitley councils in the better organized industries. It was hoped that eventually organization of both employers and workers in Trade Board trades would become strong enough to warrant their removal from government surveillance to the category of Whitley council industries, governed by a body of representatives of organized employers and workers co-operating voluntarily together for the good of the whole industry.

The background for the new Trade Boards act which became effective on Oct. 1, 1918, therefore, was threefold—first, more general acceptance of the principle of state regulation of wages; second, articulation of the democratic ideal of self-government in industry set in motion by the war; third, the foresight of those who realized that the aftermath of war would be a sharp drop in wages especially for unprotected workers, unless some machinery were provided to meet the exigency. The act of 1918 was thus born in an entirely new set of economic circumstances and was the result of a quite different concept from that of 1909. It consequently made several important changes in the act of 1909. First, the situation conditioning establishment of a Trade Board was altered, emphasis being thrown upon inadequate organization of workers or employers in a trade instead of relatively low wages; second, the rate-fixing powers of boards were considerably enlarged, third, the responsibility of the minister of labour, who since 1917 had acted in place of the president of the Board of Trade, was increased and the onus of establishing boards was placed upon him rather than upon parliament.

By 1921, a total of 63 Trade Boards covering 39 trades and governing the wages of approximately 3,000,000 workers in the United Kingdom had been set up. Of these boards 19, since they were established for Irish industries, came under the control of Eire. The number of boards functioning in Great Britain in 1944 was 47, with 6 others for Scotland only.

The Trade Boards system as it now stands is bipartite. Legislative, that is rate-fixing power, is vested in the board set up for each trade, while administrative and executive functions rest with the ministry of labour and in practice involve four distinct features: 1, setting up of boards; 2, confirmation or rejection of rates decided upon by the Trade Boards, 3, enforcement of legal rates; 4, decision in matters relating to the demarcation between boards and their spheres of activity.

The general composition of a Trade Board remains the same under the act of 1918 as that of 1909. The underlying principle is that of representation and it falls to the minister of labour to discover the component parts of each industry, to assign appropriate weight to each and to find acceptable persons to represent each interest, so that the board as a whole can represent the trade in entirety and work in harmony. It is customary for the minister to consult employers' organizations and trade unions concerning these appointments and also to name persons who can express the point of view of such unorganized sections of the trade as there may be. The "appointed" members are usually chosen from among the professional classes such as professors, lawyers, social workers, etc. It is provided by statute that where a considerable body of women are engaged in the trade at least one of the appointed members must be a woman.

The minister of labour is empowered to make regulations with respect to the constitution and proceedings of Trade Board meetings including the method of voting, but apart from those rules which he chooses to lay down, boards govern themselves.

Rates are arrived at by a process similar to bargaining assisted by the appointed members in the capacity of conciliators. Appointed members, however, have the power to vote just as other members of a board, but in practice this vote is seldom cast unless agreement between the two sides after negotiation becomes impossible and then it is done with reluctance.

As to the matter of what is a minimum wage, the act of 1918 gives no more guidance than that of 1909, and experience shows that the two sides of a board as well as the appointed members usually hold divergent views as to the terms of their reference. Employers probably most frequently interpret a minimum wage for a trade to be that already "payable to the lowest grade of worker in the least well equipped factory in the least expensive part of the country," while those on the workers' side stand for the current trade union rate in that or an allied trade as the minimum. Appointed members, on the other hand, are most likely to construe the minimum in terms of their philosophy of what wages are and should be. In practice the failure of the act to provide a more definite guiding principle works both for good and ill; on the one hand giving leeway for a broad construction of the purposes of the act, and on the other, in certain cases making for confusion and too wide divergency in rates between trades. When it comes to the bargaining coincident to wage fixing in a board, workers generally press the argument of the "living wage" as a basis for negotiation, and employers adhere to "what the trade can bear." The result is almost invariably a compromise. In this way the Trade Boards system enables the circumstances of each separate trade to be considered when the rate is fixed. Each trade, moreover, is able to vary its own minimum rates at any time without waiting upon the remaining trades. For an employer to pay wages below those fixed by a Trade Board is an offense punishable by the courts, who may also order the payment of arrears of wages.

Extensions of the Trade Board principle have been found necessary in certain large industries in which adequate standards were difficult to achieve by voluntary agreement. One such instance is agriculture. (*See* AGRICULTURAL WAGES.) The wages machinery for agriculture was overhauled by the Agricultural Wages (Regulation) Amendment act, 1940, which made it the duty of the Agricultural Wages board to fix a national minimum wage for the first time. In the case of Scotland it was provided by the Agricultural Wages (Regulation) (Scotland) act, 1940, that the Scottish Agricultural Wages board should have power to revise the rates of wages fixed by the county wages committees. An adaptation of Trade Board machinery, with features drawn from experience of collective bargaining, was introduced into the goods side of the road transport industry by the Road Haulage Wages act, 1938. The act set up a Road Haulage Central Wages board, comprising representatives of employers and workers in the industry and independent members, to make proposals for regulating the wages of drivers and attendants of vehicles used for hire. These proposals were to be circulated to area wages boards for their observations and then submitted to the minister of labour. If confirmed by him they came into force as "statutory remuneration," payment of which could be enforced by law. It was provided that wages of those employed on vehicles engaged in haulage work for the employer's own trade or business could be fixed on application to the Industrial Court (*q.v.*). A further

extension of the trade board principle, with adaptations, was introduced by the Catering Wages act, 1943, which provided for the appointment of wages boards, where necessary, in the various sections of the catering industry, *e.g.*, hotels, boarding houses, restaurants, public houses and industrial canteens

(D M Se; J Pre)

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United States.—The closest equivalent of the trade board is the wage and hour division of the United States department of labour, established under the Fair Labor Standards act (popularly known as the Wage and Hour act) of 1938

In 1942 this division was united with the public contracts division, and both came under the supervision of one administrator who in turn acted directly under the secretary of labour. The division administrator is appointed by the president with the approval of the senate

Throughout 47 of the states and the territories of Puerto Rico, the Virgin Islands, Hawaii and Alaska there were, at mid-20th century, 10 regional offices and 3 territorial offices of the division Each of these offices had subordinate field offices. In the state of North Carolina the F.L.S.A was administered through state officers and a federal representative Minnesota was divided by counties some were administered by a regional office, others by state officials

The Fair Labor Standards act established limits to the number of hours worked per week and to the minimum wages paid When the law was passed, maximum hours were 44 per week, and minimum wages were 25 cents an hour In 1940 a 40-hr week was established, and in Jan. 1950 the minimum wage rose to 75 cents an hour.

The act also provided that one and one-half times the minimum wage be paid for all hours worked beyond those of the designated work week unless exempted by some specific provision in the act Application of the act was limited, however, to those workers "engaged in interstate commerce or in the production of goods in interstate commerce" In addition to the general wage and hours provisions, the act also made possible the establishment of separate standards for specific industries by means of wage orders issued by the administrator. These wage orders followed the recommendation of an industry committee appointed by the administrator, representing equally the public, labour and the employer The industry committee held hearings open to all interested parties, and on the basis of hearings and research, submitted a report to the administrator recommending a minimum wage in general or by job classification within the particular industry One of the first industries, for example, in which this procedure was followed was hosiery In that industry two major branches were classified, and a separate minimum wage was established for each

Child labour was also provided for under the F.L.S.A. Transportation in interstate commerce of goods produced by "oppressive" child labour was prohibited A 16-yr minimum age for employment was established, although exceptions permitted children of 14 and 15 to be employed in nonmining and manufacturing occupations that did not interfere with their health, schooling or well-being The act further provided that children under 18 years of age might not be employed in any occupations declared and specified by the act to be particularly hazardous.

The enforcement of the Fair Labor Standards act depended upon the voluntary acceptance of the minimum wage stipulations, either those of the general provisions or those recommended by various industry committees; civil or criminal proceedings against violators instituted by the administrator, or suits against employers brought by individual employees or groups of employees Complications arose frequently, however, in the interpretation of the provision of the act governing occupations covered by it. Application of the law depended upon the nature of the activity of the workers rather than upon the business of the employer. In determining whether a particular type of activity came within the act, the supreme court applied the test of the "continuity of the flow of goods in interstate commerce."

Among many other rulings, the court held that the act covered employees of a company operating a toll road used for the passage of goods in interstate commerce, also employees in the central office of a chain grocery store from which goods were shipped to out-of-state stores. In 1946 the court found the F.L.S.A. applicable to employees engaged by a local company to wash the windows of buildings operated by concerns producing goods for interstate commerce On the other hand, in 1945 service workers employed by a New York office building corporation were held not subject to federal wage-hour control. The fact that more than one-third of the office space was used by concerns engaged in interstate commerce did not seriously involve these workers in the production of goods for such commerce.

During World War II and thereafter the wage and hour division co-ordinated its functions with various other government agencies which regulated wage stabilization. By mid-20th century the wage and hour division supplemented the work of the Wage Stabilization board by (1) giving information to the public through its field offices, (2) issuing rulings interpreting the application of wage stabilization regulations, (3) handling reports which resulted from rulings of the Wage Stabilization board, (4) handling petitions for wage and salary increases, (5) handling applications referring to special situations requiring action by the board The division also functioned to determine compliance with the wage stabilization program.

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(S Pe)

TRADE CYCLE. The phrases trade cycle, business cycle and cyclical fluctuation of trade are all convenient methods of labelling those alternating upward and downward sweeps in the volume of business activity which have constituted one of the outstanding phenomena of the modern business world. The most obvious manifestations of the trade cycle are a quasi-rhythmical fluctuation, extending over several years, in the level of prices, the level of money profits and the level of employment In the absence of complete statistics, it is difficult to be sure how far there occurs a corresponding fluctuation in the level of production and consumption, *i.e.*, in the real income of the community affected While it is certain that these latter quantities fluctuate to some extent, it seems probable

1. that the fluctuations in output are less intense than the fluctuations in prices;

2. that the output of ordinary goods for immediate consumption fluctuates as a rule far less than the output of instrumental or constructional goods (typified by iron and steel);

3. that the fluctuations in output do not entirely synchronize with the fluctuations in prices, but that, in the later stages of a boom of prices, production may cease to make any significant advance, while in the later stages of a depression of prices production may make a marked recovery. Nor is it safe to dogmatize about the length of the trade cycle or about the degree to which its phases synchronize in the leading industries and the leading industrial countries. Again, the change-over from depression to prosperity, or prosperity to depression, does not affect all trades at the same moment, or even always in the same direction.

In the main, however, it seems reasonable to describe the trade cycle both as a general movement and as a rhythmical one; and any explanation of its causes must take these two factors into account. Many such explanations have been offered—too many to expand or criticize fairly in the course of a short article It must be enough to set out and classify certain roads of thought, as it were, along which economists have been led to travel.

The Psychological Approach.—The first road leads into the domain of psychology. There is an invitation to find the chief

explanation of the trade cycle in the nature of man himself, and especially of those men who are responsible for conducting and controlling the operations of modern industry, commerce and finance. These business leaders are bound together not only by their business dealings but by ties of sentiment and environment they operate, necessarily, in an atmosphere of uncertainty and any error of forecasting which they make, whether of an optimistic or of a pessimistic kind, is likely to be magnified by their mutual contact into a great wave of erroneous judgment, which gathers strength for a time and then breaks, yielding place to an equally exaggerated movement in the opposite direction There seems to be little doubt of the importance of this factor both in aggravating the amplitude of the trade cycle and in moulding it into its quasi-rhythmical shape.

But precautions should be taken against supposing that all decisions made by businessmen to vary the scale of their purchases or their output are erroneous Many such decisions are clearly in the true interest of those who make them, if not of society as a whole

The Monetary Approach.—The second road leads into the tangled wood of monetary theory Those who follow it lay stress on the dependence of the scale of industrial activity on the general level of prices, and on the dependence of the latter, in its turn, on the monetary policy of the government and the banks. The independent leaders of business are advantaged during a period of rising prices, because the rise in many of their money costs of production (such as debenture interest, salaries and in some degree wages) lags behind the rise in their money receipts. They are accordingly both enabled and furnished with a real inducement to expand the scale of their operations; and owing to their habit of concentrating their attention on the movement of the price of their own products, the inducement is likely to seem greater to them than it actually is.

Conversely, in time of falling prices, businessmen are both disadvantaged by the relative fixity of some of their money costs, and believe themselves to be more disadvantaged than they are; and they are impelled therefore to contract the scale of their operations.

These price movements, if left unchecked, act cumulatively, in both directions; for as long as prices are expected to go on rising, businessmen continue to rush in to buy; and as long as prices are expected to go on falling, businessmen continue to liquidate their stocks of goods, and to refrain from replenishing them.

Now modern currency and banking systems are of such a kind, that, unless consciously operated with another end in view, they permit considerable play to these price movements. Indeed they exaggerate them by displaying an excessive timidity in altering those rates of interest whose magnitude has an important effect in determining the volume of loans issued by the banks, and consequently the volume of purchasing power put, in the form of cheque currency, into the hands of the public In the last resort, therefore, it is held that both the unhealthy activity and speculative excesses of the period of boom and the wasteful stagnation of the period of depression are due to a faulty loan-policy on the part of the banks or a faulty currency policy on the part of the government, or a combination of the two.

One objection to this explanation in its cruder forms is that the level of prices depends not only on the quantity of purchasing power issued to the public by the government and the banks, but on the willingness of the public to use the purchasing power when it has got it; and that it does not seem certain that this latter factor, especially in a time of deep depression, when everybody is determined to hoard money rather than spend it, is entirely explicable in monetary terms or controllable by monetary means. Nevertheless, there seems little doubt that a monetary policy consciously aimed at keeping the general price level approximately stable helps reduce the violence of the trade cycle.

Instabilities Inherent in the Economic Process.—The third and fourth groups of roads lead to an examination of certain real, as opposed to merely monetary or psychological, features of modern industry. The third group runs through a landscape of physical and technical features, the fourth through a landscape of legal and social ones

Consider the former by asking the question: "What rational reasons are there why industry as a whole should automatically increase and diminish the scale of its output?" and glancing at three possible lines of reply:

1. Because of a self-renewing rhythm in its real costs of production. During the later stages of a depression, there is a progressive advance in the effectiveness of labour, a progressive writing off of inflated capital charges, a progressive overhauling of methods of technique and organization, which breed renewed activity.

During the later stages of a boom there is a progressive recourse to inferior instruments of production, a progressive utilization of over-tired and recalcitrant labour, wasteful methods of management, and inferior business leadership, which ultimately breed collapse.

2. Because of variations, due to fluctuations in the bounty of nature, in the amount of agricultural produce offered in exchange for the products of industry. Normally, the effect of good harvests is to stimulate industry and of bad harvests to depress it; but there seem to have been cases where an overabundance of agricultural products leads to such a fall in their price as to impair seriously the purchasing power of agricultural producers over the products of industry, and so to induce industrial depression. Many attempts have been made to connect the trade cycle directly with a cycle of crop yields dependent on meteorological phenomena: one of the most famous was that of W S Jevons to connect the supposed ten-year period of the trade cycle with the sun-spot period.

Without accepting any such views, it is possible to hold that harvest variations, through their influence on the demand for transport and in other ways, have frequently exercised an important influence in moulding the shape and the intensity of the trade cycle.

3 Because of variations in the intensity of the desire for the fixed instruments of production and transport—buildings, machinery, railways, aircraft, ships, etc. These instruments are large and expensive; they take a long time to construct, but once a batch of them is constructed, it serves to satisfy the increased needs of the community for many years.

Investment in such instruments is therefore discontinuous, and their rate of output especially variable; and variations in the prosperity of the trades making them react severely on other trades.

Instability Resulting from Organization of Industry.—Finally there are certain legal and social features of modern industry which have been held to promote instability of prices and output.

1. There is first the fact of competition, which aggravates miscalculation, since individual producers do not gauge correctly the share of an increased market which will fall to their own lot, nor the effect which their rivals' action will have in driving up their own costs of production.

2. There is secondly the wage system, which may lead to a real disharmony between the interests of the employing class, which dictate the course of production, and those of society as a whole.

For generally speaking the employer has more interest in intensifying production during a boom and curtailing it during a depression than the workman, who suffers during the boom from speeding-up and during the depression from unemployment.

3 Finally, many economists have pointed to the unequal distribution of wealth, which in the view of many writers leads to a chronic tendency to oversaving, manifesting itself during the boom in the construction of more instruments than will be able ultimately to find remunerative employment, and during the depression in, among other things, a piling up of idle bank-balances.

(For the Keynesian theory of unemployment relating to the trade cycle *see* UNEMPLOYMENT).

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(D. H R.; X)

TRADE FACILITIES. In Great Britain the trade facilities scheme formed part of the remedial measures laid before the house of commons by the coalition government of the United Kingdom in the autumn of 1921. Prices were then at their lowest; trade was acutely depressed, and unemployment had reached an alarming figure.

One of the factors retarding the recovery was the difficulty experienced in raising capital, and it was proposed to use the credit of the government to overcome the obstacle The Trade Facilities act of 1921 empowered the treasury to guarantee the principal and interest, or either the principal or interest, of loans for capital purposes. No loans could be made by the treasury, but with the aid of the government's credit the applicant would of course be able to borrow his requirements on exceptionally favourable terms Under the original act the aggregate amount to be guaranteed was fixed at £25,000,000, but by subsequent legislation the amount was added to from time to time. The act of 1926 raised the total to £75,000,000 and extended the period of operation to March 31, 1927.

Results of the Scheme.—The extent to which advantage was taken of the scheme affords some indication of the stimulus which it gave to industry and to employment. The quarterly return issued for the period ending March 31, 1927, gave the total figure of guarantees approved by the treasury, after deduction made on account of applications sanctioned but subsequently cancelled by the applicants, at £74,251,780. The greater part, in fact about two-thirds of the whole, was given for enterprises in Great Britain A remarkable proportion went to the shipping industry, mainly for new shipbuilding. A considerable percentage was also allocated for railway development, the London underground group alone having obtained some £12,500,000 for improvements and extensions. Another prominent category was electrical propositions both at home and overseas. Unquestionably, therefore, the undertaking of many projects of diverse kinds was expedited.

A cognate scheme relating especially to imperial development and arising out of the discussions at the Imperial Economic conference of 1923, was also embodied in the Trade Facilities acts (act of 1924). The treasury was empowered, subject to certain terms and conditions, to make a contribution of an amount not exceeding three-quarters of the interest payable in the first five years of the currency of a loan raised in the United Kingdom by or on behalf of any public utility undertaking in any part of the empire overseas An important condition required that the expenditure should be in anticipation of expenditure which would normally have been incurred at a later date.

The scheme had currency for three years from its commencement (*i.e.*, to May 14, 1927) and the maximum amount payable by the treasury was not to exceed £5,000,000. Contributions sanctioned under this scheme, spread over periods of three to five years, were in round figures £148,000 to the Sudan government in respect of two schemes for the purchase of railway materials; £29,000 to the government of Newfoundland for the same purpose, and £37,000 to Western Australia for the purchase of a new ship

(W H. CL.)

TRADE FORECASTS. The expressions "trade forecast," commonly used in Great Britain, and "business forecast," commonly used in the United States, are synonymous and, unless qualified, refer to the outlook for business as a whole in a given country in the immediate future for, say, a period of not more than a year or a year and a half. The terms "trade" and "business" are used in their broadest sense to include all branches of economic activity General forecasts are, of course, frequently supplemented by specific forecasts for sections of a country and for industrial groups, individual commodities, security markets or money conditions

In most cases, a business forecast begins properly with an appraisal of conditions at the time of forecast and follows with a prediction of the direction and magnitude of the movement during the immediate future. Such a forecast may include estimates of prospective variations expected to appear with the round of the seasons, and the "normal," or long-time, growth that is expected from one year to the next assuming no disturbing influences. But since it is a well-known fact that business oscillates widely between periods of prosperity and periods of depression, estimates of seasonal variation and the growth element are not usually the factors of primary importance in a business forecast.

Ordinarily, the chief object of the forecaster is to predict the time of occurrence and the direction of the next major business swing. If the fluctuations were regular in timing, forecasting would be easy.

However, a study of past business variations shows their pattern to have been very irregular and complex, hence it is extremely difficult to predict the nature of the next movement. Faced by this fact, various forecasters have developed different methods of attempting to foretell the future course of business.

Types of Forecasts.—In the United States, Roger Babson was one of the earliest business forecasters to gain prominence. He based his predictions upon the theory that, in economic life as in physics, *action and reaction are equal;* in other words, that any deviation upward from the trend is destined soon to be offset by an equal deviation below the trend.

The *analytical school* of forecasters holds that the only method giving any hope of success is first to analyze existing conditions with extreme care, and then to determine by the application of economic principles what results are probable. The difficulties inherent in this method are: first, to secure information which is really adequate; second, to determine what weight is to be given to each factor; and third, to avoid being influenced by prevailing public opinion.

Forecasters of a third school base their predictions primarily upon *observed sequences* in the movements of variables. For example, one may have noted that, when iron production increases until the percentage of all iron furnaces in operation reaches a given figure, the stock market has reached its peak. Another may have discovered that fluctuations in volumes of new orders received for goods precede by a fairly definite period corresponding movements in the production of goods. Still another may have found that changes in prices of certain goods antedate changes in the total output of industry. Certain investigators have learned that variations in sunspot areas are followed by corresponding fluctuations in the volume of American factory output.

Frequently the forecasting device consists of composites or ratios of several different factors. The chief obstacle interfering with the success of forecasting on a sequence basis is that causal forces often change radically in relative importance, and that the time lag between cause and effect frequently varies widely at different periods.

Forecasters of a fourth school are commonly called *chart readers*. They base their predictions upon the fact that, in historigrams (graphs representing time series), it frequently happens that patterns repeat themselves. The difficulty in applying this method is that, in many cases, the expected repetition fails to materialize.

Forecasters of a fifth school base their predictions upon the existence of *periodicity* in the fluctuations of business. They hold that the apparent irregularity of the business cycle is illusory, and that, in reality, it is composed mainly of a number of series of cycles, each series having a constant wave length and amplitude.

Cycles having wave lengths averaging respectively 11½, 9½, and 3½ years are held to be dominant It is admitted, however, that other forces, either irregular or of unknown wave lengths and amplitudes, interfere very materially with forecasting based solely upon this method.

Some forecasters belong to the *eclectic* school, and make use of two or more of the methods mentioned above

Development of Forecasting.—The extensive application of scientific methods to the field of business forecasting appears to have had its beginning in the United States in the first decade of the 20th century.

During the period immediately following the World War, this movement met with general acclaim, and many persons believed that the art would soon be perfected.

Great institutions of learning such as the London School of Economics, the University of Cambridge, the University of Paris, the University of Padua, the University of Rome, and Harvard university sponsored attempts at forecasting.

In the United States, leading financial journals and statistical agencies published regularly business forecasts of one kind or another Gradually, however, it became clear that despite the great advance which had occurred in statistical technique and the tremendous increase in available statistical material, no one had yet succeeded in developing a really efficient system of forecasting. For this reason there arose a marked tendency on the part of scientists to decry all attempts at forecasting.

Furthermore, universities and statistical organizations became chary of expressing any definite opinions about the future course of business, and tended to confine their activities in this field to the study of those relationships among economic variables which presumably might prove useful to forecasters More and more, the publication of specific forecasts has come to be confined to individuals and organizations specializing in this line

Nevertheless, despite the current tendency in scientific circles to avoid predictions concerning the future, it seems certain that attempts at forecasting will continue as long as business exists, for, consciously or unconsciously, the business executive must make a forecast every time that he decides to buy or sell anything Any assistance which science can give him in improving the accuracy of his forecasts is, therefore, welcome, for it helps to increase his profits.

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TRADE MARKS. A "trade mark" may be defined as a symbol, consisting in general of a picture, a label or a word or words, applied or attached to the goods of a trader for the purpose of distinguishing them from the similar goods of other traders, and of identifying them as his goods, or as those of his successors, in the business in which they are produced or put forward for sale

A trade mark differs in its legal character both from a patent and from a copyright In the case of a trade mark the property and the right to protection are in the device or symbol adopted to designate the goods to be sold, and not in the article which is manufactured and sold.

The article is open to the whole world to manufacture and sell and all that the owner of the trade mark is entitled to prevent is such use of his mark by other traders as will lead purchasers to buy, as his, goods which are not his.

On the other hand, patent-right and copyright protect the substance of the article, and any unauthorized manufacture of it in the former case, or reproduction of it in the latter, while the protection lasts, is prohibited.

The grounds, however, on which trade marks, patent-right and copyright obtain legal recognition, though they are to a certain extent dissimilar, have a common element

Patent-right and copyright rest upon the view that the results of the original labour of the inventor and the author ought, as a matter alike of justice and of public policy, to be secured against piracy; while, as regards the proprietor of a trade mark, the question of originality does not arise so long as the mark is sufficiently distinctive really to identify his goods and, for purposes of registration, to satisfy the Trade Marks Acts

In truth, the registration of a trade mark is rather the recognition of a fact than the grant of a privilege (Kerly and Underhay, *Trade Marks Act*, 1905. p 3)

The law as to trade marks as well as that as to patents or copyright is based on a man's rights to have guaranteed to him the profit derivable from his own property.

British Trade Marks Before the Registration Acts.—English trade-mark law practically commences with the first years of the 19th century. The use of trade marks was indeed of far earlier date, for in 1742 we find Lord Hardwicke declaring that "every particular trader had some particular mark or stamp But in the very case in which Lord Hardwicke made that statement (*Blanchard* v *Hill*, 2 Atkyns, 484) he refused to protect the "Great Mogul" stamp on cards, being apparently under the influence of the notion that the legal recognition of trade marks would involve the creation of a new species of monopoly. But although the actual law of trade marks cannot be traced farther back than the beginning of the 19th century, Lord Eldon repeatedly granted injunctions to restrain one trader from fraudulently "passing off" his goods as those of another, and thus laid a foundation on which the present law has been built up. It was decided by Lord Cottenham in 1838, in the leading case of *Millington* v. *Fox* (3 Myline and Craig 338), that an injunction to restrain the infringement of a trade mark could be obtained, even although the defendant had acted without fraudulent intent. On the common law side, on the other hand, fraud was an essential ingredient in the cause of action, and remained so till the fusion of law and equity by the Judicature Acts.

The effect of Lord Cottenham's decision in the case of *Millington* v. *Fox* clearly was to recognize a right of property in trade marks, and the action for infringement became a familiar species of litigation. Under the then existing law, however, the plaintiff in such actions generally found himself in a very disadvantageous and unsatisfactory position The basis of his action was the reputed association between his trade mark and his goods This association the defendant—often a person of no means—would deny, and it had to be proved as a fact by witnesses at a cost to the plaintiff which there was little hope of his recovering. Moreover, even if the trade mark proprietor secured a judgment in his favour, it carried with it no immunity from the obligation of again establishing his right to the mark against any subsequent infringer who chose to dispute it. To complete this statement of the shortcomings of the law before the Merchandise Marks Act, 1862, it should be noted that the infringement of trade marks—except in cases where the seller of spuriously marked goods cheated the buyer—was not a criminal offence.

Under the Registration Acts.—Provision was first made for the registration of trade marks by the Trade Marks Registration

Act, 1875. This act was a considerable success, but no provision was made under it for the registration of words unless they either were old marks or were registered in combination with one or more of the "essential particulars" prescribed by the act, such as a distinctive device, heading, mark, label or ticket. These limitations excluded from registration most of the trade marks ordinarily in use.

The Patents, Designs and Trade Marks Act, 1883, remedied this defect besides altering the law in other important respects. The act of 1883 was amended in 1888 on the recommendation of a committee presided over by Lord Herschell. Neither the act of 1875 nor those of 1883 and 1888 altered the common law definition of a trade mark, nor contained any definition of the term. The description in the acts of what was registrable as a trade mark led to much litigation, and the interpretations of the judges left commercial men dissatisfied on three points: (1) The number of good and valuable trade marks which were not registrable; (2) that on allowing registration the Patent Office insisted on disclaimers which hampered the owner in obtaining protection in the Colonies and foreign countries; (3) that there was no effective period of limitation to attacks on registered trade marks, because, though registration for five years was declared conclusive by sec. 76 of the act of 1883, the powers of the court to rectify the register could be invoked even after the lapse of the five years (*re Gestetner's Trade Mark*, 1907, 2 Ch. 478). In re-enacting and enlarging the provisions of the act of 1875 the act of 1883 laid down certain essential particulars of one at least whereof a trade mark must consist to be registrable The act of 1883 first provided for "word marks," and included among them "a fancy word or words not in common use" (sec 64 [1] [c]).

The expression "fancy word," used in the act of 1883, gave rise to considerable difference of opinion. It was interpreted by the court of appeal as equivalent to "obviously meaningless as applied to the article in question," or "obviously non-descriptive." In accordance with this interpretation, the words "gem" for guns, "melrose" for a hair restorer, "electric" for velveteen, and "washerine" for a soap were all held not to be registrable. On the recommendation, however, in 1887, of a committee appointed by the Board of Trade, and presided over by Lord Herschell, the expression "invented word" was substituted for "fancy word" by the act of 1888.

In 1905, 1907, 1914 and 1919 the statute law as to trade marks was amended and remodelled A bill was introduced in 1905 at the instance of the London Chamber of Commerce, and after consideration by a select committee became the Trade Marks Act, 1905. This act repeals the bulk of the provisions of the Patents, etc , Acts of 1883 and 1888 with respect to trade marks, and embodies them with amendments in a separate statute.

The Act of 1905.—This differs from the preceding acts in containing a definition of trade mark for the purposes of the act unless the context otherwise requires; *viz.*, that it "shall mean a mark used or proposed to be used upon *or in connection* with goods for the purpose of indicating that they are the goods of the proprietor of such mark by virtue of manufacture, selection, certification, dealing with or offering for sale"; and "mark" is defined as *including* "a device, brand, heading, label, name, signature, word, letter, numeral or any combination thereof" (sec. 3). The act, modifying to the extent indicated in italics the acts of 1883 and 1888, prescribes (sec. 9) that a trade mark to be registrable must contain or consist of at least one of the following essential particulars:

1. The name of a *company*, individual or firm represented in a *special* or particular manner (under the act of 1883 it has been held that the name must be in the nominative case, and that ordinary printing is not representation in a particular manner).

2. The signature of the applicant for registration or some predecessor in his business. It is not clear that this includes descriptive trading styles.

3. An invented word or words.

4. A word or words having no *direct* reference to the character or quality of the goods, and not being *according to its ordinary signification* a geographical name *or a surname*.

5. *Any other distinctive mark; but a name, signature, or word or words other than such as fall within the descriptions in the above paragraphs 1, 2, 3 and 4, shall not, except by order of the Board of Trade or of the court, be deemed a distinctive mark.* By distinctive, is meant "adapted to distinguish in Great Britain, not in foreign markets (*In re Gallahero Application*, 1924, 41 T L.R 139) the goods of the proprietor of the trade mark from those of other persons", and "in determining whether a trade mark is so adapted the tribunal may in the case of a trade mark in actual use take into consideration the extent to which such user has rendered such trade mark in fact distinctive for the goods in respect of which it is registered or proposed to be registered" Where the mark is limited to specified colours, that fact may be taken into account in deciding whether the mark is distinctive (sec. 10).

Trade marks containing the essential particulars are not registrable if they contain any matter which would by reason of its being calculated to deceive or otherwise be disentitled to protection in a court of justice or would be contrary to law or morality, or any scandalous design (sec. 11).

Old marks are registrable, *i.e.*, any special or distinctive word or words, letter, numeral or combination of letters or numerals, used by the applicant or his predecessors in business before Aug 14, 1875 (sec. 9). In the case of new marks, but not of old marks, a trade mark is not registrable except by order of the court in respect of any goods or description of goods which is identical with a mark already on the register with respect to such goods or description of goods, or so nearly resembles such registered mark as to be calculated to deceive (sec. 19). The expression "calculated to deceive" has been considered by the courts in very many cases It is not merely or chiefly the retailer or dealer who has to be kept in view when the question of the likelihood of deception is under consideration The courts have regard also, and mainly, to the ultimate purchaser whom the trade mark may reach, and careless or unwary persons are considered as well as those who are careful and intelligent. The judge's eye is the ultimate test as to the degree of resemblance that is calculated to deceive, although expert evidence on the point is admissible The following words have been held to give rise to a probability of deception and confusion. "Oxot" with "Oxo" (meat extract: *Oxo, Ltd.* v. *King*, 34 R.P C. 135); "Nuvol" with "Nujol" (heating or lubricating oils: *In re McDowell's Application*, 1926, 43 R.P.C. 313); "Anzora" with "Onsoria" (hair cream: *Lewis* v. *Vine and Vine's Perfumery Co.*, 32 R P.C. 12); "Peps" with "Pan-Pep" (cough pastilles: *In re United Chemists Association's Trade Mark*, 1923, 40 R.P.C. 219); "Anchola" with "Anchovette" (fish pastes and potted meats. *In re Wade and Co.'s Application*, 33 R.P C. 320); "Limit" and "Summit" (shirts and collars: *In re Smith* [Thomas A], *Ltd's Application*, 30 R P C. 363); "Lavnoma" with "Lavona" or "Lovona" (toilet preparations: *Tokalon, Ltd.* v. *Davidson and Co*, 32 R P.C. 133).

Invented Words.—An invented word need not be wholly meaningless, nor is it disqualified because words may have suggested it Thus "mazawattee" was held to be an "invented word," although the latter part of it was a Sinhalese term meaning "estate," and there were estates in Ceylon (*In re Densham's Trade Mark*, 1895, 2 Ch 176), having names ending with "wattee" from which tea came, and in a leading case on the construction of the clauses under consideration (*Eastman Co's Trade Mark*, 1898, A.C. 571), the word "solio" was held to be registrable as a trade mark for photographic printing paper under both clauses, although it was objected that "soho" was equivalent to "sunio." "Savonol" for soap (*J. C. and J. Field, Ltd* v. *Wagel Syndicate, Ltd.*, 1900, 17 R.P C. 266), "tachytype" for typographical and composing machines (*In re Linotype Co.'s Application*, 1900, 17 R.P.C. 380), have been held to be invented words. But the following have been held not invented: "uneeda" (=you need a). *In re National Biscuit Co.* (1902; 1 Ch 783); "absorbine" for an absorbent preparation (*Christy and Co.* v. *Tipper and Son*, 1905, 21 R.P.C. 97, 775); "biscope" (*Warwick Trading Co.* v *Urban*, 1904, 21 R.P.C. 240); "cyclostyle" (*Re Gestetner's Trade Mark*, 1907, 2 Ch. 478); and *cf. In re Kodak and Trade Marks*

1903, 20 R.P.C. 337; "lactobacilline" for a lactic ferment (*In re La Société Le Ferment's Application* [1912], 81 L.J., Ch. 724).

Identical marks (except old marks) may not be registered in respect of the same goods, or goods of the same description, for two different persons (sec 19); and where several applicants make rival claims to identical marks the registrar may refuse to register until their rights have been determined by the court or settled by agreement in manner approved by the registrar, or, on appeal, by the Board of Trade (sec. 20). In the case of honest concurrent user or of other special circumstances making it proper so to do, the court (or registrar, act of 1919, sec. 12, sched 2), may permit the registration of the same mark or of nearly identical marks for the same goods by more than one owner, subject to such conditions or limitations, if any, as to mode or place of use or otherwise as the court (or registrar) may think it right to impose (sec 21).

New provisions were made in 1905 as to what are called "associated trade marks" Where registration is sought for a mark so closely resembling a mark of the applicant already on the register for the same goods as to be calculated to deceive or cause confusion if used by any one but the applicant, the registration of the mark may be conditional on entering both marks as associated trade marks (sec. 24).

In the case of combined trade marks provision is made for registering as separate trade marks the part in which the applicant has exclusive rights, and as associated marks trade marks of which the exclusive portion forms a part (sec. 25).

A series of trade marks of the same owner may be registered on one registration as associated marks (sec. 26).

Provision is made for allowing the registration of marks used upon or in connection with goods by an association (or person) which undertakes the examination of goods in respect of origin, material, mode of manufacture, quality, accuracy or other characteristic, and certifies the result of the examination by marks used upon or in connection with the goods. These marks cannot be registered unless the Board of Trade consider their registration of public advantage. Their registration is not conditional on the association or person being a trader or having goodwill in connection with the examination or certification. The registration gives the association or person the rights of the owner of a registered trade mark, except that assignment and transmission needs permission of the Board of Trade (sec. 62).

In respect of cotton piece-goods, marks consisting of a line heading alone or a word alone are not registrable, and no word or the heading is treated as distinctive in respect of such goods. In respect of cotton yarn the same rule applies with respect to words, and no registration of any cotton mark (in respect of cotton piece goods or cotton yarn: Trade Marks Act, 1914, sec. 1) gives any exclusive right to the use of a word, letter, numeral, line, heading or combination thereof (sec. 64 [10]).

By sec. 68, which is a re-enactment of sec. 105 of the Patent, etc., Act, 1883, it is made illegal for any person without the authority of the King to use the royal arms in any trade in such a manner as to create the belief that he has authority so to do.

Registries.—The central register of trade marks is kept at the Patent Office, Southampton buildings, London, and is under the charge of the comptroller-general of patents, designs and trade marks, who is appointed by, and acts under the superintendence of, the Board of Trade, and has a deputy—the registrar of trade marks. There is a branch registry at Manchester, whose chief officer is the keeper of cotton marks, which deals with all applications for the registration of trade marks for cotton goods falling within classes 23, 24, 25 in sched. 3 of the Trade Marks Rules, 1906.

There is a branch at Sheffield containing the marks for metal goods ("Sheffield marks") registered by persons carrying on business in or within 6 m of Hallamshire. The care of this register is vested in the Cutlers' company, who are substituted for the comptroller as to registration of "Sheffield marks" (sec 63). Applications made to the company are notified to the registrar, and may not be proceeded with if he objects. Any person aggrieved by the registrar's objection may appeal to the court. Applications made to the registrar for metal marks are notified to the Cutlers' company. Persons aggrieved by the decision of the Cutlers' company have an appeal to the courts (sec. 64).

A trade mark must be registered in respect of particular goods or classes of goods (sec 8). The procedure for obtaining registration is regulated by the acts of 1905–19 and the statutory rules made thereunder (March 9, 1920, and Sept. 29, 1925). The registrar has power to refuse applications or accept them absolutely or subject to conditions, amendments and modifications (sec. 12). His discretion is not absolute, but subject to the provisions of the act (*Re Birmingham Small Arms Co.'s Application*, 1907, 2 Ch 396), and must not be unreasonable or capricious (*Eno* v. *Dunn*, 1890, 15 A.C. 252; *Registrar of T.M.* v. *W. and G Du Cros, Ltd*, 1913, A.C 624; *In re Garrett*, 1916, 1 Ch. 436). He must, if required, state his reasons, and his decision is subject to appeal to the Board of Trade or the court at the option of the applicant (sec. 12 [3]).

"New marks" may not be placed on the register except by order of the court for any goods or description of goods which are identical with marks already on the register with respect to the same goods, etc, or so nearly resemble a registered mark as to be calculated to deceive (sec 19).

Applications as accepted are advertised, the advertisements state the conditions, if any, imposed on acceptance (sec. 13). Notice of opposition to the registration of a trade mark may be given under sec. 14 of the act of 1905 (which replaces sec. 69 of the act of 1883). The registrar after consideration decides whether the opposition is well or ill founded. His decision is subject to appeal to the High Court or by consent of the parties to the Board of Trade (1905, sec 14 [5]).

There may be added to any one or more of the "essential particulars" above enumerated any letters, words or figures, or a combination of these. But the right to the exclusive use of the added matter must be disclaimed A man is not required, however, to disclaim his own name, or trade name, or that of his place of business, if the name appears in the mark.

The register may be corrected on the request of the registered owner of a trade mark as to errors or changes of address in the name of the registered owner, or by cancelling entries of marks or by striking out classes of goods for which a mark is registered or by entering disclaimers or memoranda as to a mark, provided that they do not extend the rights given by the existing registration (sec 33).

A registered trade mark may be altered or added to in matters not substantially affecting its identity (sec. 34). A registered trade mark may be taken off by order of the court on the application of a person aggrieved, on the ground that it was registered without a *bona fide* intention to use it in connection with a particular class of goods, and that there has not been any such *bona fide* user, or that there has been no such *bona fide* user during the five years preceding the application. Non-use may be excused if proved to be owing to special circumstances and not to any intention not to use or to abandon the use of the mark (sec. 37). (See *Re Hare's Trade Mark*, 1907, 24 R.P.C. 263.)

The register may be rectified by order of the court on the application of any person aggrieved, or in the case of fraud in registration or transmission of the mark on the application of the registrar (s. 35).

Effect of Registration.—Registration is effective for 14 years but is renewable (sec. 28). The registration if valid gives the proprietor the exclusive right to the use of the mark on or in connection with the goods in respect of which it is registered (1905, sec 39). This rule is subject to the following qualifications. (*a*) Where two or more persons are registered owners of the same or substantially the same mark in respect of the same goods, no one of them shall as against any other of them have any right of exclusive user except so far as their respective rights have been defined by the court. (*b*) Registration of a trade mark does not entitle the proprietor to interfere with or restrain the use by any person of a similar mark upon or in connection with goods upon or in connection with which such person has by himself or his predecessors in business continuously used such trade mark from

a date anterior to the use of the mark by the registered proprietor, or to object to the registration of the other man's similar mark for concurrent user.

In all legal proceedings relating to a registered trade mark registration is *prima facie* evidence of validity, and after seven years from the original registration, or seven years from the passing of the act of 1905, whichever shall last happen, the original registration shall be taken to be valid in all respects unless it was obtained by fraud, or the mark is disentitled to protection as being calculated to deceive or (act of 1919, sec. 6 [11]) is the only practicable name of an article or substance manufactured under an expired patent. No word which is the only practicable name of any single chemical element or compound is registrable as a trade mark. This provision does not apply to a mark denoting only the proprietor's brand or make of such substance (act of 1919, sec. 6 [2]).

Registered trade marks are assignable and transmissible only with the goodwill of the business concerned in the goods for which they are registered, and are determinable with the goodwill (sec. 22). Associated marks are assignable and transmissible only as a whole and not separately (sec. 27). The owner of a registered mark may assign the right to use his registered mark in any British possession or protectorate or foreign country in connection with any goods for which it is registered, together with the goodwill of the business therein of such goods (sec. 22).

The assignments, etc., on proof of title, are recorded on the register (sec 33). It is a condition precedent to an action for the infringement of a new trade mark that the plaintiff should be the registered proprietor of the mark at the time when the action comes on for hearing. This last provision of proprietorship does not apply to an action for "passing-off". In actions for infringement, evidence of passing off, or that the infringing mark is calculated to deceive, is not necessary. The court decides on the probability of deception by inspecting and comparing the marks (*Hennessy* v. *Keating*, 1907, 24 R.P.C. 485).

The right to a trade mark lapses if the mark ceases to be distinctive and becomes *publici juris*; if it is separated from the goodwill (a trade mark can only be assigned with the goodwill); if the mark is applied by the trader to spurious goods (as where boxes of cigarettes were so labelled, in conformity with an alleged custom of the trade, as to indicate that they were of Russian manufacture, which was not the fact); or when the mark is abandoned (temporary disuse, however, is not abandonment unless the mark has in the meantime become associated with the goods of another trader); or where, as in the "linoleum" case (7 Ch D. 834) it has become the name of the goods, and so merely descriptive; or after 14 years where registration is not renewed. In dealing with a claim for infringement the court must admit evidence of the usages of trade as to the get-up of the goods for which the mark is registered, and of any trade marks or get-up legitimately used with such goods by other persons (sec 43).

The Trade Marks Act, 1919, provided for the registration in a separate division (Part B) of the register of trade marks, of a new class of trade marks, viz, marks which for not less than two years had been *bona fide* used in Great Britain in connection with any goods whether for sale in Great Britain or for exportation abroad, in order to indicate that they are the goods of the proprietor of the mark (sec. 2). Such registration is *prima facie* evidence of exclusive right to the use of the trade mark (sec. 4). The use of the word "Anzac" with any trade, business, calling or profession without the authority of a secretary of State, or the request of the Government of Australia or of the Dominion of New Zealand, is prohibited by a statute passed in 1916.

International Arrangements.—The Trade Marks Act, 1905, applies to the British Islands. By the international convention for the protection of industrial property (*see* PATENTS), which was signed at Paris in 1883, and revised at Washington in 1911, the signatory States (others have since acceded) agreed that the subjects or citizens of each State should, in all the other States, enjoy as regards trade marks and trade names the advantages that their respective laws then granted, or should thereafter grant, to their own subjects or citizens. So far as Great Britain is concerned the provisions made for carrying out this convention are contained in sec. 65 of the Trade Marks Act, 1905, and in sec 91 of the Patents and Designs Act, 1907 The effect of that section is to confer on an applicant for the protection of a trade mark in one of the other contracting States a priority over other applicants for registration in Great Britain during the space of four months. The section does not, however, exempt the applicant from the conditions and formalities incumbent on ordinary applicants for registration in Great Britain; nor does the fact that the foreign application has been successful of itself give the applicant a right to have his mark accepted for registration. Guatemala and Salvador, also signatory parties, have withdrawn from the convention.

The following is a list of the British Orders in Council that have been issued, applying to foreign countries sec 91 of the Patents and Designs Act, 1907: Austria, Hungary, May 17, 1909 (art. 237 of Austrian Peace Treaty; as to Hungary, art 220 of Treaty of Trianon); Belgium, June 26, 1884; Brazil, June 26, 1884; Bulgaria, July 14, 1921; Cuba, Jan. 12, 1905; Czechoslovakia, March 11, 1920; Danzig, Free City of, Nov. 21, 1921; Denmark (including the Faroe Islands), Nov 20, 1890; Dominican Republic, Oct 21, 1890; Ecuador, May 16, 1893; Estonia, Feb 20, 1924; Finland, Oct. 11, 1921; France, June 26, 1884; Germany, Oct 9, 1903; Greece, Oct 9, 1924; Honduras, Sept. 26, 1901; Italy, June 26, 1884; Japan, Oct. 7, 1899, Latvia, Oct. 12, 1923; Luxembourg, July 14, 1922; Mexico, May 28, 1889; Morocco Protectorate (French), Feb. 12, 1918; Netherlands, June 26, 1884 (East Colony), Nov. 17, 1888 (Curaçoa and Surinam), May 17, 1890; Paraguay, Sept. 24, 1886; Poland, Nov. 25, 1919, Rumania, Oct. 13, 1920; Yugoslavia, July 14, 1921; Spain, June 26, 1884; Sweden (and Norway), July 9, 1885, Switzerland, June 26, 1884; Syria and Lebanon, Oct. 9, 1924; Tunis, June 26, 1884; Turkey, Oct 12, 1925; United States, June 12, 1887; Uruguay Sept. 24, 1886.

By Orders in Council, made under the provisions of the Foreign Jurisdiction Acts, penalties have been imposed on British subjects committing offences against the Imperial Trade Mark Acts or the Orders in Council issued thereunder, e.g., Abyssinia; China and Korea (1904); Egypt (1899); Muscat (1904); Turkey (1899); Persia, Persian coasts or islands (1889–1901); Siam (1906); and Zanzibar (1906). Penalties for offences against the trade mark laws of British India are contained in the Bahrein, Muscat and Somaliland Orders in Council.

The following is a list of the orders issued as to British possessions: Australia, Commonwealth of, March 26, 1907; British India, Oct. 13, 1920; Canada, Oct 11, 1923; Ceylon, Aug. 7, 1905; New Zealand, Feb. 8, 1890; South Africa, June 25, 1918; Trinidad and Tobago, Aug 12, 1907. These Orders in Council are printed in the Index to the *Statutory Rules and Orders Revised*, in force up to Dec. 31, 1927

Colonial Trade Mark Laws.—The British Colonies generally follow the model of English trade mark legislation.

Legislation on trade marks is one of the subjects which the Commonwealth of Australia Constitution Act, 1900 (sec 9, pt v, 51, xviii.) places within the exclusive competence of the Federal parliament. By the Commonwealth Trade Marks Act, 1905, sec. 20, provision is made for registration of trade marks throughout the Commonwealth, and subject to this act and other Commonwealth legislation the common law of England as to trade marks is applied throughout the Commonwealth *See* also the Commonwealth Acts, 10 of 1912 and 7 of 1919, and 25 of 1922, extending the English acts, 1905–19 to territories under the authority of the Commonwealth.

In Canada the law as to trade marks (*Rev. Stats.* c. 63) has been regulated by Dominion acts, similar to English statute. The following colonial laws also are based on imperial legislation: British Guiana, 27 of 1914; Ceylon, 15 of 1925; Cyprus, 1920; Union of South Africa, 9 of 1916, chap. iii; Nigeria, 1910; Mauritius, 8 of 1913; Sierra Leone, 17 of 1913; Trinidad and Tobago, 15 of 1913.

Trade marks are excluded from the legislative powers of the Government of Northern Ireland (Government of Ireland Act, 1920, sec. 4 [1] [13]), not from that of the Irish Free State

Free State, Constitution Act, 1922, sched. 16 [8]), which has established its own law of trade marks by the Industrial Property Protection Act, 1927 (No. 16 of 1927).

United States.—Provision for the registration of trade marks in the United States was first made by an act of Congress of 1870, but that enactment was subsequently declared invalid by the Supreme Court (*U.S.* v. *Steffens*, 1879, 100 U.S. 82), on the ground that the Constitution of the United States did not authorize legislation by Congress on the subject of trade marks, except such as had been actually used in commerce with foreign nations, or with the Indian tribes. Congress legislated again on the subject in 1881 (act of March 3, 1881, Revised Stats., U.S. secs. 4,937–47). The act of 1881 was repealed by an act of Feb. 20, 1905 (sec. 592), which, as modified by an act of May 4, 1906, now regulates the subject. A trade mark may be registered by the owner if he is domiciled within the United States, including all territory under the jurisdiction and control of the United States (sec. 29), or resides or is located in any foreign country which by treaty, convention or law affords similar privileges to citizens of the United States (sec. 1). The right of persons domiciled in the United States was in 1906 extended to owners of trade marks who have a factory in the United States, so far as concerns the registration, etc., of trade marks used in the products of the factory (1906, sec. 3).

Registration and the protection that registration assures do not include trade marks which. (*a*) comprise scandalous or immoral matter; (*b*) consist of or comprise the flag or insignia of the United States, or of any State or municipality, or of any foreign nation, (*c*) are identical with another known or registered trade mark owned and used by another and appropriated to merchandise of the same description, or so nearly resemble such other marks as to be likely to cause confusion or mistake in the mind of the public or to deceive purchasers; (*d*) consist merely in the name of an individual, firm, corporation or association, unless it is written, printed, impressed or woven in a particular or distinctive manner, or is associated with a portrait of the individual; (*e*) consist merely in words or devices descriptive of the goods with which they are used, or of the character or quality of such goods, or merely of a geographical name or term; (*f*) contain the portrait of a living individual unless his consent is evidenced by an instrument in writing.

Decisions of the examiners on applications or oppositions are subject to appeal to the commissioner of patents, and from him to the court of appeals for the District of Columbia (secs. 8, 9). The general jurisdiction in trade mark cases is given to the Federal courts below the Supreme Court, which has power by certiorari to review the decisions of circuit courts of appeal upon such cases (secs. 17, 18). The maximum protection given by registration is 20 years. The protection given to marks already registered in a foreign country lapses when the mark ceases to be protected in the foreign country (sec. 12). Certificates of registration are issued under the seal of the Patent Office.

Other Countries.—In France (laws of June 23, 1857, and March 3, 1890) trade marks are optional, but may be declared compulsory for certain specified articles by decrees in the form of administrative orders. The decrees regulating registration are of Feb. 27, 1891, and Dec. 17, 1892. The following are considered trade marks: Names of a distinctive character, appellations, emblems, imprints, stamps, seals, vignettes, reliefs, letters, numbers, wrappers and every other sign serving to distinguish the products of a manufacture or the articles of a trade. By legislation of Aug. 1, 1905, and July 11, 1906, provision is made for marking certain classes of commodities, mainly food products, to prevent falsification and the sale of foreign products as French. *See* also law of March 9, 1911, ratifying the convention between France and Japan for the mutual protection of trade marks in China.

Under the German trade mark law of May 12, 1894, any person whatsoever can acquire protection for a trade mark, and all foreigners in Germany are placed on an exactly equal footing with Germans in the eyes of the law, so long as they have a domicile (*Niederlassung*) within the State, *i.e.*, a place of business or a residence which involves the payment of German taxes. The registration of a trade mark expires *ipso facto* after ten years from its date, but may be renewed for a similar period. *See* also laws of June 2, 1911, and May 12, 1924, and regulations of April 30, 1920.

The following other foreign trade mark laws may also be noted *Austria*, law of 1890 (published in Vienna on Jan. 6, and in Budapest on April 6, 1890), and amending laws of July 30, 1895, which enactment protects additions to trade marks, and Jan. 17, 1913, and law of May 24, 1919, providing for the renewal of trade marks under the old law *Denmark* (law of April 11, 1890, an amending law of Dec. 19, 1898, which enabled traders to register words or figures, provided that these are not indicative of the origin, kind, use, quality or price of the goods, and a law of April 29, 1913, permitting associations to register collective names, and a law of Nov. 13, 1903, as to Iceland) *Japan* (law of July 1 and regulations of July 2, 1899, and law of April 1, 1921). For offences against the Merchandise Marks Acts or Trade Marks Acts *see* MERCHANDISE MARKS

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TRADE ORGANIZATION. Whenever businessmen have been reasonably free to ply their trade, they have associated themselves together in commercial and industrial organizations of varied character and purpose. The gradation in types of organization, membership requirements, functions, activities, size, complexity of tasks performed, geographical coverage, influence and controls exercised is infinite. It varies imperceptibly from the local, sporadic informal meeting to the compactly organized national peak associations or *Spitzenverbände* that in many countries have wielded major influence on public policy and have controlled their membership through legal, financial or other sanctions implemented by the compulsory powers of government.

Three major types of trade organizations stand out: (1) The oldest and most widespread are the chambers of commerce which in commercial nations substantially match in coverage the important units of political power, national, state or provincial, and local. (2) The most important in their impact upon prices, sales, output and technology are frequently the associations of manufacturers and traders organized according to industries or products. (3) Most varied are those in the miscellaneous category of associations, the technical and research institutes, the professional organizations, the scientific bodies, the better business bureaus, the credit and cost bureaus, traffic associations, labour unions, farmers' organizations, producer and consumer co-operatives, etc.

Chambers of Commerce.—Known also by such names as commercial associations, boards of trade, development associations, prosperity boards, community leagues and the like, chambers of commerce are voluntary organizations embracing firms, public officials, professional men and public-spirited citizens of a locality or area.

They are not only interested in publicizing, promoting and developing commercial, industrial and civic opportunities but also seek to improve community schools, streets, housing, public works, fire and police protection, parks, playgrounds, recreational and tourist facilities, etc.

International Chamber of Commerce.—Trade associations at times provide the basic instrumentality through which international industrial agreements are negotiated. They frequently engage in international activities such as serving in a consultative capacity to the United Nations Economic and Social council or having meetings with trade associations of similar interests in other countries. Indeed, several trade unions and trade associations bear the name "international" merely because they have members in as few as two countries; *e.g.*, the United States and Canada.

But the one organization comprehensively international in scope and most appropriately so named is the International Chamber of Commerce Founded in 1919, it is a world federation of business organizations, business firms and businessmen It frequently "acts as spokesman of the business community in the international field and presents the business point of view to governments and to world public opinion" It was correspondingly granted the highest consultative status with the Economic and Social council of the United Nations, that of category A Its national committees "undertake appropriate action as regards their own governments" Its working committees and commissions, composed of qualified experts and expert business executives, look for practical solutions to problems in such fields as commercial and financial relations, production and distribution, transport and communications, and law and commercial practice In addition to publishing quarterly a magazine called *World Trade*, it operates a court of arbitration which provides conciliation and arbitration facilities for the settlement of commercial disputes for members of disparate nationalities In about 87% of the cases, on the average, its awards are accepted and executed

Trade Associations.—Trade associations usually limit their membership to business firms engaged in a particular branch of industry, trade or service enterprise Moreover, they rarely extend their activities beyond national boundaries Indeed, in many cases a substantial portion of their effort is devoted to measures, legislative or associational, to keep foreign competition out, or to bring it satisfactorily under control.

In terms of function there are two main types of trade associations (1) those which confine themselves to voicing the views of their members on matters of common interest, and (2) those which exercise some measure of control over their own members The latter in many countries make extensive use of voluntary, voidable "live and let live" agreements for controlling prices, output and channels of distribution In some instances trade association arrangements go beyond price and output stabilization and involve rationalization measures designed to control productive capacity

In a few notable instances such trade association activities have been endorsed by government fiat with sanctions applicable not only to recalcitrant members but even to nonmembers.

The overwhelming majority of trade associations are of the first type They prefer self-government of industry by consent rather than coercion. They avoid any attempts to stifle competition or to bar new entrants by means other than suasion and full information. Thereby they gain the advantages of good will, elasticity of operations and maximum possible membership

Other Types of Associations.—The functions performed by miscellaneous trade associations organized on a voluntary basis are numerous According to a trade association survey by the Temporary National Economic committee, the activities most frequently reported by trade associations in 1941 as of major importance were (in order of rank): influencing governmental bodies, especially making representations concerning tariffs, taxes and other matters before administrative, executive and legislative groups, trade promotion, product advertising, commercial research and market development; standardization and simplification of nomenclature, product lines, specifications, quality and performance; holding of annual conventions and other meetings, propagation of accepted trade practices and elimination of unfair competition, collection and dissemination of trade information and statistics by means of bulletins, periodicals, handbooks and trade directories; education of members in employer-employee relations and techniques, issuance of special research monographs and statistical studies; technical assistance; public and consumer education including demonstrations, displays, exhibits, clinics, etc.; accounting and auditing aid, including cost estimating, inventory control, evaluation schedules and utilization of uniform accounting manuals; credit service; traffic and transportation assistance including provision of freight handbooks, routing information, trade customs, etc.; collecting and spreading information on members' prices and bids including open price filing with or without waiting period, commercial arbitration facilities; bill collection assistance, and information with respect to patents, trade-marks, designs and styles.

UNITED STATES

Chambers of Commerce.—The oldest chamber of commerce in the United States is that of the state of New York, formed in 1768 According to its charter, dated 1770, its object was "to carry into execution, encourage and promote by just and lawful ways and means such measures as will tend to promote and extend just and lawful commerce." The first city chamber was formed in 1773 in Charleston, S C

The Chamber of Commerce of the United States, "a national federation working for good citizenship, good government and good business," was founded in 1912 By the 1950s it had about 20,000 members including more than 2,300 affiliated local chambers of commerce, approximately 70 state and 40 local trade associations and 30 local employers associations as well as national and regional trade associations Its various departments provided information and advice on all items of controversy between business and government, notably regulatory measures, expenditures, tariffs, taxes, labour-management relations, etc Its monthly magazine, *Nation's Business*, enjoyed a large circulation as did its research publications, committee reports, special bulletins and annual booklet on policies advocated by it

U.S chambers of commerce were established in several large foreign cities, notably London, Paris, Rome, Rio de Janeiro, Mexico City and other important commercial centres abroad Their range of operations and effectiveness have varied with the regulatory measures imposed upon foreign commerce Barriers to international trade mushroomed everywhere during the depression of the 1930s They were multiplied by autarchic totalitarian regimes In the U.S., they were continued during World War II by a variety of agencies including the Combined Raw Materials board, the War Food administration and agencies of the Office of Economic Warfare. Despite the U.S. reciprocal trade agreements program the barriers persisted after the war because of changing currency and commodity control arrangements fostered by such forces as rising nationalism, the dollar shortage, austerity programs, Marshall plan, restrictions on trade with countries beyond the "iron curtain" and military security measures.

In addition there were about 30 foreign chambers of commerce in the United States at mid-20th century, of which the largest, the French, founded in 1896, had approximately 500 members.

Trade Associations.—Although several trade associations of modern character were founded prior to the Civil War, notably the National Association of Cotton Manufacturers in 1854 and the American Iron and Steel institute in 1855, they did not become common until the 1870s and 1880s.

The name institute instead of association is frequently used by trade organizations primarily engaged in technical tasks and headed by a career official with a contract running for three to five years; *e.g.*, the Cotton Textile institute or the Coal Mining Institute of America. It may also indicate an independent or subsidiary association engaged principally in educational services as, for example, the American Institute of Banking created in 1900 by the American Bankers association to conduct classes for employees and junior officers

Many of the early associations were short-lived. Some of them were interested in price-fixing, in agreements to limit or divide output or sales territory or in arrangements to apportion profits. With the passage of the Sherman Anti-Trust act in 1890 and the advent of the holding company, the combine, the Gary dinners, (dinners, attended by steel executives, held at Judge Elbert H. Gary's home in New York, N.Y., from 1903 to about 1912; on such occasions economic conditions in the steel industry were discussed, and stabilization of steel prices ensued), etc., the trade association changed its focus to co-operation in product standardization, market research, statistical compilation, united lobbying for tariffs and other governmental aids, together with unified opposition against proposals considered directly or indirectly detrimental to the trade

In the Standard Oil and tobacco cases of 1911, the supreme court

held that only unreasonable restraints of trade were illegal. Certain trade association promoters, notably A J. Eddy in his book *The New Competition*, published in 1912, devised an open-price scheme tailored to fit the new situation. Market information and statistics on production, sales prices, costs, inventories, bids, unfilled orders, etc., were sent to the trade association and summarized there in the form of totals or averages which were published by the association, by its trade journal, and later by the department of commerce in its monthly *Survey of Current Business* Thus members could compare their own operations with that of the trade

By this type of co-operative competition, purposeless market instabilities resulting from ignorance were eliminated, an advantage promptly seized upon by the Bridge Builders society in the iron and steel industry in 1911, by the Yellow Pine association in 1912, and subsequently by many others.

Because of the active encouragement of the War Industries board during World War I, the number of trade associations increased from 800 in 1914 to 2,000 in 1919 During the next decade the role of fostering the associations was taken over by the department of commerce under Secy Herbert Hoover and by the Federal Trade commission, especially through the technique of the fair trade practice conference

With the passage of the National Industrial Recovery act in 1933, many trade association executives became code authorities. Fair trade practice codes written for the most part by trade association committees acquired the force of law As a result their numbers grew in two years by more than a third Despite the setback that came in 1935 when the act was outlawed by the supreme court their numbers increased greatly so that by 1938 there were about 1,000 national and trade associations and about 6,500 state and local associations

Trade associations continued to grow during World War II exactly as they had during World War I. By 1948 the total number was estimated in a survey by the department of commerce to be close to 12,000. Even the American Trade Association Executives (ATAE) had more than 1,200 members and was putting out an imposing list of studies and publications. In that survey no fewer than 27 types of national associations were recognized in the United States, of which 14 were primarily business in character

In the metal products group there were, in addition to about 100 professional associations, about 450 trade associations The largest, the National Automobile Dealers association, had 32,000 members In the food and tobacco category the figure was 250 national, about 1,000 local and 60 professional organizations In the textile, apparel and leather classification there were 280 national trade associations and 45 professional In the lumber, furniture and paper industries the figures were 200 and 20, respectively.

In transport and public utilities there were about 100 national associations and 90 professional ones The largest, the American Trucking associations, had 40,000 members, including 60 state and local associations The Association of American Railroads had a staff of 625 handling such matters as tariffs, passenger and freight services, terminals, bridges, power supply, grade crossings, employee training, co-operative advertising and, of course, governmental relations

In the chemical and rubber group about 100 national trade associations and 40 professional organizations were enumerated In the stone, clay and glass classification the figures were 100 and 20 respectively, one of the largest being the Portland Cement association which, with a staff of more than 500, for several years contested vigorously the Federal Trade commission proceedings against certain features of the basing point system

Between 40 and 60 national trade associations and usually about 40 professional organizations were listed in each of the following groups: printing and publishing, finance and real estate (including the National Association of Real Estate Boards with 42,000 members, arch foe of rent and housing controls), advertising, insurance (the National Board of Fire Underwriters had a staff numbering more than 850 persons), petroleum, coal and gas, hotels, and amusements (herein the Allied States Association of Motion Picture Exhibitors with 3,500 theatres organized into 17 regions).

Trade association activities have waxed and waned with governmental policy. After being supported by the War Industries board during World War I, they were set back when the supreme court ruled against the Hardwood Lumber Manufacturers association in 1921 and the Linseed Crushers' council in 1923. They recovered when the supreme court in 1925 marked out the permissible bounds of statistical, standardization and uniform cost accounting activities in the Maple Flooring Manufacturers association and Cement Manufacturers' Protective association cases.

At no time did trade associations enjoy as much leeway as the government permitted them to have under the National Recovery administration (NRA) They put into the codes of fair competition practically all the things they had wished to do for decades Of the first 500 codes approved, 79% provided for practices tending to establish minimum prices and 72% prescribed uniform methods of cost accounting; 57% required open-price filing, many of them with a waiting or intimidation period; 45% fixed discount and credit terms; and 27% laid down basing point or other formula systems for handling delivered prices and freight charges Those that complied were allowed to display the blue eagle emblem Recalcitrants were punished. The codes, in short, gave the public a vivid, if brief, demonstration of monopolistic tendencies

Governmental policy later swung toward vigorous enforcement of the antitrust laws From June 1, 1935, to October 1, 1939, the Federal Trade commission and the department of justice brought more than 120 complaints or indictments against trade associations and secured convictions or consent decrees in all but three During the next seven years the antitrust division initiated 100 additional suits involving trade associations. Not only were all forms of price-fixing, output allocation, market sharing, defensive combinations preventing free entry, and boycotts frowned upon, but the validity of antitrust prohibitions was asserted in new fields, notably in the cross-licensing of patents, in the use of uniform basing systems of price quotation, and in the activities of Webb-Pomerene associations

National Association of Manufacturers.—The N A M., founded in 1895, had at mid-20th century about 17,000 member firms, or approximately 8% of all manufacturing establishments in the United States, employing about half of the industrial workers and producing more than half of total manufacturing output. Affiliated with the N A M. were about 200 local and national employers' associations having about 60,000 members. The purposes of the N A M. were stated to be threefold. (1) to develop and promote sound industrial practices; (2) to foster industrial trade both at home and abroad; and (3) to create favourable public and government support in matters relating to industrial interests.

During the period 1933 to 1941, the N.A.M opposed as contrary to free enterprise 31 out of 38 major legislative enactments The seven approved were. the Reconstruction Finance corporation loans to small business, the Housing Authority act making direct loans to business, the National Housing act of 1934, the Corporate Reorganization act (Chandler act) of 1938, the U.S. Housing act (Wagner-Steagall act) of 1937, the Miller-Tydings act and the 1939 reduction in capital gains tax and corporate surtax. In the post-World War II period the N.A M. supported the termination of price controls and the passage of the Taft-Hartley law.

So far as federal fiscal policy is concerned, the N A M almost from the date of its founding continuously urged balanced administrative federal and state budgets and substantial reductions in government expenditures. Internationally, while opposed to the International Trade organization as "in direct conflict with American principles of free competitive enterprise" it supported the European Recovery program, extension of multilateral trade, special protective measures for U.S. private capital invested abroad, removal of trade and travel barriers, free convertibility of currencies, elimination of quantitative trade restrictions and the abandonment of monopoly and cartel trade philosophy. It also advocated "reasonable effort to encourage international economic understanding and co-operation through the Economic and Social Council of the United Nations."

National Industrial Council.—The first predecessor of this

organization was the Citizens' Industrial Association of America founded in 1903 to combat trade unionism. The second was the National Council of Industrial Defense founded in 1908 within the N A M , and renamed in 1919 the National Industrial Council. In 1918 the N A M. in conjunction with 18 national industrial associations organized the National Industrial Conference board (N I C B), a research agency which through the years issued a number of books, pamphlets and regular periodicals

In 1936 the N I C was reorganized and its members grouped into three classes The first consisted of state industrial associations, carrying out on a state basis about the same program that the N A M advocated nationally. The second class was employers' associations which had arisen in all the important manufacturing cities of the United States to present a locally united employer front to deal with trade unions in regard to wages, hours and conditions of labour. The third group was primarily national trade associations; *e g* , the National Metal Trades association.

Miscellaneous Associations.—Among the thousands of associations in the miscellaneous category appreciably affecting trade organization in the United States, only a few will be mentioned There were at mid-20th century, for example, more than 100 general associations, such as the Cooperative League of the United States of America, a member of the International Co-operative alliance, which in 1950 reported a membership of 100,000,000 families in 31 countries Under the Cooperative league, six major national groups were reported, the Credit Union National association (13,000 credit unions, 5,000,000 members), the National Rural Electrical Cooperative association (1,000 R E A co-ops, 3,500,000 members), the National Cooperatives, Inc , with 25 regional cooperative federations of wholesalers, 16 regional co-operatives with 4,500 local co-ops and 3,000,000 members, the North American Student Cooperative league (300 campus co-ops, 50,000 members), and the National Cooperative-Mutual Housing association (50 co-op housing projects, 20,000 members) There were in addition about 7,000 local building and loan associations, represented by the United States Savings and Loan league (*see* also Co-operation).

Furthermore, in 1948 there were 85 better business bureau associations, the largest of which was the National Better Business bureau with 1,100 to 1,200 local bureaus There were 65 commodity and stock exchanges, the oldest (1792) and the largest (1,300 employees and 1,375 members) being the New York Stock exchange. In addition, there were 160 foundations, many of which such as the Battelle Memorial institute or the Mellon Institute of Industrial Research were engaged in business and technical research

Farmers, too, were well-organized, there being about 55 farm organizations at mid-century. The oldest, the National Grange, founded in 1867, had 8,000 local granges comprising roughly 800,000 families. The largest, the American Farm Bureau federation, founded in 1919, had 18,000 locals and represented 1,250,000 farm families. Third in size was the National Farmers union, founded in 1902, with 450,000 member families. Influencing the marketing of fruits, vegetables, nuts, sugar, livestock, etc , were such marketing organizations as the California Fruit Growers exchange with 14,500 members and 227 local affiliated organizations, the Hawaiian Sugar Planters association and the National Live Stock Producers association. (*See* also Agricultural Cooperation)

Influential, likewise, were the more than 200 labour associations, of which the oldest was the American Federation of Labor, founded in 1881, with a membership at mid-century of about 8,000,000 workers in 60,000–70,000 locals. Its chief publication was *Labor's Monthly Survey*. In 1955 about 40 national trade unions, including the steel and automobile unions, split off to form the Congress of Industrial Organizations It reported a membership in 1951 of roughly 6,000,000 workers. It published the *CIO News* weekly.

Most important among the unions outside the two large federations were the railway brotherhoods with more than 1,000,000 members, publishing the influential weekly newspaper *Labor*. Among other independent unions of national importance were the United Mine Workers of America, the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America, the International Ladies Garment Workers' union and the International Longshoremen's and Warehousemen's union (*see* also Trade (Labour) Unions).

GREAT BRITAIN AND THE COMMONWEALTH

Trade organizations in Britain differ from those in the United States and elsewhere in three important particulars (1) They devote considerable effort to foreign commerce In other countries, foreign trade tends to be the specialty of a handful of import and export groups (2) British trade organizations, at least prior to 1932, spent less time advocating domestic tariffs and other legislative and administrative restrictions. (3) Their relations with government, while manifold and intimate, steadily took to the middle course of mutual consultation and collaboration

Chambers of Commerce.—Primary interest in foreign trade stands out clearly in the provisions of the founding charters and in the typical activities of British chambers of commerce The earliest ones were formed in Jersey in 1768 (the same year in which one was organized for the state of New York), in Glasgow in 1783, in Dublin in 1785 and in Edinburgh in 1786 In 1794 the "Commercial Society" of Manchester was founded with the objects of obtaining increased safety for trade and more regular payments, and of co-operating jointly in all applications to government After 1801 it ceased to hold meetings but was revived in 1820 as the Manchester Chamber of Commerce Closely allied with it was the Manchester Importers and Exporters association Other important chambers were established at Belfast (1796), Birmingham (1813), Newcastle-upon-Tyne (1818), Liverpool (1851), Sheffield (1857) and London (1881).

London Chamber of Commerce.—The London Chamber of Commerce is not only the largest but the most powerful chamber in the Commonwealth of Nations In its direct membership are leaders of British foreign trade, manufacturing, merchandising, banking, insurance and shipping

The London Chamber of Commerce is divided into 69 sections according to overseas countries, commodities or trades, or special problems such as transport rates and services, commercial law, arbitration or education. Representative of its special committees devoted to trade with special geographic areas is its Far Eastern committee. Illustrative of its special purpose committees is the London Court of Arbitration, which was jointly formed in 1892 and became jointly managed by the London Chamber of Commerce and the corporation of London It consists of 12 representatives from each body. While it does not hear cases, it appoints qualified arbitrators to deal with the disputes referred to it.

One of the major tasks of the London chamber, like that of British chambers of commerce generally, is to recruit and train young men and women to carry on commerce. It conducts examinations for certification in commercial subjects and grants scholarships enabling chosen students to study languages and commercial conditions abroad.

Chambers of Commerce in the Commonwealth.—The earliest colonial chamber (not counting that of New York, founded eight years before the American Revolution) was the Commercial Exchange of Capetown, founded in 1804 and renamed in 1861 the Capetown Chamber of Commerce. In the 1830s chambers were organized in British India—at Calcutta (1834), Bombay and Madras (1836) and Ceylon (1839) In 1840 chambers were formed in Australia (Adelaide) and Jamaica; in 1845 in Canada (Toronto)

Extensive organization both geographically and industrially took place in the Union of South Africa, mostly after the British model The national co-ordinating body is the South African Federated Chambers of Industries, with nine affiliated regional chambers of industries and many affiliated trade groups such as the food, lumber, oil expressers, and master printers associations. There are in addition scores of employers' organizations covering such trades and industries as diamond cutting, iron and steel, bus transport, radio, brewing and coal. Finally there are a few trade unions united in the *Suid-Afrikaanse Vak-en Arbeidsraad*.

In Canada there were in 1948 about 844 main organizations plus 672 branch associations of various kinds, in many cases tied in with and organized according to the associational pattern in the United States. The Canadian Chamber of Commerce, Inc , was not formed until 1926. But the Canadian Manufacturers' association founded in 1871 preceded the organization of the U.S. N.A.M. by nearly a quarter of a century In 1948 its membership included 150 boards of trade, 5 trade associations and 350 firms and corporations

Nearly a century elapsed after the founding of chambers of commerce in Britain and elsewhere before intra-empire organization was attempted It was not until 1860 that the Association of British Chambers of Commerce was formed, having at first only 16 members Several decades elapsed before it became a major channel for authoritative advice and appeal to the government. It remained a loose federation of local bodies

The formation of top associations in the other members of the British Commonwealth was delayed until the 1920s. These top organizations not only have their own chambers of commerce in London, *e.g*, Canada and Australia, but from 1886 sent official delegates to a series of congresses The congress held in 1886 was convened by the London chamber Representatives of 97 bodies attended from all parts of the commonwealth. At the third congress in 1896, 162 chambers took part

In 1911 a permanent body was established called the British Imperial Council of Commerce, later renamed the Federation of Chambers of Commerce of the British Empire. It convened congresses at intervals of three years. Work prior to World War II was ancillary to that of the imperial conferences and the imperial shipping and economic committees together with the Empire Marketing board.

British Chambers of Commerce in Foreign Countries.—These chambers advise and assist British diplomatic and consular officers and strive in general to promote British trade They vary in membership, some being closed to non-British business representatives, others admitting them subject to varying conditions Up to World War II they flourished in all parts of the world, and were particularly strong in China. The pressure of Communist-controlled governments, however, caused a number of British chambers of commerce abroad to cease operations, notably in the U.S.S.R. and China.

Foreign Chambers of Commerce in Britain.—Reciprocally, foreign chambers of commerce are free to organize and carry on normal activities in Great Britain and generally throughout the commonwealth. Most of the leading commercial countries of the world are thus represented in London Akin to such foreign chambers of commerce are those interested in the trade of special areas such as the China association or the British Merchants' Morocco association Among later bodies of this kind may be mentioned the British and Latin American Chamber of Commerce founded in 1916 and open to all firms in the United Kingdom or in Latin America.

Trade Associations.—There are three well-developed types of industrial associations in Britain: (1) those which primarily devote themselves to technical, scientific and informational tasks; (2) those which are likewise concerned with the regulation of prices, output, sales, etc.; (3) those which exist almost solely for purposes of collective bargaining with their workpeople or trade union representatives.

Prior to the outbreak of World War I British trade associations were mostly of the first type. During World War I, however, the government actively promoted the formation of associations for equitable distribution of raw materials, etc They grew so rapidly in number and influence that a committee on trusts was set up in 1919 to make a report Despite its finding that trade associations "may within no distant period exercise a paramount control over all important branches of British trade," it recommended, as did the Balfour committee on industry and trade ten years later, against antitrust laws. Under Sir Alfred Mond's sponsorship of "rationalization," trade associations took on control functions.

Beginning with the Coal Mines act of 1930 and the Comprehensive Tariff acts of 1931–32, government progressively prescribed compulsory cartelization. Regional sales agencies in the coal industry by force of law set minimum prices and allocated production quotas.

The Import Duties Advisory committee compelled a number of industries to eliminate domestic competition, giving trade associations such as the British Iron and Steel federation control over prices, output, capacity, exports, etc. Industry control of production and marketing was recognized also in the Agricultural Marketing acts of 1931–34, the Sea Fishing act of 1933, the Sugar Industry Reorganization act of 1935 as well as the Finance act of that year. For example, under the Cotton Spinning Industry act of 1936 the Cotton Spindles board was set up with powers to require a contribution (deductible from income for tax purposes) from the whole industry if proceeds were used to buy up redundant machinery

Federation of British Industries.—The active spearhead of the new power exercised by trade associations was the Federation of British Industries. Membership grew steadily from the original 350 firms and 62 associations banded together in 1916 to more than 6,000 in 1950. More than 280 trade associations also belonged, representing about 90% of all the productive industries in the country. Its most important activity was to expand that which its predecessor, the Employers' Parliamentary council, was set up to do in 1898—namely, "to take action with respect to any bills introduced in either House of Parliament, affecting the interests of trade, of free contract, and of labour, or with respect to the action of imperial or local authorities affecting in any way such interests "

In 1946 the F B I. was divided into 10 regions with 14 district offices. Each region has a regional council of leading industrialists, meeting six times a year, who maintain close contact with the policy work of the F B I., act as bodies of reference to the employer members on the regional boards for industry, and consider local industrial problems.

The director general's office of the F B.I. was divided into five departments The general secretary takes care of the press, publicity, publications, public relations, the secretariat, finance, etc The economic director, in charge of the economic advisers' department, provides information and assistance on national and international finance, foreign exchange, payments agreements, Marshall plan aid, price control legislation and policy, resale price maintenance, tariffs, quotas, etc Its technical director supervises four sections dealing with industrial research, education and design; fuel economy, trade effluents and smoke abatement; transport by road, sea, rail and air; and taxation, company law, patents, contracts and town and country planning Its deputy director general maintains a special insurance section; a travel service taking care of tickets, hotel reservations, itineraries, passports and visas both for British industrialists abroad and foreigners in Britain, a section handling exhibitions, trade openings, etc Most important is the overseas director under whom are sections handling problems of trade with the empire, the U S , Latin America, Europe, the near east, etc ; also international trade policy, dollar exports and overseas markets In addition there were more than 100 F.B I. overseas representatives at mid-century.

All policy of the F B I is determined by the grand council composed of one representative from each federation district, one from each association with 20,000 employers, one from each firm with 40,000 employees. This governing body is termed a "Parliament of Industry."

The international activities of the F.B I. at mid-century included membership on the board of trade's consultative council for industry discussing policy questions such as the European Recovery program, or proposals for liberalization of inter-European trade, or the European Payments union. Together with the British Employers' confederation, it represented British industry on the Council of European Industrial Federations, an advisory body to the Organization for European Economic Cooperation (O.E.E.C). It also represented industry on the National Production Advisory Council on Industry (N.P.A.C.I) of which the chancellor of the exchequer was chairman. Nominees of the F.B.I. and the British Employers' confederation acting jointly

served on the Economic Planning board. It was also a member of the Anglo-American Council on Productivity and of the Dollar Exports board.

Employers' Associations.—In 1950 there were in Great Britain about 2,500 associations of employers, matching at local, district and national levels trade unions in geographic, occupational and industrial coverage The National Confederation of Employers' Organizations is the counterpart of the General Council of Trades Union Congress

Miscellaneous Organizations.—Closely akin to credit and collective bureaus elsewhere are the trade protection societies affording special facilities for the collection of debts Their national body is the Association of Trade Protection Societies of the United Kingdom.

In addition there are chambers of trade, mostly local bodies made up of firms in the distributive trades They are linked together by the National Chamber of Trade, organized in 1897 and supplemented by the Incorporated Association of Retail Distributors, founded in 1920

Furthermore there are produce markets, some of which were established as far back as the middle of the 18th century; *e g*, the "Baltic" (Baltic Mercantile and Shipping Exchange Ltd) dealing chiefly in shipping (charter parties) and grain, and the corn and coal exchanges of London

The Liverpool Corn Trade association, providing a future market for wheat and maize and controlling the wheat trade of the port, was established a century later (1853) and the London Corn Trade association in 1878. The London Produce Clearing House Ltd, founded ten years later, handles forward contracts in coffee, sugar and many other items. The Liverpool Cotton association assumed its modern form in 1882

Co-operatives.—The modern consumers' co-operative movement began in Rochdale, Eng., in 1844. Each stockholder was permitted only one vote, goods were sold at regular prices, and patronage refunds were made on the basis of volume of purchases. Gradually the co-operative began to produce some of the things it sold—flour, meat, shoes, preserves, vegetables, furniture, etc. The British Cooperative Wholesale society by mid-20th century did the largest commercial business in the British commonwealth, serving more than 2,000 retail stores which in turn did more than one-sixth of Britain's retail business and had as members roughly 45% of the families in Britain and 55% of those in Scotland.

In addition there were co-operative farm supply organizations, fishery co-operatives, co-operative housing societies, dairy and other agricultural co-operatives. The top organization for all co-operatives is the Co-operative union (*see* also CO-OPERATION).

Industrial Research Organizations.—In 1918 the Department of Scientific and Industrial Research was given funds to aid industrial research. A Council of Research Associations was formed, with membership open upon approval to the research association of any industry seeking to improve its industrial techniques. By 1950 nearly 40 were listed, embracing for the most part industries such as rubber, rayon, coal tar, metals, flour jute, lace, launderers, motors, etc.

The British Government and Trade Organization.—Government in the mercantilistic period of British history regulated business and trade at every turn. Against this regimentation Adam Smith's *Wealth of Nations,* published in 1776, amounted to an economic declaration of independence. British manufacturers and the activities of the Manchester school gradually accomplished the repeal of the Corn laws, and changed government policy to one of *laissez faire.*

By 1880, however, the government began to take a renewed interest in foreign trade. It appointed commercial attachés to embassies and legations. By 1900 a commercial intelligence branch was set up in the board of trade. In 1908, in response to recommendations of the Colonial conference, trade commissioners were appointed in Canada, Australia, New Zealand and South Africa. In 1917, partly because of the exigencies of World War I, a department of overseas trade was set up, a joint department of the foreign office and board of trade

In the period between World Wars I and II the department of overseas trade grew steadily and the number of trade commissioners multiplied. Imperial trade correspondents were set up. In foreign countries, the commercial diplomatic service was substituted for commercial attachés with commercial counsellors in the higher grades and commercial secretaries in the lower grades Beginning in Oct. 1919 the consular service was absorbed Thus the department of overseas trade had groups and sections both of geographic and of commodity experts.

The main function of the department and of the three overseas services is to promote export trade by providing full particulars of specific sales opportunities and of general economic and commercial affairs. The former are transmitted directly to interested manufacturers and traders; the latter are published in the *Board of Trade Journal,* a weekly established in 1886 whose files constitute an authoritative record of commercial events, regulations, tariffs, etc, all over the world. Moreover, the reports made by the trade commissioners, commercial diplomatic officers, or consular officers are compiled for each district and published in regular annual series. British businessmen abroad ordinarily keep in close contact with government overseas officers. These in turn are systematically called home to renew and widen their contacts in the department and in the business community.

The department is likewise responsible for organizing the British Industries fair. From 1915, except for interruptions during World War II, it was held annually in London and Birmingham (controlled in the latter city by the Birmingham Chamber of Commerce) At these fairs British goods are displayed, orders are solicited from bona fide buyers, and the public is admitted at special hours The department is also responsible for official participation in international exhibitions. Beginning in 1919 a series of export credit schemes were tried. At first advances were made to exporters without recourse in respect to shipments to European countries with chaotic currencies and finances. In 1921 the coverage was extended to all countries except Russia, but the export credits department guaranteed payment of only a proportion of bills of exchange. In 1926, upon recommendation of a committee of inquiry consisting of bankers and others, an export credit insurance system was set up whereby the department insured the payment at maturity of a proportion, not exceeding 75%, of bills of exchange drawn upon approved importers overseas in respect of goods manufactured in the United Kingdom

Beginning in 1920, with the organization of the Imperial Shipping committee (dealing with such matters as the rebate system and liability clauses in bills of lading), a series of British empire organizations were set up, each with more extensive and intensive control over foreign trade In 1925 the Imperial Economic committee was organized to make surveys and publish reports on such items as meat, dairy produce, fish, poultry, etc. In 1926 the Empire Marketing board began providing publicity on empire trade such as the *Weekly Fruit Intelligence Notes* and conducted scientific research and economic inquiries. It was advisory to the secretary of state for dominion affairs.

By 1932 governmental policy in the Ottawa agreements, abandoning free trade, set up imperial preference tariffs and other instruments of mercantilistic planning. These were greatly extended during the depression, unavoidably multiplied during World War II, and continued in the postwar period under the impact of such forces as successive devaluations of the pound, continuance of food import subsidies, pressure for exports, liquidation of British investments abroad, disruption of east-west trade, loss of the China market, granting of independence to India, emergency controls set up under the Marshall plan, and reorganization and redirection of world trade Restrictions and planning, national and global in scope, were adopted by the Labour government (1945–1951) with no more than token opposition.

FRANCE

Chambers of Commerce.—From the time of their establishment, French chambers of commerce served as agencies of official administrative control and management of public commercial institutions, including inland waterways, ports, etc. In 1599 the city of Marseille established the first *chambre de commerce*

and empowered it to settle the merchant law and customs of the port, to appoint consuls and run the French consulates in the Levant, to equip expeditions against corsairs, to send embassies to the Barbaresque countries and to organize commercial missions. In 1700 Louis XIV, at the suggestion of Jean Colbert, caused an *arrêté* to be published ordering chambers of commerce to be created to nominate deputies to the royal council of commerce in Paris Most large cities soon had them, including Lyons, Rouen, Bordeaux, Lille, Bayonne, La Rochelle, Toulouse and Amiens

The French Revolution brought about a complete change in type of government control. Chapelier's law of 1791 forbade all types of economic association Chambers of commerce, however, were soon legalized again. By Napoleon's decree of 1804 (revised and codified in 1898 and 1908), chambers of commerce could be established, but only by a decree countersigned by the minister of commerce, upon the advice of the prospective municipal council, of the general council of the department, and of the existing chambers of commerce in the district. The minister fixes the number of members each chamber can have. Only those commercial houses paying *patente*, a special tax levied upon persons engaged in trade, have the right to elect members

The chambers of commerce acquired consultative as well as administrative functions. The government was bound to take their opinions regarding regulation of commercial practices, establishment of *bourses de commerce* and tribunals of commerce, improvement of transport and communications, application of local laws, sales prices of prison-made goods, and management of local public works together with the requisite special assessments, loans or taxes. In addition there was the usual wide range of legislative, tariff, freight rates and other matters upon which the chambers might make representations which might or might not be heeded.

The administrative functions of the French chambers of commerce are extensive They may be authorized to establish and administer such institutions as bonded warehouses, public salesrooms, firearms testing establishments, commercial, professional or technical schools and museums. They may be granted concessions for public works and undertake the carrying out of public services, especially the management of ports, docks, canals and navigable rivers, under the supervision and control of the local state official During World War I they, together with the municipalities, were even allowed to issue paper money and tokens to take the place of the fractional currency that had disappeared. Under the Stabilization law of 1928 these powers were ended

Foreign Chambers of Commerce in France.—When British merchants in Paris in 1873 started what they called a chamber of commerce the French government was at first disturbed lest the public think that its powers were similar to those held by their own chambers Soon, however, all the leading commercial countries of the world had chambers of commerce in Paris and elsewhere

French Chambers of Commerce Abroad.—Beginning in 1883 the minister of commerce encouraged the establishment of French chambers abroad (which of course did not have the administra-

Trade Associations.—

National Union of Commerce and Industry was founded which included 55 industrial associations representing industries other than the building trade In 1896 there appeared the Commercial and Industrial alliance, in 1903 the Federation of French Manufacturers and Merchants, and in 1919 the *Confédération Générale de la Production Française* (C G P.F), called into existence by Étienne Clémentel, minister of commerce, "to contribute to the development of the productive power and export trade of France, and to co-ordinate the activities of the syndicates and professional associations." The signing of the Matignon agreement with the C G T. (*Confédération Générale du Travail*, national trade union organization) brought about a change in organization and leadership. The C G P F became the *Confédération Générale des Patronats Français* with a program similar to that of the N.A.M in the United States and the F B I. in Great Britain.

On the national level there developed four echelons of trade organizations The *comptoirs* such as the *Comptoir Français des Produits Sidérurgiques* were essentially cartels, regional, national or international in scope, usually centred about a single commodity or group of commodities. The *syndicats*, such as the *Comité des Forges*, were trade associations of specialized trades The federations such as the *Union des Industries Chimiques* were groups formed out of syndicates and trade associations. The confederations such as the C G P F. were combinations of closely allied federations and syndicates

At the regional level there existed district associations for a wide variety of industries. In addition there existed regional federations of local associations such as the *Fédération Départementale des Syndicats Patronaux du Bâtiment et des Travaux Publiques des Bouches du Rhône* At the top were confederations of federations such as the *Comité d'Entente des Grands Groupements* at Marseille There were other groupings of specialized employer interests difficult to classify, such as the industrial societies in cities such as Nancy or Lille whose special aim was to increase efficiency.

During World War II French labour unions were abolished by the Nazis. The many varieties of employers' associations mentioned above were grouped into "occupational families" or *groupements*.

With the defeat of Hitler, chambers of commerce and trade unions regained their prewar status but the powers of trade associations and the C G P F. were drastically curtailed The government, in response to postwar emergency problems, multiplied its controls over both foreign and domestic trade, nationalizing some industries and initiating even supranational cartelation measures in others Thus the Schuman plan set up a high authority over production and sales of the combined coal and steel industries of France, Italy, West Germany, Belgium, the Netherlands and Luxembourg with power to allocate coal in times of shortage and to remove import quotas, tariffs, discriminatory pricing arrangements and freight rates.

GERMANY

The mediaeval merchant guilds of varied local type and function were the colourful predecessors of the modern chambers of commerce and industry in Germany The *Handelsvorstande* in Frankfurt-on-Main (1707), the *Handelszukunft* in Mannheim (1728), the *Kommers-Deputation* in Hamburg (1665), the *Älteste der Kaufmannschaft zu Berlin* (1820) and the merchants corporations in Stettin, Danzig and Magdeburg were typical of those that existed long before the rulers of the individual German states legalized and regulated them in the 1840s and 1850s

In addition to voluntarily performing duties of the usual type (*e.g.*, giving information on customs and trade, conducting commercial schools, administering exchanges, harbours, public and customs warehouses, and operating arbitration courts), German chambers were required by state laws to draw up an annual economic report, nominate and swear in publicly appointed experts, weighers and assessors, and assist the courts in keeping the commercial register. To meet their expenses they were empowered in some of the states, such as Prussia and Bavaria, to levy a surtax on the regular income or profit taxes to which trade and industry were subject. In addition they obtained revenues from fees for certificates of origin, from exchange and market fees, from receipts for rent of space in their buildings, etc.

All chambers were centrally organized provincially, regionally and nationally. The *Deutscher Industrie und Handelstag*, founded in 1861, became the central organization and pattern not only for chambers of commerce and industry but for those organized abroad in considerable number, notably in South America.

Trade Associations.—German trade and industrial associ-

ations became as varied in structure and function as the feudalistic guilds whence many of them sprang They fitted together in most complicated fashion, regionally, industrially and governmentally The Central Committee of German Employers' Associations, for example, in 1938 numbered among its members 2,272 industrial, trade and financial associations organized on a national, regional and local basis These belonged to 14 central business associations which in turn were divided in 8 groups (agriculture, industry, handicrafts, transportation, commerce, banking, insurance and miscellaneous)

The earliest, though short-lived, central organization of German industrialists was the *Zentralverband deutscher Industrieller* founded in 1856, interested primarily in establishing moderate tariff protection, especially for the heavy and raw material industries

A competitor organization, the *Zentralstelle fur Vorbereitung von Handelsvertragen* was organized in 1879 to uphold the interests of the finished goods industries. It was superseded by the Industrial alliance, dating from 1895 At the beginning of World War I they were brought together by the government in the War Committee of German Industry, which in 1918 became the German Industrial council

In 1919 the powerful *Reichsverband der Deutschen Industrie* (R D I) was formed, consisting of 445 national, 58 regional and 70 local associations, 1,363 individual members, and 70 chambers of commerce and industry It was divided into 19 divisions and subdivided in 32 functional groups. Wholesale and retail trade were likewise united in the *Zentralverband des Deutschen Grosz- und Einzelhandels* with local and branch associations all over Germany Similarly the powerful *Aussenhandelsverband* dominated export trade.

Government and Trade Organization.—Throughout German industrial history the government promoted and protected German business organizations, actively enforcing private agreements for the control of production and marketing conditions A striking illustration was the Potash law of 1910, which prescribed compulsory cartelization for all potash producers, and empowered the cartel board (consisting almost solely of mine-owners) to fix minimum export prices, thus invalidating low-price sales to U.S. consumers by some American-controlled mines.

During World War I compulsory cartelization became the standard pattern set by the government. After the war it was continued in the potash, coal and electrical industries, the controlling body being a council in which employers were predominant The increasing power of trade associations, while thoroughly documented in the lengthy reports of the *Enquete-Ausschuss* or inquiry into German production and marketing conditions, was approved as necessary to national strength.

In the enabling law for the "preparation of the organic reconstruction of Germany's economic system" passed in 1934, the R.D.I. became the *Reichsgruppe Industrie*, one of seven national groups, occupying a vital place in the national economic chamber. The entire trade association network thus became subordinated directly to the national economic minister

The ministry for economic affairs was the top authority in all domestic commercial and industrial questions national in scope Cartel-type controls over prices, outputs, sale, investment, new entrants, etc., were thus universalized throughout the German economy, implemented by a highly complicated network of trade associations.

After World War II the occupational authorities attempted to decartelize German industry. The net result was failure. Although Nazi legislation such as the basic law of 1934 was repealed, the trade associations and combines continued to function along traditional lines, mostly under the leadership of prewar owners and executives.

ITALY

Many of the *Camera di Commercio* in Italy show traits of local individuality reminiscent of the mediaeval merchant guilds that flourished in Italian city states, with diverse transformations in nature and functions corresponding to the vicissitudes of Italian history The Italian economy being primarily agricultural, chambers of commerce were relatively few in number and came late, the first law to regulate them being passed in 1862.

Under Fascism they were replaced by economic provincial councils, *Consigli Provinciali dell' Economia*, in 1926 and 1927 and became not only consultative bodies for state and local administrations but organs for local execution of government policy They formulated proposals for economic development in their province, compiled and reviewed commercial usages, and supervised public institutions concerned with economic matters

They exercised numerous specific administrative and executive functions through successive administrative tiers from the minister of national economy They represented the latter in actions for fraud in trade, in effecting the registration and liquidation of companies, issuing certificates of origin and identity papers for commercial travellers, upholding trade-marks, pushing through planned development, compiling control bulletins and maximum price lists, etc.

These councils consisted of not less than 12 and not more than 28 members, some of whom were *ex-officio* members of government and public institutions and others appointed by the minister of national economy to represent economic associations and institutes of agriculture, manufactures, traders and employees The chairman was the prefect of the province. All industrial and commercial firms were compelled to register and pay taxes to support the economic provincial council

Trade Associations.—Compared with trade associations in the United States, those in Italy were unique in that they drew their membership primarily from the handicraft trades and from agriculture. They were also profoundly influenced by the economic doctrines of Catholicism They consisted largely of employer and employee organizations

The first employer organization of national scope was the General Confederation of Agriculture, founded in 1911 with about 70,000 landed proprietors as members. Its activities were spearheaded by the owners of the *latifondi* in the Po valley. In 1919 the *Confederazione Generale dell'Industria Italiana* (Confinindustria) came into existence having then about 100 member organizations

In 1950 more than 200 member organizations were reported, divided commodity-wise and on a regional basis. Of the 100 commodity associations, 19 were classified under foodstuffs, 18 in the textile group, 16 in the mechanical and metallurgical category and the remainder in 14 minor groups More than 100 *Associazione Industriale* were reported, 16 in Lombardy, 12 in Tuscany and 13 in the Piedmont area.

The first trade unions in Italy were formed about 1874. In 1912 some 408,000 agricultural workers primarily interested in modifying the *metayage* or share-cropper system, together with 453,000 industrial workers were members of three major national organizations, the General Confederation of Labour with the usual trade union philosophy, the Catholic Italian Confederation of Labour with ideas based on papal encyclicals such as *Rerum novarum*, and the Italian Syndicalist association.

Under Fascism and particularly under the Corporations law of Feb. 5, 1934, these varied types of trade associations were consolidated into the pyramidal structure of the corporate state At the local level, all workers in each occupation or trade had to join a labour syndicate, all employers an employer syndicate; 13,464 of these were centralized into 882 provincial unions which were grouped into 150 national category federations. These were further bundled together into nine national confederations, four each for employers and employees in agriculture, industry, commerce and finance with a ninth confederation for professional people. Their function was to draw up and enforce labour contracts, run labour courts, etc.

The function of planning and controlling prices, quotas, investments, etc., for business enterprise was performed by 22 corporations (one for each of 22 groups of industries) composed of delegates from each of the constituent syndicates. They in turn selected delegates who formed a part of the National Council of Corporations, the other part consisting of the Central Corporative

commission which included all the ministers and undersecretaries of state and the higher officials of the Fascist party There programs and policies of industrial and commercial control were formulated and enforced by the *fasces* of the ministry of corporations headed by Benito Mussolini

The collapse of Fascism enabled Italian trade organization to return to its pre-1926 status, except that trade unions became independent and powerful, while trade associations were divested of all planning and control functions. The associations, however, rendered conspicuous consultative and informational assistance to the government in its programs of postwar industrial reconstruction, United Nations and Marshall plan aid, currency stabilization, and large-scale economic reform.

U.S.S.R.

State ownership of the greater part of industry and transport in Russia gave trade organization there an authoritarian and pyramidal structure highly similar to that in Nazi Germany and Fascist Italy. Private enterprise is restricted to undertakings which can be managed by the owner-producer without any hired labour. The wholesale and retail distributive trades, peasant markets, bakeries, dairies, service trades, etc., are mostly in the hands of co-operatives that buy their industrial articles from the trusts or combines.

The central planning agency is the Gosplan. Although its functions and authority varied after its formation in 1921, it remained the agency responsible for drawing up plans for each industry and supervising production, investment, sales, etc., on a national, regional and plant basis. It receives its general directives from the Central Committee of the Communist Party and translates them into national goals.

These are broken down by industry and product and move down via the planning departments of the commissariats, the Glavks, the combines and the trusts to the individual plants.

Planning on the plant or enterprise level usually involves carrying out the directives of the commissariat, Glavk or trust and fulfilling the objectives—designated output in quantity and value, new investment, labour productivity, etc. The echelon above the plant level is the trust, of which there may be many in one industry—for example, more than 20 in the textile industry. They allocate raw materials, labour, credit, etc, and dispose of the output to the other state enterprises, to the co-operatives, or to the public. Usually above the trust, though by no means always, is the combine of enterprises using the same raw material or processing by-products from it. The next tier of authority is the peoples' commissariat. In 1946 there were 48, some of them all-union in coverage; *e.g.*, petroleum, chemicals, armaments, electric power, etc. Others are union-republican covering only a limited number of enterprises as determined by the supreme soviet of the U.S.S.R., *e.g.*, light industry, textiles, fish, building materials, etc. The next rung of the ladder is the Interdepartmental council and the Econom-soviet, usually headed by the chairman of the Council of People's Commissars. It issues such decrees as affect more than one commissariat and confirms the supply plans of the different industries and regions as well as general plans for the transportation and warehousing of goods.

Membership in trade unions is similarly a political and economic necessity. Nonunion members, for example, get only half the accident compensation that union workers receive Before the Revolution the trade unions and their 3,000,000 workers were the spearhead of Communist concern and agitation. They at first played an active role in the management of the factories and in constructing a Socialist state.

But between 1928 and 1935 more than 17,500,000 peasants migrated to the industrial communities. These lacked orthodox trade-union background The old trade unionists had become managers, bureaucrats or party officials

Gradually a complete change was effected in trade-union policy and functions (signalled by the suicide of Tomsky, life-long friend of Lenin, veteran leader of the trade union movement, and member of the Politbureau). The new program centred about united effort to make and surpass new production goals in all industries; to increase differential wages; to improve "labour discipline", to organize "shock brigades"; to promote "socialist competition"; to regulate safety and to administer efficiently the social security and welfare programs of the state; to operate schools for children attached to the factories, rest homes, and bathing beaches, to sponsor recreational activities; to provide for lectures on Soviet policy and Stakhanovism, to participate in state and communal activities such as housing and food distribution; and to help in political campaigns.

OTHER COUNTRIES

Japan.—Japanese industrialization was fostered by government "hot-house" methods during the Meiji era according to European pattern. In the 1880s several industrial associations were founded notably the *Dainippon Boeki Rengokai* (cotton spinners) founded in 1882, the *Dainippon Orimono Kyokai* (textile industry) founded in 1885, and the *Dainippon Sanshi Kai* (silk-yarn industry association) founded in 1892 which soon had more than 300,000 members. As early as 1897 a law was passed making it compulsory for the manufacturers in each branch of industry to form associations for the "purpose of jointly abolishing deficiencies."

In 1931 the *Kanto Sangyo Dantai Rengokai* or National Confederation of Industrial Associations of Japan was founded with 39 member-associations. In the same year there was enacted a Major Industries Control law by which a bureau of rationalization was set up in the ministry of commerce and industry with power to compel nonmembers to obey the rules which "self-governing" associations set up for control of prices, outputs sales, investments, exports, etc Four years later there were some 662 such associations or guilds covering enterprises in more than 70 industries. In 1941 all firms, trade associations and cartels were further centralized under "control associations," which were operated directly by the Imperial Rule Assistance association

Brazil.—With the growth of industrialization in Brazil following World War I, trade organizations multiplied rapidly By 1940 there were dozens of chambers of commerce including 16 regional *Associação Comercial*. There were 27 employers' federations, including even a *Sindicato dos Bancos*. Even labourers were beginning to organize on a national scale in *União Geral dos Trabalhadores do Brasil*.

Mexico.—The top organization among Mexican chambers of commerce is *Confederación de Cámaras Nacionales de Comercio e Industria*. By the Chambers of Commerce and Industry act in 1936 every businessman industrialist with a capital of 500 pesos or more was required to inscribe himself in the national register In addition there is the *Confederación Patronal de la República Mexicana* representing employers in such industries as wool, mining, petroleum, etc. In the *Confederación de Trabajadores de México* at mid-20th century were enrolled nearly 40% of all the trade-union membership in the Confederation of Latin American Workers (C.T.A.L.), founded in 1938.

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TRADE ROUTES. In Mediaeval English the word "trade" meant a path; it was connected with the word "tread." Exchange, which is now of the essence of trade, was not at first implicit in the word, but rather the idea of movement to and fro. In a sense trade routes are older than trade. Many of them probably began as "raid routes." The Norse pirates, for instance, sallied forth annually in the spring by familiar courses and in the autumn returned with their ships laden with spoil. The pathways in Central

Africa which guided the European explorers of the 19th century had been organized as a thorough system by the Arab slavers

Ancient Routes.—The trade routes which now envelop the globe as with a net may be regarded as having grown from the track which at the dawn of recorded history connected Babylonia with Egypt These two lands, while both rich with the agriculture of a river plain, so differed in the details of their civilizations as to offer to each other commodities suitable for exchange. The primitive way was, no doubt, northwestward along the bank of the Euphrates and then southwestward along the fertile foot of the Syrian mountains, but that way was early short circuted by a direct route across the Syrian desert. The change was effected by the Semitic nomads of the desert, whose wealth was of horses, camels, asses, sheep and goats. Periodically they made descents on the borders of the cultivated land, robbing the tillers of the soil and the cattle owners, and compelling the towns to engird themselves with walls. In time the nomads discovered that articles of luxury taken as booty from one side of the desert commanded a high price on the other side, and gradually a lucrative system of transport and exchange was substituted for the dangerous practice of raiding The nomads knew the whereabouts of the wells and oases, and jealously guarded their secret. Ultimately, because they held the central position and could concentrate quickly for attack, they conquered and ruled the settled peoples of the encompassing fertile plains, and the desert tracks became the links of empire. Rich cities, taking a toll of the passing traffic in return for sending it forward, arose in the oases, as at Tadmor and the later Palmyra, or where the caravan routes ended at the edge of the cultivated land, as at Damascus.

From the Mesopotamian and Syrian ends of this desert ferry there gradually extended ramifications into Europe and into Asia, in each case with alternative routes by land and by sea. Toward Europe a traffic grew up through the country of the Hittites, by the Taurus passes and the upland of Asia Minor, to the Balkan peninsula and the Danube basin, and on into northern Italy Troy may have risen to wealth and power on this traffic, and by interfering with a local Greek trade through the Dardanelles may have brought upon itself the war sung by Homer. On the other hand a Semitic tribe, the Phoenicians, took to the sea and, with transshipment at Tyre, prolonged the desert route over the waters of the Mediterranean to Carthage and Spain. In the opposite direction, toward Asia, a trade was organized through the passes in the Persian mountains and around the north of the Persian deserts into Turkestan and Hindustan, while shipping from the Indies came up the Persian gulf.

The first great change of routes resulted from the conquest of Egypt by the Greeks under Alexander the Great. From the newly founded Alexandria, which took the place of Tyre ruined by the war, a waterway led up the Nile to Koptos, which is distant by caravan across the desert only 100 mi. from the Red sea—no more than the breadth of the Isthmus of Suez. According to Herodotus the Egyptians had long before joined the western to the eastern waters by a canal through the isthmus, but in the time of Alexander this had been abandoned, probably for the reason that the homeward voyage of sailing ships up the northern part of the Red sea was rendered difficult by a persistent contrary north wind, the local equivalent of the trade wind of the same latitudes in the Atlantic ocean. The Koptos route came out at the coast some 300 mi. from the northern end of the Red sea

The Greeks celebrated under the name of Hippalus the pilot who first among their mariners made use of the seasonal monsoon winds for the direct passage from the mouth of the Red sea to the coast of India opposite instead of following the shore of Arabia and Baluchistan

By the second century after Christ the ocean route to southern China was vaguely known to the Greeks of Alexandria Meanwhile the land route through the heart of Asia had penetrated to northern China, and silk from that source was finding its way to the Mediterranean through Tyre.

Silk was a commodity typical of the then traffic by land, for the cost of animal transport was great and could only be borne by goods occupying little space in proportion to their value, such as gold, silver, precious stones, fine linen and incense. Within the Mediterranean, however, cargoes of grain to such places as Rome constituted a beginning of sea carriage in bulk Fragile wares such as the art pottery of Athens were transported to every shore.

Mediaeval Routes.—The greatness of Constantinople during the early middle ages was in part based on a continuance of the land traffic through the Balkan peninsula and Asia Minor. The Saracen and Moorish fleets had rendered the Mediterranean unsafe, and piracy, which had been suppressed while the Roman empire was efficient, and again became rife Gradually the sea traffic recovered, being organized afresh by the Italian maritime cities, and in the 12th and 13th centuries the later crusaders were carried eastward by the ships of Venice The fact that at this time a single race, the Arabs, dominated the caravan tracks of the near east and also the sea ways of the Indian ocean undoubtedly favoured the development of the trade with the middle and far east, although Christendom was excluded from the eastern seas and had to buy silks and spices of the Moslems at Alexandria and Aleppo. Thus the principal trade of the world in the middle ages came to be conducted in two separate compartments, eastern and western; the goods went through, but not the men

In Europe the Italian cities, especially Venice and Genoa, undertook the forwarding into the west of the wares of the east. The lie of the Italian peninsula southeastward toward the Egyptian and Syrian ends of the desert routes was such as to favour sea transport along the Italian coasts into the heart of the western world. From northern Italy trains of pack animals carried the goods over the Alpine passes to the Rhine, down which river they were transported in boats to Cologne and the cities of Flanders for distribution over northern France, England, northern Germany, and Scandinavia. On the return journey furs from the northern forests were a principal article of traffic. Important banking houses rose to wealth in the cities of south Germany as well as in Venice by financing merchants along this trade route.

At certain times, and notably under the short-lived Mongol empire in the 13th and 14th centuries, there were notable revivals of the traffic from the far east through the heart of Asia, although normally the turmoil of barbarous peoples rendered the passage unsafe and costly. The transcontinental caravan route came out either at Aleppo or at the head of the Sea of Azof. The Venetian traveller, Marco Polo, went in at Acre during the Mongol epoch and travelled safely to Cathay or northern China The Genoese, from Constantinople, for a couple of generations in the 14th century did a considerable trade with the east through the Black sea

Growing Predominance of Sea Routes.—In the 15th century a change in the course of European trade took place which must have appeared even to contemporaries as of the first importance. Venice began to send forward the wares received from the east no longer over the Alps and by the Rhine, but by an annual fleet through the Strait of Gibraltar to Flanders, with a call of some of the ships at Southampton. The overland traffic soon yielded to the new competition, and the financial houses of the south German towns transferred themselves to the Netherlands. There had long been a local trade of English wine ships to Bordeaux and the advent of the Italian pilots, now equipped with the mariner's compass, into the outer seas with the valuable wares of the east must have stimulated ideas of bolder venture in the northern ports. The exploration of the west coast of Africa, organized from Portugal by the half-English Prince Henry the Navigator, was contemporary with, and no doubt incidental to, this development. If sea venture around the west of Europe was cutting out the continental traffic across Europe, why should not a greater venture around the south of Africa cut out the traffic across Egypt and Syria? The spices of the orient would then reach London by an unbroken voyage with only terminal handling of goods, whereas by Egypt and the Rhine there was a chain of three sea voyages, with two expensive land sections intercalated, and handling of the goods at least six and more often eight or ten times.

During the early 16th century Venice struggled tenaciously to maintain its trade long after Vasco da Gama had rounded the cape, and the last voyage of the Venetian fleet to England and

Flanders did not occur until 1532 The 17th and 18th centuries saw a virtual monopoly of the carriage of the world's trade by the sailing ship on the ocean Strictly speaking there are no trade routes on the sea Once the mariner had learned to go boldly out of sight of land, he was free of all the ocean, and might descend upon any coast Practically, however, the greater part of the water surface of the globe was left to the undisturbed possession of the albatross and the flying fish, for merchant craft were compelled for economic reasons to keep to the courses which on a balance of considerations were likely to yield the best net results to their owners In the great sailing days, however, ship masters took other courses from those followed in the later days of steam, and courses, moreover, which varied in most cases on the outward and homeward voyages In the Atlantic the trade winds, northeast and southeast, determined the sailing tracks, and the Gambia became a place of refreshment on the outward voyage and St Helena on the homeward voyage Algoa and Delagoa are names which record corresponding facts with reference to the voyages of the Portuguese to and from Goa on the seasonal monsoon winds Thus the new ocean routes to the Indies came to be punctuated with victualling and watering stations and these stations were the property of the "East India companies" of the several nations

At first the Portuguese claimed an exclusive use of the new route which they had discovered to the east, and "stapled" the goods which their ships brought home at Lisbon, and other peoples had to come and buy there. This "pride of the wholesaler" brought its retribution, for the Dutch built up a distributing trade from Lisbon throughout northern Europe, and when Portugal was conquered by Spain, the Dutch rebels against Spain steered past Lisbon and sought their own wares in the east Amsterdam then became the seat of the depot trade in spices, a term which covered many more articles than in modern parlance It would exceed the limits of this article to enter into the history of the English and French competition with the Dutch on the trade route to the Indies. Suffice it to say that England ended by defeating all its rivals, in no small measure because its motive was to sell even more than to buy.

Europe and the Indies.—The history of human civilization might be written around the story of the trade routes between Europe and the Indies The facts of physical geography are such that it was inevitable that the main trade of the world, apart from local exchanges, should be between the northwest and the southeast of the Euro-Asiatic continent Those two regions are alike characterized by ample rainfall, lowland soils, and navigable rivers and arms of the sea They are separated by a belt of great deserts through which he narrow natural ways, such as the Red sea and the Nile and Euphrates rivers. Neither the north of Asia nor the centre and south of Africa offered comparable facilities for early human development. At mid-20th century, on an area of some 3,000,000 sq.mi. in Europe there were 400,000,000 people, and on an area of some 5,000,000 sq mi between Ceylon and Japan there were 1,000,000,000 people.

Europe and America.—The second great trade of the world, that between Europe and America, was inaugurated by the voyages of Columbus. He set out to reach the east by way of the west, and as a fact his immediate successors succeeded in accomplishing that feat The Philippine Islands were approached by the Spaniards, not by the Portuguese route around the Cape of Good Hope, but across the Pacific. The track of their galleons was from Spain to Vera Cruz in Mexico, and thence the way led over the Mexican tableland to Acapulco on the Pacific shore, and then by ship across the Pacific. Thus at the very time when trade was abandoning the overland routes in Europe and the near east, a new overland route was established in America. The reason, apart from the opposition of the Portuguese, was that America projects 20° of latitude farther south than does Africa, and the passage into the Pacific by doubling Cape Horn is a far more serious venture than the rounding of the Cape of Good Hope into the Indian ocean

The sailing track from Europe to America was on the northeast trade wind to the tropical West Indies, whence shipping turned northward to Virginia and so homeward on the prevalent west winds of the higher latitudes—a great triangle of trade. Only Canada and New England were reached laboriously by tacking against the west winds. In no trade in the world was the advent of steamships of greater assistance than in the North Atlantic. Elsewhere on favouring winds a sailing ship would often make nearly as quick a passage as a steamer

The Advent of Steam Power.—The Industrial Revolution of the late 18th and early 19th centuries, though it transformed manufacturing, wrought comparatively little change in commerce The commercial revolution began only about 1870. In that year only about 10% of the world's shipping was moved by steam; by mid-20th century the percentage moved by sails was negligible The newly-made roads and canals, and at first even the railways, remained subsidiary to ocean traffic There was, however, one freshwater canal the construction of which effected changes on a world scale. The opening of the Erie canal in 1825 from the Great Lakes of North America to the Hudson river and from the Atlantic brought the harvests of the west into relation with the industrial coastland of New England New York, which had hitherto been a smaller place than either Boston or Philadelphia, shot forward in development to become the largest city in the world Some 165,000,000 people in the United States and Canada offer as great a basis for international trade as the 1,000,000,000 of the orient, and the North Atlantic trade route balances in importance the ways of the east

The first transcontinental railway from Atlantic to Pacific was completed through the United States in 1867, but the day of transcontinental carriage of goods in bulk did not begin until about 1878, when for the first time the grain of the prairies was brought to England

Later Developments.—Much more immediately significant was the opening in 1869 of the Suez canal (*q.v.*) A large part of the ocean-borne commerce to the east was almost at once diverted to the new route The approach to India, which around the cape was as easy to Calcutta as to Bombay, was now more direct to Bombay, and thence the railways of India were constructed southeastward, eastward and northeastward, radially from the terminus of the new ocean ferry from Europe. Simultaneously the piercing of the Alps by railway tunnels, of which the first, the Mont Cenis, was completed during the Franco-Prussian War in 1870, facilitated the transfer of the European points of departure for India to the Mediterranean ports Italian Genoa became the principal southern exit for German commerce, and even British liners had to call at Marseille

Toward the end of the 19th century the railway net began to cover wide areas on the continents, and for some purposes land transport seemed likely to rival sea transport Transcontinental railways traversed Asia, Australia and South America None the less for the carriage of bulk the sea holds its own. The tonnage through Panama came to exceed that through Suez, although the completion of the second interoceanic canal did not affect a change in trade routes at all comparable with that which so quickly ensued on the opening of the first.

Beginning in the 1920s the commerce of the world began to undergo yet another change with the development of air transport (*see* TRANSPORT: *Air Transport*).

The tendency of the trade routes of mid-20th century—by land, sea, and air—was to exhibit on the map the appearance of a net. Within the limits set by the consideration that goods are carried most cheaply in reasonable bulk, transport seeks the direct line from the place of production to the place of consumption Thus the "depot" trade, associated in the past with such "nodal" centres as Alexandria, Venice, Lisbon and Amsterdam, and later with London, was not increasing. But the brain centres, the centres of the higher control exchange, were if anything becoming fewer.

BIBLIOGRAPHY.—Information in regard to the trade routes of the past is to be found scattered through books on general and commercial history; there are very few works specially devoted to the subject. *See* O. Noel, *Histoire du Commerce du Monde*, 2 vol (1891, *et seq.*), with a useful bibliography, H. de B. Gibbins, *History of Commerce in Europe* (1891), E. Speck, *Handelsgeschichte des Alterthums*, 3 vol. (1901–06); E. H. Warmington, *The Commerce between the Roman Empire and India* (1928). The history of trade routes is closely

involved in that of geographical discovery; *see* E H Bunbury, *History of Ancient Geography* (1879) and H. Yule, *Marco Polo* (3rd ed 1903) *See* also Russell Smith, *The Ocean Carrier* (1908), A J. Sargent, *Seaways of the Empire* (1918)

(H. J. MA , X.)

TRADESCANT, JOHN (1608–1662), English traveller and gardener, was born at Meopham, Kent, on Aug. 4, 1608 His father was John Tradescant (d 1637?), who established a museum and "physic garden" at South Lambeth, described by Daniel Lysons in *The Environs of London, Being an Historical Account of the Towns, Villages and Hamlets within Twelve Miles of that Capital* (1792–96) as "one of the first established in the kingdom."

The younger Tradescant travelled to Virginia in 1637 to collect specimens of plants, flowers and shells for the Lambeth exhibition. His *Museum Tradescantianum· or a Collection of Rarities, preserved at South Lambeth, near London* was published in 1656 Sir William Flower in *Essays on Museums* (1898) wrote, "The wonderful variety and incongruous juxtaposition of objects make the catalogue very amusing reading" In addition to the English and Latin names of plants in the garden, lists of animals, shells, coins, minerals, utensils, etc., were included.

Tradescant's first wife, Jane, died in 1634, and in 1638 he was married to Hester Pooks of St. Bride's, London. By his first wife he had two children, Frances, who married Alexander Norman, and John, who died on Sept 11, 1652

Tradescant died on April 22, 1662.

TRADES UNION CONGRESS, THE. The Trades Union congress came into existence in Great Britain when the Manchester and Salford trades council convened a trades union conference in Manchester in Whit-week 1868 There were earlier national conferences, but the Trades Union congress itself dates its birth from the gathering at Manchester of 34 delegates representing 118,367 members of unions. In 1869 a parliamentary committee was appointed to carry out the decisions of the congress In its early days the congress was concerned largely with trade union legislation It was not long before it was considering political questions, though for years the "economist" or laissez-faire school held their own against the more advanced school In 1882 the congress adopted by 71 to 31 votes a resolution in favour of land nationalization, but in later years a similar resolution was rejected. In 1888, however, the principle was decisively endorsed by 66 to 5 votes It was not until 1885 that the principle of the legal regulation of hours of labour was adopted by the Trades Union congress, and in 1890 it carried a resolution in favour of an Eight Hours bill By this time, it may be said, the congress had finally repudiated economic individualism and embraced the Socialist philosophy, and before many years passed it had created the Labour party As early as 1869 a paper dealing with direct labour representation in parliament was read at the T U C In 1886 it appointed a labour electoral committee which, however, came under Liberal influence, and in 1893 it ceased to operate In 1899 a resolution was carried for a special congress of trade unions and Socialist organizations. The result was the inauguration of the Labour Representation committee, and the birth of an independent political labour movement.

The influence of the congress grew with the increase in trade union membership. But it was World War I which laid the foundations of its present prestige. The decision of the congress to take part in the wartime administration of the nation marked an important stage in its history. The congress emerged from the war with greatly increased membership and authority.

General Council Organization.—In 1919, therefore, proposals were submitted to a special Trades Union congress for the replacement of the old parliamentary committee of the congress by an enlarged executive body, for the creation of a machinery of co-operation between the congress and the Labour party, and for the establishment of joint administrative departments under the auspices of the congress and the Labour party The parliamentary committee was superseded by the general council, a body composed of 32 members representing 17 groups of trades and industries into which the affiliated membership of the congress was divided.

For administrative purposes the 17 trade groups were formed into 6 group committees as follows: (1) mining and quarrying, railways, transport; (2) shipbuilding, engineering, iron and steel, building; (3) cotton, other textiles, clothing, leather; (4) glass, pottery, etc , agriculture, general workers; (5) printing, public employees, nonmanual workers; (6) two women members and three members appointed by the general council from organizations with women members.

The congress also accepted in 1920, as did the Labour party conference of 1921, proposals for the establishment of four joint departments. (1) research and information; (2) press and publicity; (3) international and (4) legal. This new central machinery resulted in a great expansion of activities by the general council of the T U.C. itself, and by the council in conjunction with the political labour movement. In 1925 the general council reported to the congress that the rapid expansion of work necessitated separate machinery, and on March 31, 1926, the joint departments ceased to exist. The administrative side of the T U C. established departments dealing with organization, trade boards, research, publicity, social insurance and international matters.

Council Activities; Later History.—The general council of the T.U C was designed to handle a wide range of questions with steadily increasing authority It instituted a standing trade boards advisory council composed of representatives of organizations catering to workers covered by the Trade Board acts Its education committee promoted an agreement with several institutions to assist in adult education facilities for trade unionists In 1927 the general council inaugurated a scholarship program which provided three scholarships a year tenable at the Labour college and Ruskin college.

Another important side of the activities of the general council was the forging of closer bonds with the trades and labour councils throughout the country. Before 1895 trades councils were represented at the annual Trades Union congress. But from that date until 1924 there was no direct contact between these local representative bodies of trade union branches and the T.U C , although the trades councils (many of which were local Labour parties) were affiliated to the Labour party and sent delegates to its annual conferences

After the establishment of the general council, efforts were made to remedy this defect in organization, and in 1925 a model form of constitution for trades councils was worked out, arrangements made for the publication and circulation of special literature on trade unionism, and a regular monthly statement from the general council to the trades councils was inaugurated

The general council took an increasingly important function in large industrial disputes. At the Hull congress of 1924, its hands were strengthened in this matter In the event of a breakdown of negotiations in a dispute, "the deadlock being of such a character as to directly or indirectly involve other bodies of workpeople affiliated to the Trades Union congress in a stoppage of work or to imperil standard wages and hours and conditions of employment, the council may take the initiative by calling representatives of the unions into consultation, and use its influence to effect a just settlement of the difference." Before this resolution was carried the general council had, in fact, intervened by mediation or the granting of moral and financial support in disputes in which affiliated societies were concerned. In the prolonged boilermakers' dispute in 1924, in the dock workers' dispute, the tramway dispute in the London area, the Southhampton shipyard dispute, and the building trade dispute in the same year, the general council used its good offices. But the adoption of the resolution of Sept. 1924 placed greater authority in the hands of the council On the occasion of the dispute in the coal industry in 1925, the council, in conjunction with the Labour party and the Miners' Federation of Great Britain, established a committee to prepare a policy for the coal industry, and the proposals of this joint committee were submitted to the royal commission on the coal industry. After the publication of the royal commission's report, the general council, through its industrial committee, resumed consultations with the Miners' federation and was closely associated with it during the course of negotiations.

Finally the council declared a general strike in 1926 and for the first time in its history tried to stop all industry The government, however, declared the strike a threat to constitutional government and in 1927 passed the Trade Disputes and Trade Unions act. This act imposed severe limitations on strike activity, especially on picketing, and created a class of unlawful strikes which it was an offense to foment or assist. These were strikes extending beyond a single trade or industry where they were also *designed to coerce the government—a not too clear category* which was in fact never put to the test in the courts. The act of 1927 also prevented unions of workers in the national service from affiliating to either the Trades Union congress or to the Labour party, and limited political activity by trade unions, substituting "contracting in" (signed indication of willingness to subscribe to the political funds of their unions) for "contracting out" (liability of all members to contribute when a union had taken a ballot and secured a majority in favour of a political fund, unless they signed a form expressing unwillingness to pay, but no member could be penalized in his industrial position in the union because he contracted out) as the basis of trade union connection with the Labour party.

Despite efforts to modify this law by the T.U.C., it stood until 1946

During the intervening years the T.U.C at first declined in power and membership, despite the formation of a Labour government in 1929 Not until World War II necessitated great industrial expansion did the T.U.C regain some of its status lost in 1927 Early in the war the council sent a committee to join with principal employers' organizations in the creation of a National Industry Advisory committee to facilitate smooth working and to minimize labour-management difficulties in wartime. After the formation of the coalition government in 1940 trade unions were steadily consulted in all matters affecting their members' interests, and many trade unionists became temporary civil servants and played an active part in the adjustment of labour difficulties.

Throughout the war strikes were few, and mostly short and unimportant. They were usually called without sanction of the trade union executives and arose mostly out of local grievances. Indeed, after 1926 the severity of strikes in Great Britain was much less than it had been previously; and the vast majority of differences in peace as well as in war were settled by negotiation without stoppages of work.

In 1946 the entire Trade Disputes and Trade Unions act was repealed, and the law reverted to exactly what it had been in 1927—all restrictions on the sympathetic strike were removed, the legality of general strikes was again uncertain since the leading authorities differed, the rights of picketing were restored to what they had been under the Trade Disputes act of 1906, and trade unionists' contributions to the political funds of their unions were once more on a basis of "contracting out."

Some controversy arose in 1946 over the question of the closed shop, especially in the coal mines and in other services controlled by public corporations. The Trades Union congress, however, made it clear that while unions would continue to press for 100% membership, there was no general intention of insisting on membership in a particular union, among those regarded as bona fide, as a condition of employment. It was, however, becoming more important to avoid the existence of rival unions claiming to represent and to negotiate for the same body of workers

A good deal of special machinery set up during World War II for dealing with labour questions was retained and adapted to the conditions of peace. A National Production Advisory council, aided by regional boards, was set up to replace the wartime machinery of collaboration between employers' organizations and trade unions and served as a general advisory agency to the government on labour matters. In the factories the wartime system of joint production committees was retained and extended to non-war industries. National production advisory committees were also set up for particular industries, and the trade unions played a large part in the working parties appointed by the board of trade to report on the changes in organization, technique and machinery to enable them to improve their efficiency and to work in with the plans for national industrial development

In 1951 the system of compulsory arbitration that had been in effect since World War II under the National Arbitration order was withdrawn and replaced by a new Industrial Disputes order under which arbitration became voluntary. An Industrial Disputes tribunal replaced the National Arbitration tribunal, but the minister of labour could not refer any dispute to it unless he was satisfied that full use had been made of any existing machinery for negotiation and conciliation.

The Trades Union congress played an active part in all major world federations of trade unions. When the World Federation of Trade Unions became divided by the varying attitudes of the nations regarding the European Recovery program, the T.U.C, in connection with the U.S. Congress of Industrial Organizations and labour organizations of Belgium and the Netherlands, seceded from the W.F.T.U. in 1949 and established a new International Confederation of Free Trade Unions. By mid-20th century the I.C.F.T.U. included most of the western nations, and the W.F.T.U. had become largely Soviet-controlled.

Membership.—Beginning in 1868 with 118,367 members, the T.U.C doubled that number in one year and by 1873 totalled more than 1,000,000 members in 150 unions Membership fluctuated between 400,000 and 800,000 until 1890 when the million mark was again reached At the beginning of World War I there were slightly more than 2,000,000 members in some 200 unions. At the time of the Armistice membership had increased to 4,500,000 There was a decline in the 1920s to 4,000,000 The Trade Unions and Trade Disputes act of 1927 caused a marked drop in membership, and by 1934 there were just slightly more than 3,000,000 members World War II brought up membership sharply to 4,500,000 Increases were steady until 1949 when there were almost 8,000,000 members, some of the growth due to the repeal of the Trade Unions and Trade Disputes act in 1946 which permitted the re-entrance of the civil service unions into the T.U.C.

(A. Gr.; X.)

TRADE (LABOUR) UNIONS. Trade unions are associations of employed persons for collective bargaining about their conditions of employment and also for the provision of benefits, legal defense and the promotion of their members' interests by bringing pressure to bear on governments and parliaments and, in certain cases, by political action They undertake other functions besides these—for example, educational work and, in some cases, participation in the organization of industry through co-operative societies or by representation on control boards or in the management of productive operations; but their main work is in the field of collective bargaining, and in some countries the development of social security legislation has made their benefit activities less important than they formerly were.

The words "trade union" were originally used to mean a union of local trade clubs or societies to conduct a joint movement, the words "trade club" or "trade society" being used to describe the primary units of working class combination Trades' union meant a combination of societies covering a number of different trades (for example, carpenters, bricklayers, etc, in a building trades' union). General combinations of societies in all trades were called trades unions or general unions. Later, as the local trade clubs amalgamated into larger bodies, the words "trade union" came to be used in their present sense, to cover any combination of workers for collective bargaining The French equivalent is *syndicat ouvrier*, or simply *syndicat*, which still means mainly local trade union; the German word is *Gewerkschaft*, the Italian *sindacato;* Americans use mainly the term "labor union."

GREAT BRITAIN

No date can be assigned to the origin of trade unions; but in Great Britain they did not become numerous until the 18th century, mainly as local trade clubs of skilled workers in a particular town. There were occasional journeymen's combinations in the 16th and 17th centuries, to make demands on guild masters or other employers; but there is no basis for the attempt to treat trade unions as descendants either of the mediaeval guilds or of

the bachelor or journeymen fraternities sometimes associated with them in a subordinate status

The earliest trade societies arose among skilled workers, such as printers, tailors, saddlers, wool combers, brushmakers and weavers They were usually small groups, often centred at a particular house of call, and they carried on friendly benefit activities as well as regulation of the conditions of employment, especially in relation to apprenticeship, hours of labour and standard wage rates

These small trade clubs, until the 19th century, usually formed wider unions of delegates only on particular occasions, when they wished to put forward a common claim or to fight some concerted move of their employers Such joint movements were most often limited to a single town or district and to a single industry, but in the case of weavers (and later miners) they sometimes covered considerable areas, for otherwise it was easy to defeat them by withholding work from a particular locality and transferring it elsewhere This was especially the case in the textile trades, under the domestic system That is why the weavers were the pioneers of trade unions covering a wide field; but their combinations of this type never lasted long and were usually broken up by the joint action of employers and the law Some trades, without permanent unions, had well-organized travelling arrangements whereby a journeyman seeking work outside his home district applied to the local house of call and was either found employment or helped on his way to another district (for example, wool combers, brushmakers, printers).

Mere local trade clubs were seldom interfered with by the law, but attempts to form wider unions soon brought the workers into conflict with municipal or national authority. In Great Britain, where the sections of the Elizabethan Statute of Artificers empowering the local justices to regulate wages and apprenticeship were not repealed until 1813–14, workers' combinations for the purpose of urging the justices to fix wages or to prevent the employment of illegal (that is, unapprenticed) men on skilled work were regarded as in themselves lawful up to the enactment of the Combination acts (1799–1800) which definitely made all trade combinations unlawful.

But well before that the judges had come to regard as unlawful any combination which they regarded as being in unreasonable restraint of trade; and that was more and more held to cover all attempts to regulate wages or conditions of labour, as distinct from merely asking the justices to do so. Indeed, the Combination acts were passed less for the purpose of declaring trade unions to be criminal conspiracies—for in effect the courts had come so to regard them already—than for that of providing easier means of bringing minor offenders to book by empowering the justices to deal with cases of combination by summary jurisdiction, whereas previously such charges had involved procedure by indictment for conspiracy in a higher court. Formally, the Combination acts applied to employers' as well as to workers' combinations; but no employer was ever prosecuted under them

In Great Britain, the name "trade union" still legally covers employers' associations, and a few such bodies are registered under the Trade Union acts But in practice this wider sense of the term has little importance.

Early Legal Position.—Trade Unions were prohibited in France under the Le Chapelier Law of 1791, which outlawed all private associations; but in neither France nor England did the outlawry prevent their existence, though it rendered their leaders always liable to prosecution and their continuance precarious.

In Great Britain the Combination acts had been part of a series of laws passed to repress popular movements during the period of the revolutionary wars; and their enforcement was very uneven, being most severe in the mining and northern textile areas, where large numbers of potentially riotous persons were involved, and least so among the skilled urban craftsmen, whose small clubs were usually unmolested. The Combination acts were repealed, together with other acts against combinations in particular trades, in 1824, thanks mainly to the efforts of Joseph Hume and Francis Place, and the repealing act also removed the common law taint of illegality. It was replaced the next year by a much less generous government measure, which gave trade unions a bare legal right to exist, but imposed many restrictions on their actions This act of 1825 remained in force till 1871. Other repressive statutes remained, in the famous case of the Dorchester labourers, or Tolpuddle martyrs, in 1834, the prosecution was not nominally for combining, but for "administering unlawful oaths," and the same charge figured in the indictment under Scots law of the Glasgow cotton spinners' leaders in 1837.

1825–1888.—British trade unionism after 1825 grew very fast and by 1830 attempts were being made to form a general trades union open to all kinds of workers During these years the unions played their part in the reform agitation and, after the Reform Act of 1832 had left them voteless, turned to large-scale industrial action in the hope of improving their condition Many of them passed under the influence of Robert Owen's ideas and launched ventures in co-operative production, including the Grand National Guild of Builders set up by the Builders' union in 1833 with the purpose of taking the entire building industry into its hands. Owen, taking the lead, tried to combine all the trade societies and unions into a Grand National Consolidated Trades' union which, after a year of bitter conflicts with the employers and the government, collapsed in 1834, its fall hastened by the sentence on the Dorchester labourers From this point most trade unions and clubs abandoned the practice of administering oaths of secrecy to their members The fall of the Grand National did not destroy the movement, but broke it up again into small independent local societies, with only a few unions (*e.g.*, the stonemasons) surviving as national bodies.

By 1845 recovery had gone far enough for a new central body—the National Association of United Trades for the Protection of Labour—to be set up, and for a revival of attempts at co-operative production under its auspices; but this body died away after a few years, and attention was given mainly to building up highly organized national or regional unions of skilled workers in particular trades—notably the Amalgamated Society of Engineers (1851) and the Amalgamated Society of Carpenters and Joiners (1861). The cotton operatives also reorganized strongly in local societies, federated for common action, and began to secure recognition and develop modern collective bargaining methods

The miners, who had prematurely created a national union in the 1840s, only to have it destroyed by depression and conflict, built up a new nation-wide movement in the 1860s and began to press successfully for acts regulating safety conditions as well as for higher wages.

At this point the British unions became involved in a series of legal struggles which lasted from 1864 to 1875. Aided by the Reform Act of 1867, which enfranchised many urban workers, they not only repelled the attacks on the legality of trade unionism, but secured in the Trade Union Act of 1871 an assured legal status and, in the Master and Servant Act of 1867, the Employers and Workmen Act of 1875 and the Conspiracy and Protection of Property Act of 1875, great improvements in the workers' status at law and in the provisions regulating strikes and picketing. In 1869 the trade unions took part in forming a Labour Representation league to send workmen to parliament, and two miners were elected M P s in 1874. There was a great growth of trade unionism in the late 1860s and early 1870s, including Joseph Arch's National Agricultural Labourers' union and other movements among the less skilled workers.

Many concessions were won, and many employers agreed to recognize and bargain with the unions now that their legal status had been made plain But with the passing of the trade boom of the early 1870s and the onset of depression many of these gains were lost, and a period of stagnation followed and lasted through most of the 1880s.

New Unionism.—It was ended by the rise of the new unionism of 1888–89, largely a product of socialist agitation during the preceding years and of dissillusionment with the Liberal party after Joseph Chamberlain's secession.

The outstanding event of this period was the London dock strike of 1889, led by John Burns and Tom Mann, in which the

dockers won an unexpected victory (the "docker's tanner"—6d an hour). Workers, skilled and unskilled, flocked into the trade unions, and many new unions were formed with low contributions and few or no friendly benefits to bring in the worse-paid workers (dockers, gas workers, workers' union, etc.). The peak reached in 1890–92 was not kept; but, after many members had been lost, the new unions established their position beside the old, which began to adopt less exclusive policies under the influence of the new ideas The new unionists laid great stress on agitation for a legal minimum wage and eight-hour day, and on the right to work—that is, the obligation of the government to provide work or maintenance for the unemployed These demands led straight to a revival of political action, which had languished after the movement of 1869–75 James Keir Hardie's Independent Labour party (1893) set to work to induce the trade unions to join forces with the Socialists in an independent political party; the Labour Representation committee was founded on this basis in 1900 and became the Labour party in 1906, when it won 30 seats in the general election that carried the Liberal party back to power.

Later Legal History.—Before this, the unions had become involved in a further contest with the law. In the case of the Taff Vale Railway company *v* the Amalgamated Society of Railway Servants it was decided that a union could be sued for damages caused by its agents' actions during a strike. This decision, which threatened the right to strike, was reversed by the Trade Disputes Act of 1906—the Labour party's first important success

Almost at once a new crisis arose. The house of lords decided in the case of W V. Osborne *v.* the Amalgamated Society of Railway Servants that a trade union could not lawfully take political action, as unions had been doing unchallenged for many years This decision too was reversed, by the Trade Union Act of 1913, which allowed political action by unions, on condition of a prior ballot vote in favour of and exemption ("contracting-out") for objectors This act was temporarily altered, to substitute "contracting-in," by the act of 1927, passed after the general strike, but on the repeal of the 1927 act in 1946 the act of 1913 resumed its force.

1910–1950.—From 1910 to 1914 there was acute industrial unrest in Great Britain, signalized by many strikes, by the emergence of syndicalist and industrial unionist ideas derived from France and from the U.S., and by the creation of powerful new unions by amalgamations. This movement was cut off short by the outbreak of World War I in 1914 and the declaration of an industrial truce. During the war the unions continued to make large gains in membership, and, official trade union action being restricted under the Munitions of War Act of 1915, an unofficial leadership grew up in the shop stewards' movement, which became increasingly antiwar, especially after the Russian revolution of 1917 The shop stewards, who had previously been quite minor workshop representatives of the trade unions, where they existed at all, took up the demand for workers' control of industry voiced by syndicalists and guild socialists, but came later under the leadership of the elements which went in 1920 to the making of the Communist party.

The end of war in 1918 was followed by a further period of widespread strike action, interrupted by the depression and by the great defeat of the miners in 1921, but resumed in the general strike, called by the whole trade union movement (though not all trades were actually called out) in support of the miners in 1926 The defeat of this movement for a time seriously weakened the trade unions, which were further weakened by the depression of 1931–33, but thereafter rapidly regained strength, without resorting again to policies of mass action.

World War II brought, from 1940 onward, a further increase in membership and influence, with the unions taking a vital part in organizing the national productive effort. Trade union progress continued under the Labour government from 1945, with the unions securely entrenched on all manner of advisory and consultative bodies, both with the government departments and with the employers, and serving more and more as agencies for securing working-class compliance with the restraints rendered necessary by international economic difficulties, as well as representative bodies for forwarding working-class interests. By 1950 trade union membership (*see* Table I) had reached 9,235,000, organized in 704 unions, and including 1,405,000 women (These figures excluded a few unions not making returns) The membership was highly concentrated in a small number of larger trade unions (*see* Table II).

TABLE I.—*Trade Union Membership in the United Kingdom*

	All Unions	Trades Union Congress
1866	—	199,000
1871	—	289,000
1873	—	733,000
1886	—	470,000
1888	—	727,000
1890	—	1,037,000
1892	1,501,000	1,153,000
1893	1,497,000	1,000,000
1900	1,022,000	1,250,000
1910	2,565,000	1,662,000
1914	4,145,000	2,682,000
1918	6,533,000	5,283,000
1920	8,334,000	6,418,000
1925	5,506,000	4,366,000
1930	4,850,000	3,710,000
1933	4,392,000	3,295,000
1939	6,244,000	4,867,000
1945	7,803,000	6,671,000
1948	9,101,000	7,937,000 (1949)
1950	9,235,000	7,827,912

There were in 1950 another 11 unions with more than 50,000 members, including boilermakers (83), dyers, bleachers, etc. (80), locomotive engineers (69), painters (98), foundry workers (75), cotton weavers (74), furniture trades (73), seamen (60), plumbers (54), health service employees (53), post office engineers (45).

Negotiating functions were largely concentrated in the hands of the big unions, or in some cases of federations in which they were among the leading members—for example, National Federation of Building Trades Operatives, Confederation of Shipbuilding and Engineering Trade Unions, Printing and Kindred Trades federation, Northern Counties Textile Trades federation In most industries national agreements had been concluded with employers' associations or federations, covering methods of negotiation, wages, hours and other conditions of labour. Recognition of trade unions for collective bargaining had become almost universal, and in many cases trade union representatives were sitting with employers on government-sponsored control boards (*e.g.*, cotton) or development councils or voluntary joint bodies dealing with economic policy Trade union accumulated funds amounted in 1950 to £62,000,000 In that year the income of 416 reporting unions, with nearly 8,000,000 members, was £17,000,000, and expenditure £14,000,000. The main items of expenditure were working expenses (£8,200,000), superannuation (£1,700,000), sick and accident benefit (£1,000,000) Dispute benefits cost only £245,000, and political fund expenditure was £451,000.

The British Trades Union Congress.—The central organization of the British trade unions, the Trades Union congress, was formed in 1868 It elects a general council of 33 members, representing occupational groups, to conduct its business between the annual meetings of delegates. Nearly all the big unions belong to it.

Voting at congress is by card vote, according to membership. The general council has no executive power to bind its affiliated unions or to engage in collective bargaining. (The general strike of 1926 was called, not by the general council or congress, but by a specially summoned conference of trade union executives.) The general council has, however, in practice great influence in formulating policy on behalf of the whole movement, its influence grew rapidly as more closely co-ordinated policies became needed. There is a separate Scottish T.U.C., made up mainly of districts of British unions but partly of separate Scottish unions; it has no great power, but is useful in airing Scottish opinion. Some British unions cover Northern Ireland, and a few extend to the Republic of Ireland; but the Irish have their separate trade unions and congress as well.

Locally, trade union branches are federated in the numerous trades councils, but these have small funds and not much authority They are mainly propagandist bodies. The general council co-ordinates their work through an annual Trades Councils' con-

TABLE II —*Great Britain: Largest Trade Unions, 1950*

Name of Union	No of Members	Occupations of Members
Transport and General Workers	1,342,000	Dockers, vehicle workers, canal workers and general workers
General and Municipal Workers	885,000	Municipal and public utility employees, engineering and shipyard and builders' labourers, general workers
Amalgamated Engineering union	716,000	Skilled and some unskilled throughout engineering trades
National Union of Mineworkers	602,000	All grades of coal miners, except managerial
National Union of Railwaymen	392,000	Mainly traffic grades and less skilled shopmen
Union of Shop, Distributive and Allied Workers	345,000	Shop assistants and warehouse workers, and especially co-operative employees
Amalgamated Society of Woodworkers	199,000	Carpenters and joiners, cabinetmakers
National Association of Local Government Officers*	197,000	Clerical and administrative grades
National Union of Teachers*	194,000	Mainly in state schools
Electrical Trades union	193,000	Skilled and less skilled
National Union of Public Employees	175,000	Manual workers on road work, etc
Union of Post Office Workers	149,000	Postmen, sorters, clerks, etc (not engineering section)
National Union of Tailors and Garment Workers	136,000	All grades
National Union of Agricultural Workers	135,000	England and Wales only
Civil Service Clerical association	133,000	Middle and lower ranks of civil service
National Union of Printing, Bookbinding and Paper Workers	124,000	All grades in bookbinding and papermaking (*less* skilled grades in printing)
Iron and Steel Trades confederation	101,000	All grades, except blast furnacemen
Railway Clerks' association	85,000	Clerical and supervisory grades
National Union of Boot and Shoe Operatives	82,000	All grades
Amalgamated Union of Building Trade Workers	81,000	Bricklayers and stonemasons

*Not in Trades Union congress

ference and a Trades Councils' Advisory committee.

(G. D. H. C.)

UNITED STATES

Although U.S. trade unionism is almost as old as the nation itself, and although its objectives and methods which gave it its lasting character were definitely crystallized with the American Federation of Labor during the final quarter of the 19th century, its rise to the position of a major factor in U.S. life came only with the New Deal. It is thus proper to treat the year 1933 as the great dividing line in its development

Knights of Labor.—As a continuous, more or less unified movement, with its peculiar philosophy and strategy, trade unionism in the United States cannot be said to have become established before 1880. In the preceding decades several of the large national unions had been organized, and occasionally more general uprisings had taken place only to die out after a few years, usually in the wake of business depression. By 1880 the Knights of Labor, organized as a secret group in 1869, had appeared in the open as a union of all workers, skilled and unskilled, manual, clerical and professional, and even of the small businessman. During the next ten years there was unfolded one of the most dramatic and significant episodes in the history of U.S. labour. Hardly known at the beginning of the period, the Knights achieved by 1886 a membership of close to 1,000,000 and an influence far transcending its size.

The Knights had set out first to organize all workers. For this slow and gigantic task, the organization had neither the financial resources nor an adequate staff of organizers. It depended on the spontaneous uprisings of men and women. Such uprisings occurred often in the few years from 1880 to 1886.

But when strikes ended in failure and strikers lost their jobs and when there was no place to turn for the sinews of war, it became more difficult to arouse enthusiasm and action. At the same time much of the attention and energy of the officers of the organization was dissipated in carrying out the ambitious economic program of the Knights, which ran from simple trade union action over wages to vast co-operative schemes or plans for the reorganization of the currency and banking system of the country. To these sources of weakness was added the inevitable conflict for jurisdiction between the Knights and the established craft unions. The episode of the Haymarket bomb in 1886 at Chicago, Ill., brought the Knights of Labor undeservedly into disrepute and hastened its end.

Rise of the American Federation of Labor.—Even during the heyday of the Knights, a new central organization of U.S. labour was already forming under the leadership of Samuel Gompers and his associates. This organization, appearing in 1886 as the American Federation of Labor (*q.v.*), had as its precursor the Federation of Organized Trades and Labor Unions, begun in 1881. The Knights sought to absorb the existing craft unions, to subject them to the loss of autonomy and to involve them in industrial disputes in which their own direct interests were apparently not at stake. Against this tendency craft unions revolted, organizing themselves in the loose federation which remained for a half-century the sole unifying agency of the American labour movement.

The principles on which the American Federation of Labor was founded originated in the practical experience of the leaders of this new movement and in their reaction against the practices of the times. They saw in craft unionism the solidarity and permanence which they found missing in the one big union, the Knights, and in the industrial unions, mixtures of skilled and unskilled, sponsored by the Knights.

They observed that the best chances of continuity and strength in a movement of organized labour lay in formulating narrow and attainable economic objectives instead of embracing a large and attractive program of economic reform which the trade unionists themselves had neither the interest nor the capacity to make effective. In view, finally, of the frequent and disastrous failures of independent political action, they abandoned attempts to form a labour party and sought to achieve political influence by other means.

In its beginnings, then, the American Federation of Labor was dedicated to the principles of craft unionism and autonomy, and of collective bargaining to win recognition of organized labour and advances in working conditions.

To this plan the federation consistently adhered. Its undeviating policy made it a loose federation of about 100 national and international unions, each retaining full autonomy over all the affairs of a labour organization. In return, each union received from the federation protection of its charter or of the workers and industrial territory over which it claimed jurisdiction. Out of this policy grew bitter jurisdictional disputes among unions affiliated with the federation. Although the federation continued to throw the weight of decision and influence toward the claimant with the clearest title to the disputed jurisdiction, this did not prevent far-reaching changes in the structure of affiliated unions.

Independent Unions.—The largest group of unions independent of the American Federation of Labor prior to the New Deal consisted mainly of the railroad brotherhoods, the unions of locomotive engineers, firemen, conductors and trainmen, with an aggregate membership of about 500,000 These railroad unions at no time affiliated with the federation, preferring to retain full control over their own internal affairs The Amalgamated Clothing Workers, for many years the most famous independent union, was admitted into the federation in 1933

Analysis of Growth.—As an effective force in U.S. industry, organized labour hardly began to be felt before 1900. The period following the collapse of the Knights of Labor was devoted to building the foundations of the labour movement, to strengthening the few established organizations and to extending unionism into new fields The decade 1890–1900 with its severe depression and general unemployment was not favourable to the growth of unions With the recovery of business toward the end of the decade the growth of the labour movement began and continued with only slight recessions until 1920 From 1900 to 1914 the total membership of U.S. trade unions increased by nearly 2,000,000 (from 869,000 to 2,687,000) and trade unionism penetrated many unorganized industries, making its most notable advances in the coal industries Among the manufacturing industries the progress of organization, while substantial, was slow

This whole situation changed radically after the outbreak of World War I. The rapid improvement in business and rise in productive activity, the steady absorption of the unemployed in face of the cessation of immigration, the further stringency in the labour market after U S entry into the war, the rising levels of prices and of wages, were all factors contributing to the strength of organized labour. The membership of trade unions, consequently, nearly doubled from 1915 to 1920 (2,583,000 to 5,048,000), and unionism won a place for the first time in the textile industry, packing houses, machine shops, among the shop men and unskilled on the railroads, in the clothing industries and among many clerical occupations Only in the iron and steel industry did the movement fail to make effective progress

The war gains were not held. The liquidation of the war industries, the depression of 1921 and the revulsion in industry against organized labour caused the unions to lose 1,500,000 members by 1923.

In spite of good business and employment the losses continued through the decade. The severe depression of 1930 further weakened the labour movement and left it in 1933 with fewer than 3,000,000 members.

With the coming of the F. D. Roosevelt administration's New Deal, however, membership rose rapidly under the stimulus of legislation favourable to labour. The 1934 membership of 3,609,000 increased every year thereafter until it reached approximately 16,000,000 at mid-century.

Handicaps to Growth Before the New Deal.—For generations U S. industry drew a substantial part of its labour from the annual masses of immigrants from Europe. Although there was a drastic restriction of immigration after World War I, U.S. industry was still far from a condition of labour shortage. New sources of labour within the country were constantly being tapped, leading to an easy labour market.

All labour movements suffer from the internal dissension that arises out of clash of doctrine. Sooner or later the holding of a new view of the purposes of the labour movement grows into an attempt to capture the movement and to convert it to this view. Mild beginnings in this direction have usually ended in bitter warfare and in the disruption of one or more unions. Such was the early history of the relations between the labour movement and the socialists, after 1905 between the Industrial Workers of the World (I.W.W.) and the American Federation of Labor, and after 1918 between the Communist movement and the established trade unions. In the clothing industry, for instance, the struggle for control waged during and after World War II between the Communist Workers' party and the administration of several of the unions in this industry resulted in nearly destroying organizations that only a few years before were among the most effective in the country

Before 1933 U S unions were handicapped by their uncertain and unfavourable legal status. The free use of injunctions in disputes, prohibitions against interference with interstate commerce and the "yellow-dog" contract were the devices which hindered union expansion, although the Norris-LaGuardia act of 1932 was a major improvement antedating the New Deal. Virtually all of the disabilities, legal and political, were swept away by the legislation supported by the Roosevelt administration

Organized labour in the United States was also handicapped by "welfare capitalism." Many industrial leaders abandoned by repressive measures to engage in competition with labour unions for the loyalty of their employees In place of the national trade unions with members recruited throughout the whole of an industry, regardless of geographical location or ownership of the business, industry created company or plant unions. These organizations, sometimes described as employee representation plans or works councils, were limited either to a single plant or to several plants under common ownership. Their number grew rapidly during the decade following World War I. (*See* also Company Unions)

The most fundamental of the trade union's problems is that of adjusting its policies to changing economic conditions. Often, before World War I as well as after, strong and established trade unions were reduced in size and strength because they failed to gauge the probable inroads of machinery and business depression

Sometimes the struggle between a union and machinery would last for a generation, but in the end the union was beaten. This was largely the history of the cigar makers' union In general, also, nearly all of the organized industries in the United States remained partly nonunion. Unless the union is able to organize the nonunion area, or so to protect the competitive position of the union area that the nonunion firms do not grow, the union will find business being diverted to the unorganized area and control slipping from its hands. The failure of the United Mine Workers to organize the nonunion coal fields of West Virginia and at the same time to strengthen the competitive position of the union operators in Illinois, Pennsylvania and elsewhere led to temporary disruption of the union in the years after 1925.

The New Deal and the Revival of Unionism.—The 1920s were the first period of economic prosperity which did not witness an expansion of unionism During the depression which followed the stock market collapse of 1929 and assumed catastrophic proportions in 1932 and early in 1933, labour was too benumbed to do more than engage in a few desultory desperate strikes, mostly under Communist leadership.

With the new administration of Franklin D. Roosevelt came a new dawn for labour. Now government stepped in not only to restore the most seriously deteriorated standards of employment but to pave the way directly for unionism

New Deal labour legislation originated in the National Industrial Recovery act (NIRA) passed in June 1933. Its labour provisions included both protective labour legislation (child labour was regulated, minimum wages and maximum hours of work were to be set for each industry operating under an approved code) and labour relations legislation.

Section 7(a) of the NIRA gave employees the "right to organize and bargain collectively through representatives of their own choosing" and to be "free from the interference, restraint, or coercion of employers of labor" in their organizing and bargaining activities. Through the decisions of the National Labor board and the first National Labor Relations board interpreting section 7(a), a solid beginning was made toward a common law of collective bargaining.

Section 7(a) stimulated segments of the "dead" U.S. labour movement. Governmental protection of trade unionism encouraged both reunionization and unionization. In the period 1933–35, the United Mine Workers, the International Ladies' Garment Workers' union and the Amalgamated Clothing Workers made the most vigorous comebacks

Prior to 1933 there was only a handful of permanent trade union members in the mass production industries. This can be

attributed to several factors· the determined opposition of large manufacturers to unionism, the heterogeneity of the labour force, ineffectual organizing tactics and the dominance of the craft philosophy.

The new political climate, with its ascendancy of government over business and the former's patronage of unionism as a major stabilizer of the economy, gave the U.S labour movement unprecedented opportunities to expand its numbers. To facilitate this, the A F of L chartered federal (plant-wide) locals. Yet this new opportunity soon brought a characteristic difficulty The initial organization of these previously unorganizable workers raised two crucial policy questions. How vigorously should organizing work be carried on in the mass production industries? What should be done with these newly chartered federal labour unions?

A federation minority, with the support of most of these new federal locals, demanded an aggressive organizing drive and the chartering of industrial unions in the mass production industries The craft unionists, representing a majority of the federation's membership, argued for a more cautious policy and for the preservation of established jurisdictional rights These "old" unionists tended to look upon industrial unions in the mass production industries as dual unions and hence disruptive of the labour movement They held this view because the craft unions theoretically had the right to organize certain workers in these industries.

The issue came to a head in the 1935 convention of the American Federation of Labor The industrial unionist resolution stated that "in the great mass production industries . industrial organization is the only solution." It was at this convention that the "older" elements in the A F. of L. showed a lack of statesmanship.

Their refusal to compromise meant that the traditional A F. of L trial and error method was discarded. Following it would have resulted in the relinquishing by the craft unions of their unexercised or paper jurisdictions in the mass production industries and in clear, unclouded titles to the industrial unions about to be chartered.

As a result of the convention's defeat of the industrial union resolution, representatives of eight international unions announced on Nov 9, 1935, the formation of the Committee for Industrial Organization Its purpose was "to encourage and promote (industrial union) organizations of the workers in the mass-production industries of the nation, and affiliation with the American Federation of Labor."

Still refusing to compromise, the executive council of the A F. of L. in Jan 1936, ordered the immediate dissolution of the C I O movement as a dual unionism move. They could not force themselves to believe that the "industrialists" were only demanding that the A F. of L continue to apply its own experimental method of the spirit of the grant of industry-wide jurisdiction to the United Mine Workers in 1901. When the C I O unions refused to dissolve their organization, the council in Aug. 1936 suspended all ten of them (two others had subsequently joined). The Tampa, Fla , convention (1936) approved this action. In March 1937, the council ordered all city centrals and state federations of labour to expel all delegates from the ten suspended unions.

While the split stemmed originally from the conservatism of a few key A.F. of L. leaders, it was made permanent by John L. Lewis in his capacity as head of the C I O. In late 1937 a tentative agreement was reached between A F. of L. and C I O peacemaking committees, but at the last minute Lewis rejected the plan which would have granted industrial jurisdictions to the original C I O. unions, with negotiations to proceed between the new "dual" unions and the A F. of L. unions concerned, but all the C.I.O. to re-enter the portals of the A.F. of L. en bloc. After 1937 numerous attempts were made to bring the A.F. of L. and the C.I O together, but all failed.

In Nov. 1938 the C I.O. unions voted to set up a separate federation to be known as the Congress of Industrial Organizations

Great Upheaval of the 1930s.—The federation's outlawing of the C I O in 1936 as a dual union was overshadowed by a series of sensational victories under the latter's banner.

In Sept 1935 the United Rubber Workers were granted a charter by the A F of L. but at their constitutional convention they rejected the official candidate for the union presidency. The C I O , in February–March 1936, came to the aid of the rubber workers, who were on strike; the financial support, encouragement and technical advice given the strikers represented the C I.O.'s debut as the leader and inspirer of the mass production workers

The first concerted C.I.O. organizing campaign was undertaken in the steel industry—citadel of the open shop. The chief product of the NIRA period in the steel industry was a growth of employer-sponsored organizations To initiate organizing activities among the steelworkers the C.I.O. placed $500,000 at the disposal of the Steel Workers' Organizing committee. Under the skilful leadership of the United Mine Worker officials the S W O.C. pursued a two-pronged attack It not only attacked the fortress frontally but it also infiltrated and made use of strong dissident elements within the company unions to promote independent unionism

As an aftermath of secret negotiations between John L Lewis and Myron Taylor, president of the United States Steel corporation, it was announced on Feb 28, 1937 that the corporation's chief subsidiary, the Carnegie-Illinois Steel corporation, would sign a contract with the S W O.C Within three months of the signing of this contract, the S W O C had reached agreements, practically without resort to strikes, with approximately 140 companies, including 14 U.S. Steel subsidiaries and the Jones and Laughlin Steel corporation.

However, against "little steel" the S.W.O.C campaign was far from an immediate success Following the signing of the agreements with U S. Steel's subsidiaries, the S.W O.C. called strikes against four of the largest independents, but they refused to follow the lead of U.S. Steel in recognizing the union. Aided to a great extent by the support of middle class opinion and "citizens' committees" in the communities where strikes were called, the independent producers were able in the majority of cases to stop the S.W.O.C. in its tracks and "little steel" succeeded in avoiding unionism and collective bargaining until 1941

Steel, especially "big steel," proved unexpectedly easy. The first real victory in battle came in the auto industry Auto workers were ready and anxious for union organization in 1933. They were complaining of the speed-up, a complicated system of wage payment, absence of job security, an espionage system in some plants and in general of policies they characterized as those of industrial autocracy. To facilitate organization of auto workers the A F of L. chartered federal unions and in Aug. 1935 granted a charter to the United Automobile Workers

Dissatisfaction with the A F of L. arose at once. In granting the U A.W. a charter the executive council had permitted the craft unions the right to claim the men whose work fell within their jurisdiction in this industry. The federation's insistence on the new union's acceptance of a hand-picked president was another cause which led the union to join the C.I.O. shortly after its inception.

The tactics accompanying the drive in the auto industry differed appreciably from those in the steel industry. Where the S.W.O C. organizing campaign was carefully planned and centrally organized, the rank and file in the auto industry often initiated strikes in spite of the restraining influence of the union leadership.

On Dec. 28, 1936, 8,000 workers in the Cleveland Fisher Body plant of the General Motors corporation walked out, and by Jan. 1, 1937, the strike had spread to two other large Fisher Body plants. Within a short period of time the movement spread to other General Motors plants, the workers' chief weapon being the sit-down strike. Court orders to eject the strikers from the plants were issued, but the fear of serious bloodshed influenced Gov. Frank Murphy of Michigan to order the sheriff not to serve them. On Feb. 11, 1937, trade unionism attained its first real victory in the auto industry when the General Motors corporation signed with John L. Lewis as the spokesman of the U.A.W. The signing of this agreement was followed by a sit-down strike of Chrysler employees, which was ended on April 6, 1937 when that

corporation recognized the union. Ford succeeded in holding out until the summer of 1941.

The United Electrical, Radio and Machine Workers of America was formed in March 1936 out of an amalgamation of rebelling A F of L federal unions and a loosely tied group of independent local unions

To organize the textile industry the C.I.O created the Textile Workers Organizing committee staffed by Amalgamated Clothing Workers officials. Between 1937 and 1941 the C.I O was also able to make inroads in meat packing, shipbuilding, oil, metal, mining and numerous other industries.

While the organizational efforts which made the newspaper headlines were those of the C.I O , the importance of the campaigns carried on by affiliates of the A F of L. and those directly under federation auspices should not be minimized The formation of the C.I.O. shook the A F of L. internally The original issue of craft *v.* industrial (or "horizontal" *v.* "vertical") unionism found itself blanketed by this larger issue of unionizing rivalry To support a federation-directed organizing campaign as well as to combat the C I O., an assessment of one cent per member a month was voted

The A.F. of L international unions vigorously seconded the efforts of their parent body and the total membership of the federation increased from 2,000,000 in 1933 to approximately 8,000,000 at mid-century. In absolute numbers the following showed the greatest growth· teamsters, ladies' garment workers, carpenters, electrical workers and hod carriers. Other A.F. of L. unions such as the hotel and restaurant employees, retail clerks, meat cutters and butcher workmen and building service employees had a large percentage rate of growth. During this same period the A.F. of L. chartered many new unions.

While there was a tremendous increase in trade union membership during this period, to a total of about 16,000,000, it still remained true that the bulk of union members were concentrated in a few large organizations at mid-century About a dozen unions, each with 250,000 or more members, contained almost half of the total union membership These giants, plus 15 or 20 medium-sized unions, formed the main body of U S. unionism.

What factors help to explain this rapid growth in trade union membership after 1933? Undoubtedly the existence of a favourable governmental climate comes first, especially after the re-election of Roosevelt in 1936. With the C.I.O. a new generation of leaders and organizers entered the lists. Its campaigns were aggressive, well financed and led by capable tacticians Probably a major factor was the air of victory radiating from the C.I.O.'s leader, John L. Lewis, who in 1933–37 was a veritable George Washington of the American labor revolution

The A.F. of L.'s rejuvenation under the spur of rivalry belied the forecasts of doom by its detractors The early strategic victories in the campaign over General Motors and U.S. Steel created the conviction of the "C I.O. march to victory" The extended period of full employment during and after World War II enabled the new unions to become fully entrenched in their respective industries.

The La Follette investigating committee of the late 1930s brought to light the mechanism whereby employers prevented the spread of unionism prior to the New Deal The investigation covered a variety of industries throughout the country and disclosed the existence of a widely practiced industrial militarism—arsenals, "standing armies" and espionage. These disclosures came at a time when the favourable climate of the New Deal had already been giving way to the more normal suspiciousness of unionism's intentions always present in the minds of U.S. middle groups, and thus delayed an out-and-out swing in public opinion.

National Labor Relations Act.—The upheaval derived its impulse from the general political climate and not from the specific enactment to give unions greater rights—namely, the National Labor Relations (Wagner) act of 1935, to take the place of section 7(a) of the National Industrial Recovery act which had been declared unconstitutional. Employers as a rule were convinced that it would meet with the fate of its predecessor, and the act was held in virtual suspension. Its constitutional validity rested on the authority of congress to prevent industrial strife which impeded interstate commerce The act itself cited as its justification the objective to minimize industrial conflict through the equalization of the bargaining power of the employees and management

The employees could achieve something nearer equality in bargaining power only if they could organize and bargain collectively without fear of employer reprisals. The promotion of collective bargaining meant that an agency—the trade union—had to be stimulated so that it could represent the workers in negotiations with management.

The Wagner act declared that "employees shall have the right to self organization, to form, join, or assist labor organizations, to bargain collectively through representatives of their own choosing, and to engage in concerted activities, for the purpose of collective bargaining or other mutual aid or protection"

The act stipulated two methods of protecting these rights First, it included a list of unfair labour practices which employers must not commit The National Labor Relations board was made responsible for the prosecution and adjudication of all unfair labour practice charges One of the forbidden practices, employer domination of employee organization, forecast the doom of company unions. Second, the board certified the union authorized to represent the employees and could hold elections among the workers to that end The union selected by a majority of the employees voting was the exclusive bargaining agent for the entire unit. The board also determined the election unit, whether the plant, craft or industry

The NLRB was in no way concerned with the contents of the collective bargaining agreement nor with efforts to interpret or enforce it. In brief, the settlement of disputes over the terms and conditions of employment were outside the board's province The board intervened only to create the foundation of the collective bargaining structure and to keep it from being undermined by employer animosity

The unexpected validation of the NLRA in the spring of 1937 was a turning point in U S constitutional development—a change amounting to a peaceful revolution The supreme court staged what appeared like a counterreformation as a move to ward off the Roosevelt reformation.

At one stroke the national government became endowed with a far-reaching jurisdiction over protective labour legislation and the relations between employers and unions as well. And simultaneously government was freed of the restraining hand of the absolutely formulated freedom of contract doctrine under the due process safeguard in the constitution.

The National Labor Relations act came before the court in the form of five cases. The court in 5 to 4 decisions held that it made no difference whether manufacturing was strictly speaking interstate commerce What was important was whether particular conduct (commission of unfair labour practices by employers) affected interstate commerce If it did, congress could legally regulate it.

Because it could be shown that most manufacturing industries substantially affect interstate commerce, the significance of these and subsequent decisions was to widen vastly the prerogative of congress over the whole field of labour problems

Even with this broad interpretation the act did not apply to all industry It was estimated that about 13,000,000 people, or about 40% of all nonagricultural workers in the country at mid-century, were subject primarily to state regulation. The bulk of these were employed in retail trade, building construction, utilities, amusements and recreation, hotels, garages, insurance and real estate, laundering and dry cleaning and miscellaneous personal services To give to these workers Wagner act rights, several states enacted state labour relations acts

Protective Labor Legislation.—The peaceful constitutional revolution in 1937 also made possible the Fair Labor Standards act of 1938. It established basic minimum wages and overtime payment requirements for employees engaged in interstate commerce or in the production of goods moving in interstate commerce. Under amendments to the act passed in 1949 the minimum straight time hourly rate was increased to 75 cents an hour. The act stipu-

lated that one and a half times the worker's regular hourly rate of pay be paid for all hours worked over 40 a week The act also placed restrictions on child labour by prohibiting the shipment of goods in interstate commerce if produced in any establishment employing oppressive child labour

More stringent minimum wage and overtime pay requirements were written into the Davis-Bacon act (1931) and the Walsh-Healey Public Contracts act (1936) In combination these two acts provided that the secretary of labour set minimum wage rates on work done under contract for the federal government. The latter act also provided for overtime payments after eight hours work a day

The Social Security act of 1935 provided for two nationwide systems of social insurance to protect wage earners and their families against loss of income from unemployment, old age and death. First, the old age and survivors insurance program was an all-federal system operated through the Social Security administration. Covered wage earners and their employers shared equally in the cost of the program. Second, unemployment insurance was a federal-state plan under which each state would set up its own law and state administrative agency, with the federal government paying all operating costs It was financed by a 3% federal tax levied on the pay roll of employers. Prior to 1932 organized labour was hostile to compulsory unemployment insurance—an opposition founded on the basic A F. of L. suspicion of government. The extent and duration of the 1929–33 depression, however, caused the A F. of L in 1932 to support unemployment compensation legislation. Like the NLRA, the Social Security act was validated in a decision in 1937.

To protect workers in industries exempt from federal regulation, many states passed minimum wage and maximum hour laws applicable to them Nonetheless, the chief form of state protective labour legislation, mostly antedating the New Deal period, dealt with industrial injuries and accidents under workmen's compensation, with the later addition of unemployment compensation Other state protective legislation included child labour regulations, industrial safety and sanitation codes, apprenticeship regulations, equal pay laws, fair employment practices and sickness disability compensation The trend was toward a gradual levelling of standards in all states.

Labour Relations in World War II.—Shortly after the start of the national defense program in June 1940, the number of U.S. strikes began to increase rapidly, coinciding with a sharp rise in employment. To avoid lost production President Roosevelt on March 19, 1941, created the National Defense Mediation board.

It was given jurisdiction over all labour disputes certified by the secretary of labour as threatening "to burden or obstruct the production or transportation of equipment or materials essential to national defense" The NDMB was a tripartite board composed of labour, industry and public members appointed by the president.

The NDMB endeavoured to conduct three-party collective bargaining in cases where labour and management could not work out a solution to their differences. However, the board was also authorized to institute fact-finding procedures to investigate the causes of differences between employers and employees with public recommendations for equitable settlements The board, however, lacked any enforcement authority, and to achieve compliance with its recommendations it had to appeal to the president. The NDMB was abolished in Jan. 1942 after its C.I O. members had earlier withdrawn as a result of the board's refusal to accept the closed-shop principle for the captive coal mines.

In late Dec. 1941, after U S. entry into World War II, an industry-labour conference was convened in Washington, D.C., to formulate a policy of wartime industrial relations. At this conference trade union leaders gave the famous no-strike pledge. The conference participants were in agreement that all industrial disputes should be settled by methods which would not hamper war production, but they could not agree on the union security question.

As an outgrowth of this conference the president on Jan. 12, 1942, established the National War Labor board. It was empowered to deal with every type of dispute that "might interrupt work that contributes to the effective prosecution of the war." The NWLB was also a tripartite board whose members were appointed by the president If the board could not gain a voluntary settlement it would in the last analysis act as a compulsory arbitration panel

As a result of an executive order issued Oct. 3, 1942, the NWLB was charged with the administration of another vital wartime measure—stabilization of wages as part of the administration's anti-inflation program Thus, in addition to settling industrial disputes, the board had to see to it that no adjustments in wage rates were made without its approval.

To cope with the tremendous volume of work arising from its wage stabilization powers, the board had to decentralize In Jan. 1943, it set up 12 regions, each served by a regional war labour board which had delegated to it virtually all the powers of the parent body in determining both voluntary and dispute cases in wages as well as resolving industrial disputes arising from other causes

The NWLB was actually the final appellate body in all wage and other industrial disputes. The War Labor Disputes (Smith-Connally) act of June 25, 1943, gave to the NWLB powers not only to "decide the dispute" but also to specify the "terms and conditions . governing the relations between the parties"

The Smith-Connally act also gave the president power to seize privately owned war plants and to operate them under government control, where an actual or threatened strike or lockout involved interference with war production. It forced union officials to notify the appropriate federal agencies of the existence of a labour dispute affecting war production For 30 days thereafter, no strike could be called in such private plants On the 30th day, the NLRB was to conduct an election among the employees directly involved, to determine whether they wished to strike.

Failure of the industry-labour conference to agree on the union security question tossed it into the lap of the NWLB. In solving this problem the board often granted both "maintenance of membership" and the checkoff Under this type of union security, union membership was not compulsory but anyone who was a member of the union after the brief escape period had expired had to remain in the union or be discharged.

In an attempt to stabilize the general wage level the NWLB developed the "little steel" formula Announced on July 16, 1942, it stated that wage rate increases, made because of increases in the cost of living, would be limited to 15% of the existing rate on Jan 1, 1941 While prohibiting general wage rate increases above those set by the "little steel" formula the NWLB did sanction: (1) wage increases clearly necessary to correct substandards of living; (2) intraplant wage adjustments to create a balanced wage rate structure; (3) increases to adjust interplant wage inequalities; and (4) fringe wage issues. The latter referred to paid vacations, paid holidays, preparation time, shift differentials, sick-leave pay, dismissal or severance pay, etc.

In more than 300 cases the board directed managements and unions to negotiate the elimination of intraplant wage inequities—different rates of pay for jobs entailing the same skill and experience To accomplish this goal the parties were required to analyze the content and character of each job in the plant, assess each job's relative standing in the production scheme and set the appropriate rate for each job classification The board thus stimulated a rationalization of the wage rate structure.

During the war, unionists were members of a variety of boards (NWLB, War Production board, War Manpower commission, Office of Price Administration) engaged in promoting the war effort. As a result of union representation on these various boards, not only was the war effort promoted but the status of unions in the community and in the nation was enhanced.

Restrictive Labour Legislation.—The end of hostilities terminated the no-strike pledge. The years 1946, 1947 and 1949 saw numerous large-scale strikes. The unions, especially in the newly unionized industries, still had to convince employers that they had taken root and proved it by successfully standing guard over the real wages and job control acquisitions in the collective agreements. To the latter it added a new device of "social secu-

rity by contract" in the shape of pensions and other social insurance protections obtained by collective bargaining But with these determined stands in the economic arena unionism suffered a serious loss in its legal status. The 80th congress under Republican control enacted in 1947 the restrictive labour law popularly known as the Taft-Hartley law.

As a prelude to the passage of the Labor-Management Relations act of 1947, numerous states had enacted one or more union control laws. As early as 1939 Pennsylvania had amended its state labour relations act, and Wisconsin repealed its act and passed a new one Between 1939 and 1947, five states passed new labour relations acts of a restrictive nature These laws dealt, among other things, with mass picketing, jurisdictional strikes, sympathetic strikes, primary and secondary boycotts, refusal to handle nonunion materials, prohibition of the closed shop and the check-off, registration and submission of information by the unions to the state government, filing of financial statements and regulation of strikes in public employment and public utilities.

There were at least three major factors contributing to passage of the Taft-Hartley act. Employers, while no longer opposing the collective bargaining objective of the NLRA, saw themselves pilloried in the one-sided recital of "unfair practices" The public was concerned with the strike wave which followed World War II, especially the perennial coal strike threats Lastly, the conservative middle class groups, with their suspicion of unionism on so many scores, added their influences in congress

Curiously enough, while government controls were now being quickly dismantled, the Taft-Hartley act went much farther than did the Wagner act in regard to the role of government in industrial relations. It provided for government regulation of the manner in which bargaining was conducted and of the contents of the collective agreement.

More specifically, the Taft-Hartley act retained the basic provisions of the Wagner act—the stipulation of the rights of employees and the means for protecting those rights—but placed a host of union activities under government surveillance. Foremost of these was the definition of certain union activities as unfair labour practices. The NLRB was to prevent their occurrence, and injunctions were relied on for enforcement.

Certain restrictions were placed on the internal administration of unions. Under a union shop contract men could be discharged only for cause or for failure to pay their union dues and initiation fees. Furthermore, the NLRB was charged with determining whether these dues and fees were excessive. In order to be able to use the services of the NLRB, unions had to file extensive information with federal authorities. Union officers had to file affidavits of nonmembership in the Communist party.

The act also defined the procedures to be followed in attempting to write a new collective agreement and in dealing with strikes or lockouts which threatened the national health or safety, giving the president the power to exact a cooling-off period of 80 days enforceable by court injunction in which an *ad hoc* board probed the dispute. The Taft-Hartley act stated that certain provisions could not be included in a collective bargaining agreement even though both parties might want them The chief outlawed provision was the closed shop Also prohibited were the compulsory checkoff, payment by an employer for services not performed, inclusion of plant protection workers in a bargaining unit with production workers and a one-sided union administration of health and welfare funds to which employers agreed to contribute.

Unions could be sued in the federal district courts for violation of contract. Employees of the federal government were prohibited from striking, the penalty being immediate discharge, forfeiture of civil service status and denial of re-employment for three years. Before a union could negotiate for a union shop a majority of the eligible employees in the unit had to approve it in a special election Statutory rules were established for the NLRB to follow in defining the bargaining unit.

There was a separation of the judicial and prosecuting functions previously performed by NLRB employees The general counsel was now given a status independent of the board and was charged with the responsibility of prosecuting all unfair labour practice charges. A final major provision of the Taft-Hartley act established the Federal Mediation and Conciliation service as an independent agency

The effect of this demotion in legal rights was to stop for a time at least a further unionization of the south Approximately 14,800,000 workers, or 48% of the workers in occupations in which unions had sought agreements, were employed under collective bargaining agreements in 1949, contrasting with 4,000,000 in 1935. In manufacturing industries, 7,900,000 workers, or 69% of those employed, were covered and in nonmanufacturing industries, 6,900,000 workers, or 35% of those employed.

Labour and Political Action.—With the New Deal, organized political action became one of the chief activities of the U S labour movement. As the law-making instrument had suddenly acquired a cutting edge, it lent itself more to furthering labour's objectives Politics was no new experience to the American Federation of Labor. As early as 1906 the pattern was established "reward your friends and punish your enemies." The early investments in political action, however, were meagre With the scope of government rigidly limited by judicial interpretation, it would have scarcely rated as prudent investment to have gone further Not so after the revolution of 1937.

Labour's first real political victory came with the election of Woodrow Wilson and a Democratic congress in 1912 The policy bore its first fruit when the Democrats passed legislation, notably the Clayton act, which labour had desired for years. Labour gave its full support to Wilson's re-election and reaped full recognition in World War I.

In 1924, under Gompers' insistence, the A F of L. stretched its own nonpartisan policy to support Robert LaFollette's independent candidacy. The years 1924–36 represented a blank so far as political action was concerned. Roosevelt's election in 1932 occurred without labour's active support. But in 1936 labour felt that with the broadened opportunity it had received with the New Deal, a most strenuous effort to re-elect the president would be warranted Two political agencies were created Labour's Non-Partisan league was organized primarily by leaders of the C.I.O and was accompanied by a contribution of $500,000 from the fund of the United Mine Workers to the Democratic cause The American Labor party was organized in New York state by trade unionists, socialists and liberals eager to support Roosevelt without having to back Tammany hall candidates.

At a special meeting of the executive board of the Congress of Industrial Organizations, under the spur of Sidney Hillman, the labour leader closest to the White House, held in Washington, D.C., July 7, 1943, the C.I.O. Political Action committee was created.

Under the direction of Hillman the P.A.C. in 1944 flooded the nation with publicity supporting the candidacy of Roosevelt. Its grass roots work—that of house to house campaigning—was limited.

Yet the P A C. did make a significant contribution to the Democratic victory in 1944 for it filled the gap in many communities where the Democratic machine was run-down and inefficient. Two years later the P.A.C paid for its failure to build block and ward organizations. P A.C -backed candidates were defeated en masse in 1946. The Taft-Hartley act was a consequence.

The response of labour was instant and direct Taft-Hartley should be repealed immediately and its supporters be defeated at the next election. To co-ordinate the A F of L.'s political activities the 1947 convention authorized the executive council to set up Labor's Educational and Political league. The railroad workers followed suit with a Railway Labor's Political league in late 1947. There was also a recasting and revitalizing of the C.I.O.-P.A.C.

Labour played a role in the unexpected triumph of Harry S. Truman in 1948. The P.A.C. endorsed the Democratic ticket, but the A F. of L. executive council refused to repudiate its traditional policy of not endorsing a presidential candidate by name Notwithstanding this refusal many top leaders of the A.F. of L. came out for Truman.

Communism and International Labour Relations.—U S.

labour became concerned with Communist infiltration into positions of command as early as the 1920s. Fired by a sense of mission as the vanguard of the proletarian revolution, the Communists asserted an exclusive right over the labour movement and felt it their duty to assume leadership

Even before the passage of the Taft-Hartley act, U.S. labour was ejecting leaders who had subordinated the interests of the trade unions to those of the Communist party The act with its compulsory anti-Communist affidavit for union officers gave greater sweep to a spontaneous trend Communists had played a vital role in the early stages of the C I O mass production unions because of their indefatigable zeal as organizers However, in 1949 the C I O., disregarding union autonomy, ordered about a dozen of its internationals suspected of Communist influence to purge themselves of it under penalty of ultimate expulsion. Simultaneously a constitutional amendment was passed barring Communists or their consistent followers from membership on the executive board Prior to this drastic purge the Communists had been defeated after several years struggle in the C.I.O.'s biggest affiliate, the United Automobile Workers.

While U.S. labour acted to solve this crucial internal trade union problem, it also showed novel activity on the international scene It vigorously backed up the administration's program of rebuilding western Europe and containing Communism A new term came into use—"labour diplomats" These "diplomats" set out to win the confidence of the non-Communist unions in western Europe and to encourage them to resist Communist encroachment. The culmination was the International Confederation of Free Trade Unions formed in Dec 1949, to ensure "collaboration between the free and democratic trade union movements throughout the world." The World Federation of Trade Unions set up in 1945 as labour's counterpart of the policy of continuing the "grand wartime alliance" had quickly become a soviet tool. The A F. of L. had never joined in, but the C.I O did, together with the unions of Britain and western Europe. In the new trade union international (I.C F.T.U) the A.F. of L. and C I.O. appeared for the first time as co-operating and equal members U S. labour imposed its stamp upon the new international when the traditional commitment to socialism was omitted from its platform in order to avoid raising an issue which might divide labour on opposite sides of the Atlantic ocean (*See also* LABOUR LAW; STRIKES AND LOCKOUTS.)

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(S. PE)

CONTINENTAL EUROPE

France.—In France trade unions became active in Paris and Lyons in the 1820s and 1830s, but had no legal recognition until 1864, when a regime of toleration began, and no assured legal position until 1884. The right of combination was still refused after this to public employees. The federation of *syndicats* formed under the act of 1884 came at the outset mainly under Socialist party (Marxist) influence, but did not make much progress until in 1894 it was absorbed into the *Fédération des Bourses du Travail*, which had been formed the previous year by the *bourses du travail* (a mixture of trades councils and local labour exchanges) The combined body came under the influence of Fernand Pelloutier, an anarchist-syndicalist, who stood for a revolution based on local working-class solidarity rather than on national organization. It opposed parliamentary action, favouring direct action by strikes to coerce both the employers and the government. In 1895 a *Confédération Générale du Travail* was founded, but was amalgamated with the F.B T in 1902, and passed under syndicalist leadership. The new C G.T. remained aloof from the socialists, who were divided into a number of rival parties. Under Pelloutier's leadership it developed the theory and policy of revolutionary syndicalism—no agreements with employers, sudden strikes, sympathetic strikes, sabotage and antimilitarism—with a social general strike in the future as the means of ushering in the new era of workers' control. To Pelloutier's doctrines Georges Sorel added the notion of the general strike as an inspiring social myth and of the practice of aggressive direct action as a training in revolutionary techniques The C.G T., which had its period of maximum activity between 1902 and 1914, thus grew up wholly apart from French socialism, though of course many trade unionists belonged individually to socialist bodies The C G T 's policy was laid down in the Amiens Charter of 1906, which had considerable international influence on trade union developments during the following years.

The majority of the C.G.T., despite its antimilitarist philosophy, supported the war effort in 1914, and the consequent dissensions led, after the Russian revolution, to a split. The C G.T. formulated in 1919 its doctrine of a *nationalisation industrialisée*, based on workers' participation in the control of industry, but took a nonrevolutionary line. The Communists founded in 1921–22 a rival body, the C G.T.U. (*Unitaire*), and up to 1935 the French trade unions remained divided into hostile factions, which greatly reduced their power

In that year, under pressure of the crisis of 1934, the two main bodies united in a new C G.T. This was a leading element in the popular front movement, which was victorious in the general election of 1936, and the trade unions remained united, largely under Communist leadership, until 1948, when a section headed by Léon Jouhaux, long the leader of the French trade union movement, broke away to form a C.G.T —*Force Ouvrière*, in fairly close association with the Socialist party, but by 1950 the secession was unable to shake the Communist control over the main body of manual workers, the elements supporting *Force Ouvrière* being largely white-collar workers. The Catholic trade unionists (*Confédération Française des Travailleurs Chrétiens*), who had always formed a distinct element in French trade unionism, had little strength outside the textile industries and certain white-collar groups.

Germany.—In Germany workmen's associations first came to the front in the 1840s, mainly on a political basis; and the movement was renewed in the 1860s under the leadership of Ferdinand Lassalle. The Marxists also became active, but these new movements were also mainly political, and there was no considerable growth of trade unions until the 1870s. From 1878 to 1890 trade unions, as well as socialist bodies, came under the ban of Bismarck's antisocialist laws.

On their repeal the movement developed rapidly, the largest section being closely associated with the Social Democrats, though nominally independent of them The *Freie Gewerkschaften*, organized under a *Generalkommissson der Gewerkschaften Deutschlands*, had reached by 1914 a membership of 2,000,000; and there were two smaller movements, the more important under Catholic and the lesser under liberal auspices These bodies remained separate under the Weimar republic, with the *Allgemeiner Deutscher Gewerkschaftsbund* (successor to the general commission) by far the preponderant element.

The severe depression of the 1920s hit trade unionism hard; and it was also rent asunder by dissensions between Social Democrats and Communists. The Communists formed some separatist bodies, but tried in the main to work through and capture the free trade unions, which were largely paralyzed by political dissensions until the whole movement was destroyed and transferred to a nazi-controlled *Arbeitsfront*, governed from the top, after the nazi accession to political power in 1933.

After 1945 trade unionism was gradually revived, but separately in eastern and western Germany. In 1950 there were two separate trade union movements, one associated with the Unified Socialist (Communist) party in eastern Germany and the other in western

Germany.

Western European Countries.—Rival Christian and mainly socialist free trade union movements existed in Italy, Belgium, the Netherlands and a few other countries, and the former were linked both between World Wars I and II and in 1950 in an International Federation of Christian Trade Unions Trade unionism was strong in the Scandinavian countries, in Finland, and fairly strong in Switzerland

In Austria it was suppressed under the nazis, but revived, especially in Vienna, after 1945. In Spain it perished after the Civil War of 1936–39; previously it had been long divided between the predominantly anarchist-syndicalist National Confederation of Labour (C.N.T.), strongest in Catalonia, and the mainly socialist General Union of Workers (U.G.T.), strongest in central and northern Spain

In Italy too there was a long history of dissensions between syndicalists and socialists, until the whole movement was suppressed and replaced by *sindacati* under fascist control in the 1920s The fascist unions, based on compulsory workers' contributions and conducted under strong party control, had no independent role, though much was made of them as a façade under the fascist regime After the liberation of 1944, trade unionism re-emerged, passing mainly under the control of the communists and left-wing socialists, until in 1948–49 various groups split away to form separate federations, one under Catholic and the other under moderate socialist auspices As in France, up to 1950 the main body (*Confederazione Generale Italiana del Lavoro*) remained predominantly under communist influence.

Soviet Union and Eastern Europe.—In Russia trade unions first appeared on a considerable scale in the revolution of 1905, but were thereafter crushed out. They reappeared in the 1917 revolution, and speedily became highly organized in a national movement under Communist control The Soviet trade unions were used as agents of the state in the execution of social policies, and were given a large share in the control of the commissariat of labour. When, however, they threatened in the late 1920s and early 1930s to assert their independence of Communist party control, their leadership was promptly purged, and they became more and more welfare agencies and subordinate instruments of state policy. As welfare agencies they retained very important functions in the organization of social services for their members, but industrially they became mainly instruments for helping in the drive for higher production and for Communist propaganda abroad as well as at home. The *Vsesoyuzny Tsentralny Soviet Professionalnykh Soyuzov*, or All-Union Central Council of Trade Unions, took a leading part in forming the World Federation of Trade Unions in 1945, and gave particular attention to efforts to foster trade unions under Communist or near-Communist leadership in colonial countries and in the far and middle east, and also to building up their influence over the trade union movements in eastern Europe and in France and Italy. Of the countries under Soviet domination, Czechoslovakia had the most strongly organized trade union movement; but growth had been rapid elsewhere, especially in Poland and Hungary.

OTHER COUNTRIES

Australia and New Zealand.—Outside Europe and the Americas, the strongest trade union movements are in Australia and New Zealand. These have a long history, having been started mainly by settlers from Great Britain, including, in Australia, Chartists and others transported for political offenses. The Australian and New Zealand unions fought their earliest battles for the eight-hour day, and subsequently for the minimum wage, and were the creators of the Labour parties which rose later to political power. The systems of arbitration built up in both countries at first favoured union claims, but later, when a living wage had been secured, offered fewer advantages so that strong left-wing opposition developed, accompanied by many strikes. Industrial unionist ideas, derived from the United States, became influential in the period before 1914, and retained some hold, especially among miners and dock workers, who were influenced also by Communism. The main body of trade unionists, however, supports the Labour party and works under the arbitration system.

India.—In India trade unions did not become important until the 20th century, and have been rent by many divisions. Between World Wars I and II there existed rival central bodies, the Indian Trades Union congress and the more moderate Indian Federation of Labour, besides many independent bodies, such as the Railwaymen's federation and the Gandhist Ahmedabad Labour union

Communists made many attempts to capture control of the unions, with some success, and there were also rivalries between the Socialist party and the Indian Congress party leadership, to which the main body of the Socialists remained attached up to 1947 The split between the Socialist and the Congress parties led to new rivalries, and the position remained unsettled at mid-20th century.

China and Japan.—In China trade unionism has been a battleground of rival political tendencies ever since its emergence as a defined movement in the 1920s. Trade unionism of a sort, in the form of guilds and clubs of workers in the same trade, has a very long history, and the basis of modern trade unionism is still in working groups of this type or in factory councils More formally organized trade unions came into existence during the period after World War I, with Communists playing a leading part After Chiang Kai-shek's coup of 1927, unions under Communist influence were suppressed, and the movement was driven largely underground Later, the Kuomintang leaders began to organize government-sponsored unions under approved leadership, and the Communists in addition to carrying on their own "red" unions, adopted a policy of infiltration into these "yellow" unions and of fomenting mass strikes wherever opportunity arose—as it continually did because of the vast inflationary rise in prices. The struggle for the control of the unions was resumed after 1945, and the Communists, whenever they established control of an area, set up or consolidated unions under their own control and gave them large authority in relation to privately owned undertakings. Strikes multiplied in the areas still under Nationalist control, and the Communists were able, despite repression, greatly to increase their hold on the workers throughout the country, and thus to prepare the way for their victories of 1949

Trade unionism in Japan, after developing fairly rapidly in the 1920s, was for the most part suppressed in the 1930s, except for benefit societies under official surveillance It emerged again after 1945 and became a point of contention between left-wing and moderate tendencies

Malaya.—In parts of Malaya and in Hong Kong, Chinese labour organizations at mid-20th century were strong and largely under Communist influence. In Malaya Chinese guilds and associations of the traditional type were numerous, and on them were superimposed societies and clubs, largely of friendly society type, formed under the Societies Ordinances of 1889 and 1895, and on these again regular trade unions under the Trade Union ordinances which came into operation in 1946. Meanwhile the Malayan Communist party, founded in 1928, set up cells among the workers; and after 1945 these were expanded into trade unions nominally covering most industrial groups and federated into a General Labour union, which was later divided into separate bodies for Singapore and for the rest of Malaya.

Colonial Trade Unionism.—Trade union movements at mid-20th century had begun to develop in other colonial areas, particularly in the British West Indies and in west Africa. They were in most cases closely connected with political movements, but had an economic basis in the low standards of living and in the conditions of mining and plantation economies in backward areas There had been extensive strike movements in Trinidad, Jamaica and other parts of the West Indies, in Mauritius and in Nigeria and other parts of west Africa

The policy of the British government was to recognize colonial trade unionism and to endeavour to guide it as far as possible into nonpolitical channels. As against this, the World Federation of Trade Unions, especially after it had come entirely under Communist control, tried to develop colonial trade unionism as an auxiliary to the anti-imperialist movement of the coloured peoples and to influence it toward mass strike action whenever oppor-

tunity occurred. In Jamaica William Bustamante rose to power in the 1940s mainly by organizing mass trade unions among the plantation workers and other discontented groups, though after his accession to office his policy became very different The rival movement led by N. W. Manley had greater strength among the more skilled workers Jamaica has its own Trade Union congress, which forms a sector of the Caribbean Labour congress, with similar bodies throughout the British West Indies.

INTERNATIONAL ORGANIZATIONS

Internationally, world trade unionism was split after 1949 between two rival organizations—the Communist-controlled World Federation of Trade Unions, set up in 1945 on a wider basis, and the International Confederation of Free Trade Unions, founded late in 1949 mainly by the national bodies which had seceded from the W.F.T.U. in protest against its Communist direction Trade union organization began with the International Federation of Trade Unions, set up in 1901, and centred in Germany up to 1914. The I.F.T.U. was reconstituted in 1919, with headquarters in Amsterdam, Neth., and the Russians soon set up a rival Red International of Labour Unions as an auxiliary to the political Communist (third) international

The contest between these bodies continued up to 1939; but after 1941 there were close contacts between the British and Soviet trade unions, and in 1945 an attempt was made to set up an inclusive international The W.F.T.U. was intended to reconcile differences; the British T.U.C. and the U.S. Congress of Industrial Organizations, as well as the Soviet V.Ts.S.P.S took part in its foundation, only the American Federation of Labor refusing to join The rift came with the strong opposition organized by the Communists against the Marshall plan The headquarters of the W.F.T.U., under French leadership, joined in this opposition, and, after vain attempts to check this, the British T.U.C. and the C.I.O. left the organization and proceeded, with the A.F. of L. and the Dutch, Scandinavian, Belgian and other national groups, to establish a rival federation, including minority groups in France, Italy and various other countries The bodies attending the inaugural conference of the I.C.F.T.U. included the French Christian Trade Union federation, but not the distinctively Christian movements from other countries, to whose presence the free trade union movements of the Netherlands, Belgium, etc., objected During the conference it was decided to invite all the Christian federations to join, subject to their dissolving their separate international federation

While the western trade unions were forming their new international in London, the W.F.T.U. was holding a conference of trade union movements in Asia and Oceania at Peking, China, attended by delegates from China, Malaya, Burma, India, Ceylon, Indonesia, Indo-China, Thailand and other areas, to draw up a common program for Communist trade union action The two internationals were also contending for control of the international trade secretariats of trade unions in particular industries (transport workers, miners, railwaymen, metal workers, textile workers, etc.). These bodies, many dating back to the period before 1914, had refused to merge themselves in the W.F.T.U. before the split, and after the split a number of them formed a joint committee which co-operated independently in preparing for the foundation of the I.C.F.T.U., to which they would become attached, but probably in such a way as to keep their independence Other secretariats remained attached to the W.F.T.U., which regarded them as subordinate departments and was forming new ones in rivalry with those which rejected its control.

The W.F.T.U. claimed in 1945 to represent 67,000,000 trade unionists, including 30,000,000 members of Soviet *profsoyuzy;* the I.C.F.T.U. in 1949 claimed 48,000,000 participating in its inaugural conference and another 2,000,000 expected to join. (*See* also INDUSTRIAL RELATIONS.)

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TRADE WINDS, the name given to the regular northeasterly and southeasterly winds which blow from the tropical belts of high pressure toward the equatorial belt of low pressure. Their regularity, especially over the oceans, explains their name, the term "trade" being used in the otherwise obsolete sense of "course" (*cf.* "tread"). Their distribution may be considered broadly as being between 3° to 35° N., and from the equator to 28° S., but at any particular period their influence is felt over a narrower area on account of their seasonal swing into higher latitudes during the respective summer seasons of the two hemispheres The best area for the study of these winds is the Atlantic ocean (See *Met. Office Publication*, no. 203; also METEOROLOGY.)

TRADING POSTS flourished in North America from earliest colonial days until late in the 19th century as places of exchange of goods and currency between Indians and the settlers and traders In 1565 the explorer Pedro Mendenez wrote to Philip II of Spain mentioning the existence of trading areas along the Gulf of St Lawrence to which Indians brought bison skins for trade to the French The first English trading post was established at the Jamestown colony in Virginia. Corn and pelts were the chief articles of exchange until beads, or wampum (*q.v.*), were established as currency Wampum, as made by the Indians, was shells which had been ground and polished to the shape of cylindrical pellets, but in 1621 a glass furnace operated by Italian workmen had begun to manufacture artificial wampum in Virginia

In 1668 two French traders, Sieur des Groseilliers and Sieur de Radisson, opened a post on the shore of Hudson bay which eventually was chartered by Great Britain as the Hudson's Bay company (*q.v.*) Throughout the period of colonial expansion, the principal mother countries—Great Britain, France and Spain—set up strategic trading posts which supplied the Indians with guns and ammunition and, later, liquor After the Revolutionary War, in an effort to control the liquor problem and to establish a fair standard of trade, a law was passed authorizing government trading posts controlled directly by the president. All border forts became trading posts In 1806 an office of Indian trade was created. By 1810 posts had opened in Ohio, Georgia and in the Louisiana, Indiana, Michigan, Mississippi and Orleans territories.

The government measures did not solve the problem, however, as English trading posts, handling illegal liquor and supplying the Indians with war materiel, continued to operate in the Ohio and Mississippi river areas until after 1814. Furthermore, the government posts were bitterly opposed by private traders. In 1822 the posts were abolished.

In 1811 John Jacob Astor (*q.v.*) set up a post on the Columbia river which became one of the largest fur centres in the nation. Another famous post was the one near Gardner, Kan., the town marking the beginning of the Oregon trail west. By the 1840s trading posts had been established throughout the southwest and the Pacific coast. Many of the original sites have since become large cities—Kansas City, Boise, Spokane, Winnipeg, and Vancouver among them

The physical structure of a trading post is described by the Smithsonian Bureau of American Ethnology (*Handbook of American Indians*, 1910) as "a large square inclosed by a stockade . . within the stockade were storehouses, quarters for the men, and a room for general trade."

TRAFALGAR, THE BATTLE OF. The British naval victory over the French and Spanish fleets off Cape Trafalgar, on Oct. 21, 1805, was a sequel to the breakdown of Napoleon's scheme

for invading England

An account of the movements leading up to it, known as the Trafalgar campaign, will be found under the heading NAPOLEONIC CAMPAIGNS.

Admiral Villeneuve, returning from the West Indies, succeeded in making the port of Ferrol; thence he should have sailed for the Channel and effected a junction with the Brest fleet, but, judging that Napoleon's schemes were already defeated, he made for Cadiz instead Nelson, after his arrival at Gibraltar from the West Indies, had fallen back on the English Channel fleet, but Collingwood was watching Cadiz with three ships. On Villeneuve's arrival, he retreated slowly towards the Straits, and the French pursued him; but they had no wish to be drawn into the Mediterranean, and after a time retreated to Cadiz, and Collingwood was able to resume his station; he was joined at the end of August by reinforcements amounting to 22 ships. The importance of defeating or effectively blockading this allied force which now numbered 33—15 of them Spaniards—was fully realised by the Admiralty, and in September they decided to send Nelson to take command of the blockading force.

Nelson in Command at Cadiz.—Nelson left Portsmouth on Sept. 15 with three sail of the line, arriving off Cadiz on the 29th of the same month—his forty-seventh birthday. He had sent ahead a frigate to forbid any hoisting of colours or firing of guns, in order not to draw the attention of the Allies to the arrival of British reinforcements. But the unofficial welcome he received was such as to put heart into any commander of a fleet. During the first fortnight of October he was reinforced by a further six ships, so that his strength was at one time 34, but at the time the battle was actually fought he had only 27 ships at his disposal; six had been sent to Gibraltar to revictual, and Admiral Calder, who was going home to face court-martial for his unsatisfactory action off Finisterre, was magnanimously allowed to return in his flagship. Nelson did not keep the bulk of his fleet close to Cadiz; only the frigates were inshore, most of the ships being some 30 to 40 miles to sea, connection being maintained by a line of signal ships.

Villeneuve Ordered to Mediterranean.—Nelson's first task was to induce Villeneuve to put to sea, and this was performed for him by Napoleon himself. A new coalition of European powers had just been formed against Imperial France, and Napoleon, unable to use his troops against England owing to the breakdown of his schemes, had marched them against Austria. He thus required naval support in the Mediterranean, and Villeneuve was ordered to leave Cadiz and enter that sea; furthermore, should he encounter an enemy fleet to which he was not inferior, he was not to hesitate to attack them. These commands reached the French Admiral at the end of September. He knew, however, that they could never be acted on successfully, and a council of war held at the beginning of October decided that, though a sortie might be possible, to give battle to the British fleet would be suicidal. At this time, too, it appears that the Allies were under-estimating the strength of the British. Later in the month Villeneuve heard that Napoleon was sending Admiral Rosily to supersede him. This he regarded as a reflection on his honour, and he decided to put to sea before his successor arrived He did not intend to give battle to Nelson if he could get into the Mediterranean without doing so, but he fully realised that he would probably be forced into action; and he thought that, in such a case, Nelson's probable plan would be to obtain local superiority over part of his fleet. To guard against this he formed a reserve squadron of 12 ships under the Spanish Admiral Gravina, which was to keep to windward of the rest of the fleet, and thus be able to come to the assistance of any part of it that was in difficulties.

Nelson's Battle Orders.—Nelson had also drawn up orders for the guidance of his officers, and had explained to them how he intended to fight the battle. His instructions are embodied in the "Nelson Memorandum," which was drawn up at a time when he expected to have a larger force than 27. None the less the principles it contained are applicable with equal force to a smaller fleet. They were that the attack was to be made in two bodies, the larger, under Collingwood, was to obtain local superiority over the enemy's rear, while Nelson, with the smaller body, was to preserve him from the interference of the van and centre, should they attempt to go about to the assistance of the rear, as they normally would On the day of battle Collingwood's squadron consisted of 15 ships and Nelson's of 12.

Villeneuve Puts to Sea.—It was on Saturday, Oct. 19, that the first of the Allies got to sea. Nelson knew of their movements immediately, and made sail for the south-east so as to cut them off from passing through the Straits Only part of the allied fleet got to sea on the Saturday, and on Sunday the 20th the weather was so bad that they returned to the neighbourhood of Cadiz. Nelson, throughout, kept his main fleet out of sight, but followed them, move for move, receiving all the information on which he based his decisions from his frigates. Monday the 21st was a fine day; the wind was light and blowing from the north-west, and at dawn the two fleets were in sight of one another The Allies were sailing south, making for the Straits again, and the British were some 12 miles to the west of them. Nelson at once ordered his fleet to form two lines of sailing, in accordance with his plan outlined above His own squadron was the more northerly of the two, and each admiral was leading his own squadron, Nelson in the *Victory*, and Collingwood in the *Royal Sovereign*. In this formation, they approached the allied fleet, and as they came more clearly into view, Villeneuve, for the first time, saw that he had underestimated their strength He at once sacrificed the originality of his dispositions by ordering Gravina, with the reserve squadron, to come into the line; and, shortly afterwards, partly with a view to keeping Cadiz open as a refuge on his lee, and partly to counter what he thought was designed as an attack on his rear as he was sailing south, he ordered his whole fleet to wear and sail roughly north

Collingwood's Attack.—Villeneuve's order to his fleet to wear was made about 8 o'clock, and it was not properly finished when Collingwood, who was to initiate the attack, ordered his squadron to change its formation from an irregular line ahead to an irregular line of bearing This was about 8-50, some two hours after Nelson had first ordered the advance. Collingwood's object was to bring his force into a line as nearly parallel as possible with the part of the enemy line that he was to engage, and the concavity in their line was such that this manoeuvre would virtually produce that result. Nelson had given his second-in-command a free hand in deciding how to carry his line into battle, so that the credit for this movement, admirably suited as it was to the circumstances and designed to enable the British ships to use their broadsides as they got into action, must be given to Collingwood For the rest, he carried out brilliantly the part assigned to him—namely to break through the enemy and engage the rear 12 ships. His own vessel, the *Royal Sovereign*, being a very fast sailer, was in close action just after 12 o'clock, and to her fell the duty of selecting the gap which would enable him to cut off 12 ships. Actually he cut off 15 and became engaged with 16

Nelson's Attack.—It now remains to consider the movements of Nelson's line The commander-in-chief it will be remembered had kept for himself the duty of preserving Collingwood from any interference from the allied centre or van For this purpose he continued his advance in the order he had first assumed, that is to say, irregular line ahead. With the object he had before him, he naturally wished to disguise the point at which his attack was finally to be directed, and line ahead was the most flexible and easily-managed formation he could adopt. It had the drawback of exposing the head of the line, as it approached, to the concentrated fire of the enemy, but Nelson was prepared to regard this as a justifiable risk in view of the advantage of flexibility which the formation conferred, and which was peculiarly valuable in the particular circumstances. The event proved him right. He began by aiming at the van rather than the centre of the allies, whose leading ships, nervous of having their T crossed, crowded on sail to prevent this manoeuvre being executed, thus taking themselves further from that part of their line which was now being attacked by Colling-

wood, and which Nelson did not intend should be assisted by them. Indeed, the whole of the allied van and centre, mystified by Nelson's movements and uncertain of his aims, could do nothing but wait for him to declare his intentions, while they left the rear to look after itself. Nelson was himself leading his line, and as the *Victory* approached the allied van, he turned to starboard, followed in succession by the ships in his squadron and sailed down the allied line, looking for a suitable place at which to break through. This turn enabled him to open fire, but he preferred to hold it Finally he found a gap astern of the *Bucentaure*, twelfth ship in the line and Villeneuve's flagship, and, passing through, he opened fire, raking the ships on either side with terrible effect. The majority of his line deployed to starboard and broke through the Allies at various places between the points pierced by Nelson and Collingwood, but two more ships ahead of the *Bucentaure* were engaged, the leading ten ships finally being left without attention. Six of these, under Dumanoir, at length made some attempt to go about to the help of those behind them, but their arrival was too late to be of any use, and they made off; for, in the meantime, Nelson's 12 had been matched with 7, with the inevitable result. By this time, too, victory had declared itself for Collingwood, who had been left without interference, as Nelson had designed, to complete the destruction of the rear.

Completeness of the Victory.—In all, 20 prizes were taken —about 60% of the allied fleet. A larger percentage was taken or destroyed at the Nile, but the comparison is not a sound one, for at the latter battle the enemy were caught in a confined space. At Trafalgar they had plenty of room to manoeuvre and a friendly port on their lee; yet they could not escape, such was the paralyzing effect of Nelson's tactics—an inspired mixture of the traditional and original. Nelson had solved a problem that had puzzled British admirals for a century—namely, how to prevent the French making off while most of their fleet was still more or less intact. For this reason Trafalgar is regarded as the greatest of naval battles, and Nelson as the greatest of admirals

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TRAFFIC AND TRAFFIC REGULATION.

The problems of road traffic, though changing through the centuries, have always been closely related to the capacity and quality of the road system. The narrowness and awkward layout of the old town-streets led to congestion and delay, while in the country the roads were often so bad as to render passage problematical. indeed a common law right still exists in England enabling the traveller to go upon adjoining land if the road is so founderous as to be impassable or incommodious. The 19th century brought more spacious streets, but once again these are inadequate for the traffic volume, while in the country the roads designed and perfected for horse-drawn vehicles are now called upon to carry traffic of a type for which they were never intended. The problem is perpetual.

GREAT BRITAIN

In large modern towns the problem has become more acute than ever before, because (1) a continuous increase of population has caused the town itself to extentl outwards, its size thus becoming quite disproportionate to a cramped central area which nevertheless continues to be the focus of the town's activities, and (2), following the advent of motor traffic, the number of vehicles on the roads has within little more than a generation multiplied many times over. So inadequate is the road space for this sudden increase that very serious congestion occurs. A further complication is that the roads themselves, being open to pedestrians and giving immediate access to frontages, are not safe or suitable conduits for fast mechanical traffic The railways, before they developed high speeds, provided suitable tracks, but no such provision was made on the roads; and in the ten years before World War II more than 2,000,000 people were killed or maimed on the roads of Great Britain

The Object of Traffic Control.—Control of traffic has a two-fold object (1) to develop free and rapid flows of road traffic and (2) to prevent those traffic flows from endangering their own units and the public at large. Ultimately the major roads will have to be made structurally safe and suitable for high speed traffic, but that task has been barely begun, and it will occupy a period of many years. Meanwhile there is a difficult interlude: until the roads have been made to fit the traffic, the traffic must be so regulated as to adapt its conduct to the unfit roads This involves restrictive traffic laws.

Existing Laws and Regulations.—Road traffic has three main elements: vehicular, pedal cyclist and pedestrian. Units of all three classes are traffic units. Vehicular traffic in general is governed by detailed laws and regulations, and motor traffic in particular is subject to special laws as to licensing of drivers and registration of vehicles, insurance, and the construction, maintenance and equipment of vehicles. A motor driver, on entering the public road, is responsible to avoid the commission of more than 200 traffic offenses, the pedal cyclist 30 and the pedestrian 2, viz., not to cause obstruction or to remain on a crossing place longer than necessary A principal aim of traffic laws is to promote safety; but the faults which cause injuries are not confined to one class of road user. An official analysis of 200,000 accidents in 1937 allocated blame as follows: drivers 33 6%, pedestrians 30 5%, pedal cyclists 22 8%, the remaining 13 1% being due to miscellaneous causes. In the light of this record, a certain absence of balance is noticeable in the matter of restrictive laws; and, as traffic control to be fully effective must govern all traffic units, a more even balance as between the three classes will be needed, both in restrictions and facilities

Congestion and its Remedies.—London affords an example of the congestion caused by the traffic converging daily on the centre of towns. As long ago as 1846 a London newspaper complained that "All our principal thoroughfares have become too small for the enormous stream of traffic hourly poured through them. We want new roads long and wide, establishing perfect lines of communication between the extremities, yet the best we can get is to patch and mend." In 1912 a census was taken of vehicles of all classes passing 38 of the more congested points between 8 A.M and 8 P.M. on a selected day. The total reached was 806,131. In 1937 a count taken at the same 38 points gave a total of 1,363,629, an increase of 69.1%. Such an increase of traffic in 25 years, without any corresponding increase of road space, presents a very serious problem Expressed in millions, the number of passengers carried by the various forms of transport in London has been estimated as follows.

Year	Railways (including suburban and underground)	Tramways	Trolley-buses	Omnibuses and coaches	Total
1912	686	797	—	552	2,035
1922	892	1,043	—	904	2,029
1932	947	1,038	—	1,905	3,890
1933.	942	1,002	27	1,950	3,921
1938	1,082	701	368	2,167	4,318

Note Figures for 1912, 1922 and 1932 relate to "Greater London"; those for 1933 and 1938 relate to the "London Passenger Transport Area"

The number of journeys has increased much more rapidly than the population; a new travel habit has in fact been established, for, whereas in 1900 every Londoner is estimated to have travelled 158 times a year by public conveyance, since 1925 the figure has been about 460. Resort has been had to many expedients to reduce congestion Fixed obstructions in the roads have been removed, and suitable streets made "one-way". there are 180 one-way streets in London, and the whole centre of Birmingham is worked very largely on the one-way principle Existing road layouts at various spots have also been used as roundabouts, *e.g.*, Hyde Park corner and Trafalgar square in London, signal-control being used to alternate traffic streams at points where they would

otherwise cut one another. Further measures which have been considered include the use of parallel back streets for the relief of the main traffic routes, and the exclusion of all private cars from the crowded centres; but the wisdom of these proposals is more than doubtful. Main traffic streams, being lethal, should be canalized and not spread over increasing numbers of back streets already devoted to shopping, residence, etc., while exclusion of private cars would be retrograde, for the wide use of the private car is the register of its value. At the same time, it is essential that existing main traffic routes should be made better conduits than they are at present. all standing vehicles which obstruct them should be absorbed into adequate parking spaces off the highway, and, for purposes of loading and unloading goods, back-access to premises fronting the traffic routes is required Main traffic streams will thus be afforded a better and smoother flow, which can be further expedited by the use of linked traffic signals.

These measures, however, are palliatives rather than remedies, and much bolder steps are seen to be needed. In towns where main roads still run through the town centre, an outer ring road is wanted, to enable the through traffic to by-pass the town altogether. The larger towns furthermore stand in need of at least one good circular road within the confines of the town itself, to enable the town's own traffic to by-pass the centre as much as possible For ring roads in built-up areas, by far the best plan is to build at a separate level, thus evading contact with all cross roads except a selected few; and a sunken road, rather than an elevated one, seems to be favoured, on grounds of amenity. Access to the ring road can readily be provided by means of ramps connecting with roundabouts at ground-level, and the ring road will pass under (or over) the roundabout without any delay being suffered by its own traffic.

In addition to all this, the existing main roads in the centre of towns will as a rule require some considerable improvement, more especially by way of designed roundabouts at the major intersections. In large roundabouts the central islands can be used for shopping, business or residential development, access for pedestrians being provided at separate level.

Road Safety.—Whereas the problem of congestion relates in general to towns only, the problem of road safety relates to town and country alike. The number of fatal and non-fatal accidents in Great Britain has increased sevenfold in 30 years.

Year	Fatal	Non-fatal	Total
1909*	1,070	26,091	27,161
1919 .	2,488	47,262	49,750
1929 .	6,505	145,296	151,801
1938	6,440	189,224	195,664

*Excluding accidents attributed to pedal cycles

Restrictive Safety Measures.—In order to keep the danger within bounds, restrictive measures are imposed, including the control of speed. The lethal effect of human errors, which are the root cause of casualties, is increased as vehicle speed is increased and reduced as vehicle speed is reduced; and when speed is increased the force of impact increases, not as the speed, but as the square of the speed. To reduce the lethal effect, speed limits are enforced in all "built-up" areas; and both the 30-mile speed limit imposed by the Road Traffic Act of 1934, and the 20-mile limit imposed in 1939 for the "black-out" hours, led to substantial decreases in fatalities. For the reduction of casualties generally, reliance is mainly placed in enforcement of the various traffic laws, in addition to road education for children, and propaganda for adults, conveyed by press and radio broadcast and in local safety campaigns.

Constructive Safety Measures.—Aids to safety already introduced include automatic traffic signals and traffic signs indicating danger points; dual carriageways for vehicles where practicable; and refuges, pedestrian crossing places and guard rails to assist the foot passenger. More radical measures, however, are needed, the general outlines of which seem now to be widely agreed. Speed should never be unnecessarily hampered, but high speeds can be safely permitted only when motor traffic is segregated, and its tracks are fenced against all chance comers. The fast flows of traffic must therefore be diverted from the daily haunts of the general populace, and canalized in new conduits. A system of one-purpose motorways for the country as a whole is required, which, in conjunction with ring roads in towns, will divert much of the faster traffic from existing villages and towns It is envisaged that, on these new roads, there will be no frontages, no loading and unloading, no standing vehicles, no pedestrians and no pedal cyclists. The junctions (which will probably be wanted at something like five-mile intervals) can be like those envisaged for ring roads in towns, the motorway passing either over or under the roundabout. Full-sized flyover junctions of the clover-leaf type, which would occupy more than ten times the space of one of these junctions and would cost three times as much, are needed (if at all) only at an intersection of two motorways

The motorways will in course of time create an arterial grid for the whole country, which will be fed both in town and country by a system of sub-arterial roads, the majority of the latter being main roads now in existence. On the sub-arterials the problem of segregating the pedestrians from the motor traffic will remain, and no complete solution is yet in sight. Segregation can be effected either in relation to place or time Place segregation is achieved by providing, at all points of possible contact, separate levels for vehicular traffic and pedestrians, which is too costly for widespread use Time segregation can be achieved by means of systems of co-ordinated automatic traffic signals, whereby separate time-periods are provided for vehicles and pedestrians respectively, while allowing the traffic to move at a reasonably fast speed This arrangement can be applied, alike in town and in country, to all portions of existing main roads where there is a roadside population.

Town and Country Planning.—At this point the technique of traffic control links up with that of town and country planning, one of the aims of the latter being to safeguard inhabitants from traffic dangers. In the County of London plan (1943) the "aim has been to study and define the function of the various areas or zones, and, while making them more efficient and dignified for their purpose, to free them from damaging intrusion. . . . The greatest intruder is traffic, not the approach traffic for the particular buildings, but the never-ending stream of longer or shorter distance through-traffic" (par. 29) The arterial and sub-arterial roads will "canalize the main through traffic and split up the area into a series of cells . . . free from through traffic . . By this method, precincts are formed which can be maintained or replanned as residential communities, business or industrial precincts, entered only at specific points from the main sub-arterial grid" (par 201). Precinctal planning will make a most important contribution to the safety of pedestrians On the arterial and sub-arterial roads the interests of the traffic will be absolute, all other interests being subordinated, but in the local roads in the precincts traffic considerations will be entirely subordinated to the needs of the local frontagers and pedestrians.

The Pedal Cyclist.—Substantial protection can be afforded to pedestrians and also to the occupants of vehicles, but the case of the pedal cyclist is far less simple. The average pedal cyclist is not so good a traffic unit as he might be, for the majority of cyclist accidents are due to the cyclists themselves. Complete segregation of cyclists from other traffic is not possible in existing roads; and cycle tracks, when provided, are broken off at the points of greatest danger, viz., the junctions. For obvious reasons tracks cannot be provided in busy town roads. The cyclist is best protected if the law exacts and enforces a higher standard of behaviour, and if the faster traffic is increasingly canalized in one-purpose roads, thus rendering all other roads safer for local traffic.

If the rapid disappearance of horse-drawn traffic continues, there will soon be only two types of wheeled traffic on the road —motor vehicles and pedal cycles. The licensing of motor drivers and the registration of their vehicles was an initial and fundamental measure for ensuring orderly and lawful use of the road; and parallel measures for cyclists have been advocated from time to time, in order to provide means of identification and to enable

the irresponsible cyclist to be deprived, if necessary, of the right to cycle

Special Occasions.—For ceremonial occasions, special traffic regulations are necessary, as also in the case of large race and other sports meetings. For control of traffic, supervision from the air in conjunction with wireless telephony has been found useful

Ribbon Development.—Ribbon development on main roads exposes inhabitants to fast traffic and is totally subversive From the point of view of planning, it is now increasingly realized that new houses or shops should be permitted only on precinct roads, dedicated to ordered building development and clear of all the *existing roads* (*major and minor alike*) which lead from place to place

The Changing Face of Great Britain.—Industrialization and mechanical traffic are still altering the whole face of Great Britain, and the location of industry will greatly influence the road maps of the future New industrial development probably will tend more and more to create new townships, and excess population of the larger towns will be thinned by removal to satellite towns New towns will be designed with special heed to the modern traffic problem, and the main communications between them will no doubt be roads specifically constructed for the needs of fast mechanical traffic, thus hastening the inevitable adaptation of the whole country to the motor age (A. Tp)

THE UNITED STATES

The rapid increase in motor driven vehicles on the city streets and country highways has created problems of traffic control which have required a great variety of treatment for their solution The maximum density of vehicular movement occurs principally in large cities where, owing to the relatively narrow thoroughfares, the higher speed of modern vehicles, frequent stops and conflicting cross-routing, conditions result which were never anticipated in the planning of our city streets Not only has the traffic in cities produced these problems of congestion, but also on the important highways between cities vehicle traffic has increased to a point where its speed and density both require drastic regulation. A comparison of the two largest American cities is given in the following table, indicating most clearly the causes of vehicle congestion as shown by the growth of vehicles at a much higher rate than the simultaneous increase in population

NEW YORK				
Type of Vehicle	1915	1920	1930	1938
Passenger	59,850	152,036	625,539	793,445
Commercial	12,148	83,746	126,152	129,208
Total	71,998	235,782	751,711	922,653
Population (in millions)	4·3	5·0	6·9	7·5
Persons per car	60	21·0	9 2	8·1
CHICAGO				
Passenger	36,419	86,709	409,441	507,911
Commercial	7,384	22,900	56,751	58,842
Total	43,803	109,609	466,192	566,753
Population (in millions)	1·9	2·4	3·37	3·4
Persons per car	43·0	22·0	7·2	6·0

Major street crossings in large American cities handle from 4,000 to 6,000 vehicles and 20,000 to 40,000 pedestrians in a maximum hour. These heavy intersections, by reason of the time required for handling the cross traffic, necessarily back up and slow the whole movement on the main thoroughfare. For many years, at isolated points, traffic officers were able to direct the traffic during the congested periods of the day. During the period from 1918 to 1930, various expedients such as traffic towers with signals operated by hand were installed in many cities—notably on Fifth avenue, New York. The problem, however, became too complicated as control at many other points in the city street system became necessary, so some co-ordinated automatic control was required Systems of signals displaying red, green, and yellow lights at certain intervals, operated from a central control point, have been developed along a number of different lines. A general classification of fixed time signals would be as follows:

1 Independent signals
2 Simultaneous system
3 Progressive system

Independent signals are used at isolated intersections where crossing traffic requires regulation These are usually operated on a fixed time interval or are traffic-actuated by cars driving over a contact plate on the highway of lesser traffic

In the simultaneous system, all signal lights are changed at a fixed time, and are the same on each street in a given direction; *i.e*, green or clear lights are shown permitting all north and south traffic to move throughout the controlled area, while the red or "stop" signal is set at crossings for east and west movements Then, after a fixed interval, the signals and the corresponding traffic movements are reversed This system is the simplest form and is used with some modifications in many cities.

The progressive system of operation is designed to keep all traffic moving continuously in a given direction. It is usually applied to the heavier thoroughfares where the cross-traffic is relatively light.

By this system signals are changed on one street so that a green light is seen at the beginning of one traffic block, and as the car progresses at a predetermined speed the red light at the other end of the block changes to green, permitting a continuous movement at from 20 to 30mi. an hour.

Many variations of the simultaneous and progressive systems have been worked out to fit special districts, and are operated by some form of electric control at a central point from which cables are run through to the various lights so that the timing of the intervals can be changed as desired by adjustment at the central station. The complete cycle used generally varies from 30 to 50 seconds.

The use of automatic control signals has been extended to cover intersections on main highways such as State highways, county roads, and other main arteries, in order to protect vehicles from collision where high speeds are permissible on the longer reaches of main thoroughfares. The very high speeds possible with modern motor vehicles have necessitated the introduction of various devices to separate lanes of traffic and to avoid intersections at grade. One of the most common of these expedients is the division of major highways by a central dividing strip to separate opposing lines of traffic. At intersections, the "cloverleaf" form of route separation has been developed in a number of different ways—the process being to confine cross traffic to roadways passing under or over the intersection. Cars enter or leave one or other of the main highways by merging or diverging right turns, thus avoiding crossing opposing traffic at grade.

Another form for regulating traffic at intersections is by means of a traffic circle in which all traffic must pass to the right and avoid direct intersection of opposing traffic by rotary movement around the circle and leaving by a right turn at any desired point.

Another regulation at intersections, which has become generally used, is the "Full Stop" sign requiring all vehicles entering from a minor thoroughfare to come to a full stop before entering the main thoroughfare.

One-way traffic on selected streets in cities, and regulation of right and left turns at street intersections, have been resorted to in a variety of ways by different traffic officials. A continuous effort has been made to establish standard methods throughout the country so that the type and operation of signals will be recognized correctly by drivers and the proper operation of their cars accomplished with the least possible delay.

Maximum speeds on public highways have been steadily increased until in some States 50mi. an hour is legal, and in other States the speed is unlimited between cities but the responsibility

for accidents is placed severely upon the car operator. Local speed limits are generally displayed on roadside signs by municipalities and other public authorities

One of the financial problems met in large cities in traffic control is the cost of keeping police officers on post at intersections Automatic traffic lights in many cases effect a great reduction in the police force required. However, on heavy thoroughfares in our larger cities, many officers are still required to see that drivers promptly and correctly obey the traffic lights and to protect and regulate movement of pedestrians. In some cities pedestrian regulation is as rigidly enforced as vehicle movements at the principal crossings To meet special conditions at certain hours of the day an officer is sometimes posted at an intersection to control signals by hand that are automatically operated during the remainder of the 24 hours

Traffic regulation is also affected by the rules as to parking of vehicles on public streets. There are many views taken of this privilege, relative to the interest of automobile drivers, stores, and other buildings desiring access from automobile patrons On the other hand the narrowing of the streets by solid lines of parked vehicles seriously interferes with vehicular movements. In some cities absolute prohibition of parking in business districts has been enforced. Meters have been installed in many cities for payment for parking at the street curb. (H. M Bx)

TRAHERNE, THOMAS (1637?–1674), English writer, was, according to Anthony à Wood, a "shoemaker's son of Hereford." He entered Brasenose college, Oxford, in 1652, and after receiving his degree in 1656 took holy orders. In the following year he was appointed rector of Credenhill, near Hereford, and in 1661 received his M.A. degree. He found a good patron in Sir Orlando Bridgeman, lord keeper of the seals from 1667 to 1672. Traherne became his domestic chaplain and also "minister" of Teddington. He died at Bridgeman's house at Teddington on or about Sept. 27, 1674. He led, we are told, a simple and devout life and was well read in primitive antiquity and the fathers. His prose works are *Roman Forgeries* (1673), *Christian Ethics* (1675), and *A Serious and Pathetical Contemplation of the Mercies of God* (1699). His poems have a curious history. They were left in ms. and presumably passed with the rest of his library into the hands of his brother Philip. They then became apparently the possession of the Skipps of Ledbury, Herefordshire.

In 1896 or 1897 they were discovered by W. T. Brooke in a street bookstall A. Grosart bought them, and proposed to include them in his edition of the works of Henry Vaughan, to whom he was disposed to assign them. He left this task uncompleted, and Bertram Dobell (*q.v.*), who eventually secured the mss., was able to establish the authorship of Thomas Traherne.

The discovery included the poems and four complete "Centuries of Meditation," paragraphs embodying religious reflections.

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TRAILERS for motor cars in the U.S. were not produced in significant quantities until after 1930. The U S registration of house trailers was reported as more than 224,700 in the early 1950s; however, state classifications and registration requirements differed widely. Many are equipped with conveniences of the home such as ranges, electricity, refrigerators, running water, toilets, and even bath tubs and showers. The larger trailers have four wheels and separate brakes Two associations—the Automobile Tourist association and the Tin Can Tourists—were formed in the U.S.

TRAILL, HENRY DUFF (1842–1900), British author and journalist, was born at Blackheath, London, on Aug. 14, 1842, and died in London on Feb. 21, 1900 Traill was one of the best known journalists of his day; he wrote important biographical and critical studies, and in 1893–97 directed the production of a vast work on *Social England*. But he is now remembered for his witty parodies and *jeu d'esprit*. His best known work is *The New Lucian* (1884; new and enl. ed., 1900). Traill also wrote one or two plays. Nellie Farren made a noteworthy success in his *Glaucus, a Tale of a Fish* at the Olympic theatre in 1865. In collaboration with Robert Hichens he wrote *The Medicine Man*, which was produced in 1898 at the Lyceum.

TRAIN BANDS. In the early part of the 17th century the commissions of musters directed the county officials to muster all persons liable for service and organize them into bands for training The bands so organized became known as trained bands or train bands, a phrase which by the end of Charles I.'s reign was superseded by the term militia.

TRAINING CAMPS, U.S. MILITARY. Training in some form is conducted in most military and naval installations of the United States. These posts, camps and stations which comprise the defense training pipe line may be classified generally into four major groups, although types and length of training vary according to the different requirements of the four armed services. The four groups are: (1) reception or induction stations, (2) basic training or indoctrination centres, (3) specialized and technical training centres and (4) operational type units such as those included in infantry divisions, air force groups, fleet unit complements, technical services, etc. In some instances groups (1) and (2) are physically located on the same post or base.

Under normal peacetime conditions army recruits were routed through replacement training centres, where they received 13 weeks of fundamental military training primarily designed to make the transition from civilian life to basically qualified soldiers. Each soldier then progressed to advance individual training, either concurrently with the unit to which he was assigned or in specialized school courses. Following the outbreak of hostilities in Korea in 1950, however, this system was found to be less economical and less practical in times of emergency. To meet the urgent requirement for trained men under emergency conditions advanced individual training centres were established in addition to basic training divisions already activated Active training divisions at this time were located at Camp Breckinridge, Ky.; Camp Chaffee, Ark.; Ft. Jackson, S.C.; Ft Leonard Wood, Mo.; Ft. Dix, N.J ; Ft. Knox, Ky.; Ft Ord, Calif and Ft. Riley, Kan. Individual advanced training centres established were: antiaircraft artillery, Ft Bliss, Texas; artillery, Ft. Sill, Okla.; armour, Ft. Knox, Ky ; chemical corps, army chemical centre, Md.; corps of engineers, Ft. Belvoir, Va.; medical corps, Ft. Sam Houston, Texas; ordnance corps, Aberdeen Proving Grounds, Md.; quartermaster corps, Ft. Lee, Va.; transportation corps, Ft. Eustis, Va.; signal corps and military police corps, Camp Gordon, Ga. Women's army corps personnel were trained at Ft Lee, Va. The chief of army field forces, with headquarters at Ft. Monroe, Va., directed all army training

At mid-20th century men inducted into the United States navy received initial training at recruit training centres located at: Newport, R I ; Great Lakes, Ill.; San Diego, Calif. and Bainbridge, Md. Navy recruit training was of eleven weeks duration, upon completion of which the sailor was assigned to specialized technical training schools or to duty with fleet units or shore installations Candidates for technical schools were carefully screened through competitive aptitude tests. Exceptionally qualified persons might be selected for flight training, which if successfully completed might qualify for regular or reserve officer commission.

The main boot (basic) training bases of the United States marine corps are located at Parris Island, S.C. and San Diego, Calif. As of 1951, marines completing basic training might be assigned to administrative or guard duty in any of several hundred locations within the United States; join fleet marine force units in the U S.; be sent to overseas bases or fleet duty or participate in training programs or manoeuvres Amphibious unit training was conducted in both Virginia and California

Members of the women marines trained at Parris Island, S.C. while women in the navy (WAVES) received initial training at the naval air station, Patuxent, Md

The bureau of naval personnel along with other bureaus within their respective fields was made responsible for all basic training of personnel as individuals The deputy chief of naval operations became responsible for all operational training of a ship or

its personnel as units of a ships company

Airmen being inducted into the United States air force at mid-century received a 13-week basic course in military tactics at the indoctrination centre, Lackland air force base, Texas or the indoctrination centre at Sampson air force base, New York Considerable emphasis was placed on physical training Upon completion of the basic course, airmen were sent directly to a technical school or assigned on-the-job training at a duty station Selection for one of the numerous technical schools of the air training command was based upon aptitude tests and personal interviews. Those qualifying for aviation cadet or navigator training attended air force flying training schools and were commissioned second lieutenants upon completion of 12 months' flight training Graduates of either technical or flight schools were assigned to air force bases. The woman's air force training center was set up at Lackland air force base, Texas.

There were no military training camps for civilians after the beginning of World War II, with the exception of two-week training periods during the summer months for national guard and organized reserve units In addition there was an organized reserve training program in all services conducted the year round.

(C. W. He.)

TRAINING CORPS, OFFICERS'. Great Britain.—The creation of the Officers' Training Corps (Junior and Senior divisions) dates from 1908. The Junior Division is composed of boys of 13 years of age and upwards in public secondary schools and is officered by the masters in those schools. The former incur no military obligation when they leave school, but the latter as they are commissioned officers of the Territorial Army are under the same obligations and enjoy the same privileges as other officers of that Army.

The Senior Division contains university contingents consisting of officers and cadets. The cadets are prepared for "Certificate A" and for "Certificate B," the latter certificate carrying certain privileges in connection with candidates for commissions in the Regular and Territorial armies The contingents include cavalry, artillery, medical, surveying, sound ranging, engineers, signal, veterinary, infantry, air units, etc, whereas the Junior contingents are, with the exception of 3 engineering units, all infantry

(F. R H-J, X.)

United States.—The origin of military training in civil educational institutions within the United States rests in the Morrill Act of July 2, 1862. This act required that colleges and universities receiving grants of public land include in their curricula certain elementary military instruction under supervision of the secretary of war. The resultant training was limited and unsystematic but proved the need for this form of instruction. This need was emphasized by the World War (1914–18), and an attempt was made to meet it in the National Defense Act of 1916, wherein a Reserve Officers' Training Corps was authorized to extend to a wider range of institutions than land grant colleges. The Corps was scarcely organized before the United States was forced in 1917 to supplement its work by training camps (*q.v.*).

The R O T.C. as an effective force in civil military education dates from the National Defense Act of 1920. It consisted of a senior and a junior division The former, established at various colleges, universities and selected military schools, and divided into units corresponding to the principal combat arms and specialist services, included a four-year course averaging about four hours per week and one summer camp of six weeks. The junior division, established in selected high schools and equivalent institutions and including only infantry units, was confined to boys not under 14 years of age It provided a three-year course of three hours per week and was practically the equivalent of the basic course for infantry in the senior division

These courses were financed largely by the Government and were in the main conducted by officers of the regular-army, in some cases by civilian professors. Graduates of the senior division were at once eligible for a reserve commission as second lieutenant in the arm studied. Enrolment in the R.O.T.C. varied with appropriations, but in the 1930's it averaged about 120,000 per year. In 1930, a reasonably average year, 5,870 men were graduated from the 321 units of the senior division. The R.O.T.C. did not operate, however, without considerable opposition from peace groups This sentiment was particularly pronounced in land grant colleges where basic training had been made compulsory, and led finally to an interpretation by the attorney general that the Morrill Act did not require these institutions to compel universal attendance This left the question of compulsion up to each individual land grant college, although not relieving them of the necessity of including the training, but in the end had little effect on the output of trained personnel.

As the importance of aircraft in warfare became more generally recognized, several steps were taken by the Government toward training emergency pilots and other aviation personnel Under the Civilian Pilot Training Act of June 27, 1939, certain colleges were authorized to establish special "primary training" courses By June 30, 1940, almost 10,000 men had been given this training, and plans had been laid for an increase in this output to nearly 50,000 for the following year.

(F. P. T.)

TRAJAN (MARCUS ULPIUS TRAIANUS) (AD 53–117), Roman emperor, was born at Italica, in Spain, on Sept. 18, 53. The family to which he belonged was probably Italian by blood His father began as a common legionary soldier, and fought his way up to the consulship and the governorship of Asia The younger Trajan was a soldier born and bred.

For ten years he was a military tribune, serving all over the empire, then he held important posts in Syria and Spain. By 89 he had a considerable military reputation. In that year he was ordered from Further Spain to the Rhine to deal with the revolt of Saturninus He covered the distance very quickly, but the rebellion had been crushed before his arrival He was consul in 91. Nerva on his accession made him consular legate of Upper Germany, and on the advice of L. Licinius Sura adopted him as his son and successor on Oct. 27, 97 The senate confirmed the choice and acknowledged him as the successor. Trajan at the time was in Germany. Shortly afterwards, at Cologne, he received news of the emperor's death (Jan. 25, 98). Trajan's authority was at once acknowledged all over the empire He gave the senate an assurance like that given by Nerva, that he would neither kill nor degrade any senator, and ordered the foundation of a temple and cult in honour of his adoptive father, but he did not come to Rome till he had inspected the Rhine-Danube frontier. The praetorians, who had been a menace to Nerva, were quickly overawed, and he proceeded to make his long-awaited entry into Rome. Here he at once made himself popular with both senate and people. Soon afterwards he left for his first Dacian campaign. It would appear that Trajan himself wrote an account of this war, but only one sentence has survived. We are left with the evidence of Trajan's column and the monuments at Adamklissi.

This much may be said. Roman prestige and security were threatened by the terms of peace exacted by Decebalus from Domitian. Trajan took the initiative in 101; his advance, more or less unopposed at first, ended in an indecisive battle at Tapae, at the entrance to the Iron Gate pass. Trajan retired to winter on the Danube. The winter seems to have been disturbed by a raid by Dacians and Roxolani into Moesia. The next spring Trajan invaded Dacia again. His advance ended in an attack on a stronghold (identified as Muncel Cetate), and a complete victory near Koatesd. Decebalus surrendered, a garrison was left in Sarmizegetusa, and Trajan withdrew. In 105 Decebalus revolted, and again (probably) invaded Moesia. Trajan started at once from Ancona, and seems to have spent the first season in Moesia, making his way to his bridge at Pontes and wintering there. The next year (106), after prolonged and desperate fighting, Sarmizegetusa was taken, and Decebalus committed suicide. Dacia was annexed, the capital became a colony, *Ulpia Traiana*, and the new province was gradually Romanised in the usual way.

There followed seven years of peace, broken at last by war with Parthia The *casus belli* was the appointment by the new king of Parthia, Chosroes, of a nephew to the throne of Armenia without the customary application to Rome, but there must have been something behind that, for Chosroes' instant apology failed to placate Trajan. There were three campaigns. The first (114)

resulted in the annexation of Armenia almost without opposition

The next year, still without much fighting, Trajan occupied Mesopotamia up to the Tigris There he halted, and went to Antioch for the winter. In 116 he first marched through Edessa and Nisibis, forced the passage of the Tigris without difficulty, and annexed Adiabene, which became the province of Assyria Then he turned down the Tigris to Ctesiphon. Chosroes fled, and Trajan went on down stream to the shores of the Persian gulf, where he looked over the waters to India, and said sadly, "If only I were younger." The captured territory became the province of Parthia

Then, on the way back, the trouble started. Before the end of the year a serious rising in the north had to be crushed, and the Parthians were threatening a counter-attack Trajan decided to abandon lower Mesopotamia, installed the young prince Parthamaspates as king in Ctesiphon, and withdrew, not without trouble on the way. Meanwhile the Jews all over the East had risen and massacred everyone they could find, Greeks and Romans alike Trajan, alarmed by this and other signs of trouble all over the empire, set out for Rome. He died on the way, at Selinus in Cilicia, on Aug. 8, 117. His reign closes ominously; while he had been in the East trouble had started in Africa, Egypt, Libya, Palestine, Sarmatia, Britain He was deified, of course, and his triumph was celebrated after his death. Trajan's reign takes one more long step towards complete despotism, which we shall see when we consider the provinces For Italy Trajan did much. His new forum was the glory of Rome. there are columns and triumphal arches to commemorate his victories, he reclaimed the Campagna, built new harbours at Ostia, Centumcellae and Ancona, built roads and aqueducts, and tried to arrest the decline of Italy in agriculture and man-power, by extending the *alimenta* system of Nerva, forbidding emigration, encouraging settlements on the imperial lands, making senators invest in real estate in Italy, and so on.

His provincial administration is a little less easy to summarise In intention it was excellent, but his long absence in the East led to difficulties. Numerous prosecutions for extortion show the extent of the evil and the emperor's efforts to stop it This reign sees also a new phenomenon, the breakdown of local government on the financial side. Various municipalities have to receive curators, and the province of Bithynia and the "free cities" of Achaea had their financial administration taken over by imperial *correctores*. Pliny was sent to Bithynia, and his letters to Trajan and the replies are preserved. In the enormous mass of detail referred to the emperor we can see foreshadowed the complete centralisation that was to come under Diocletian Mention must also be made of the view (Rostovtzeff, see *inf.*) that Trajan's wars were completely disastrous to the empire, overstraining its man-power and economic strength irrevocably.

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TRALEE, a seaport and county town of co Kerry, Ireland, on the Ballymullen or Leigh river, and on the Great Southern railway. Pop. (1951) 11,047. Tralee, anciently Traleigh, the "strand of the Leigh," owes its origin to the foundation in 1213 of a Dominican monastery It was incorporated by James I A ship canal, permitting the passage of ships of 200 tons' burden, connects it with Tralee bay. Large vessels discharge at Fenit, 8 m. westward, where there is a pier connected with Tralee by rail. Coal, iron and timber are imported, and there is a considerable export of grain. There is a large trade in butter. Railways serve the neighbouring seaside watering-places of Ballybunnion and Castlegregory. Ardfert cathedral, 4 m. N.W. of Tralee and now united to the see of Limerick, was founded by St. Brendan and had once a university. A neighbouring round tower fell in 1870.

TRALLES (mod. *Güsel Hissar*), an ancient town of Caria, Asia Minor, situated on the Eudon, a tributary of the Maeander It was reputed an Argive and Thracian colony, and was long under Persian rule, of which we hear in the history of Dercyllidas' raid from Ephesus in 397 B.C Fortified and increased by the Seleucids and Pergamenians, who renamed it successively Seleucia and Antiochia, it passed to Rome in 133. Rebuilt by Andronicus II about 1280, it was superseded a few years later, after the Seljuk conquest, by a new town, founded by the amir Aidin in a lower situation. (*See* AIDIN.)

TRAMWAY. A track or line of rails laid down in the public roads or streets (hence the United States equivalent "street railway") along which wheeled vehicles are run for the conveyance of passengers and, occasionally, of goods; also a light roughly-laid railway used in coal mining and for carrying out public works

Construction.—The earliest form of construction consisted of primitive lines or trams of wood or flat stones Later, in 1676, the longitudinal timbers forming the rails were laid on transverse logs and provided with a stout capping of beech or sycamore to facilitate easy renewal of worn sections without undue disturbance of the understructure In 1767 iron plates were substituted for the wood capping, and early in the 19th century iron rails were used

The first tramway or street railway intended for public passenger traffic was the New York-Harlem line opened in 1832 The rails had a deep wide groove which proved so dangerous to the ordinary light narrow-tyred vehicles of the period that they had soon to be removed Twenty years later Loubat, a French engineer, devised and used a wrought iron rail with a narrower groove and with a clearance suitable for wheel flanges In 1855–6 Charles L. Light, an English engineer, designed a rail with a groove limited to ½ in. in depth and carried up to the surface with a slight slope for a tramway in Boston, U.S.A. who form of grooved rail, however, seemed to suit the conditions of local traffic in the United States, and an entirely different kind of rail was introduced and used in the construction of a tramway in Philadelphia. This consisted of a flat rail 5 in. wide, with a step at one side raised ¾ in above the surface. It was made of wrought iron and weighed 50 lb. per yard.

Loubat in 1855 laid down a tramway in Paris—the first of its kind in Europe It was a replica, in most respects, of his New York form of construction The rail was 3 in wide on the surface and had a groove 1½ in. wide and ⅞ in. deep, with a tread 1⅛ in wide It was of a semi-hexagonal section at the lower side, to rest upon a timber sleeper which was chamfered to receive it, and upon which it was spiked diagonally through the sides. A fishplate of iron, 6 in long and ⅜ in. thick, was laid under each joint The rail weighed 19 kg per metre or 38 lb. per yard The tramways first constructed by G. F. Train in England in 1860–3 had a step rail of the Philadelphia pattern This rail was manufactured of wrought iron and weighed 50 lb per yard It was 6 in wide and had a step ¾ in. above the sole. The rails were spiked to longitudinal timbers laid on transverse sleepers. English people, unlike the American, would not however tolerate the danger and obstruction caused by the step rail, and the tramways in London had to be removed after a brief period of working, while those initiated by Train at Birkenhead and in North Staffordshire were preserved by the timely substitution of a flat grooved rail

The adaptation of the steam locomotive for street tramway purposes necessitated tracks of greater strength and rigidity than were sufficient for horse traction The older methods of supporting the rails were inadequate for stability, and many attempts were made to overcome the difficulty Finally recourse was had to the girder rail which soon proved its superiority to the built-up rail, and it eventually became predominant in tramway construction. A form of girder rail was patented in 1860 by Charles Burn; reinvented and patented in 1877 by Achille Legrand of Paris; and with modifications again patented in 1878 by J Gowans, who succeeded in establishing its greater merits after the lapse of 20 years from the time of its original inception.

The method of construction of modern street tramways follows the same general principle in all countries; variations depending upon local conditions which govern the depth of the con-

crete foundations, weight and composition of the rail, and the class of paving In cities the foundation consists of six or more inches of concrete. The rails weigh about 110 lb. per lineal yard, and are of 45 ft or 60 ft in length, according to requirements. Heavy fishplates are used for the joints of the rails or the rail ends are electrically welded together Steel tie-bars are interposed at short intervals and, where electric traction is the motive power, the rails are bonded together by copper rods to provide a continuous path for the return current (and to prevent leakage and consequent possible electrolysis of contiguous pipes). The surface of the rail is laid flush with the paving which may be of wood blocks or granite or basalt setts, grouted with cement.

FORMS OF TRAMWAY TRACTION

Animal.—The original street tramways were worked solely by animal traction, the cars being drawn by one to four animals, according to the contour of the routes and traffic necessities. An average speed of six to seven miles per hour was customary, and the cost of horse maintenance and renewals averaged 40% to 45% of the total working expenses

Steam.—The need for higher speeds, quicker acceleration and larger and more comfortable cars than were practicable with animal traction, led to the evolution of a type of steam locomotive suitable for street tramway purposes Some extraordinary designs were produced, not only for the engines themselves but for their position in the car One inventor placed his engine at the front, another in the centre; and a third provided an engine at each end of the car Between 1871 and 1883 many experiments on other forms of locomotives were carried out, including fireless locomotives in which well-insulated cylinders (filled with water which was heated from a stationary boiler at the end of each journey) together with the machinery were placed under the floor of the car. Ammoniacal gas and compressed air also found devotees but after many trials an enclosed steam engine coupled to the car became standardized, and rendered on the whole quite efficient service until displaced by electric traction It was employed on most of the tramways in the manufacturing areas of England. Locomotive power and repairs and renewals of engines approximated 42% of the total working costs.

Gas.—The development of the gas engine for industrial purposes seemed to offer possibilities for its introduction for street traction Accordingly trials were made, principally in Germany, of small gas engines placed on the outside platform of the car, with the gas receivers accommodated under the floor, the gas being taken from the town mains and then put through a compressing engine before being admitted into the cylinders

Cable.—The principle of cable haulage was first applied to street tramways in 1873 in San Francisco by Andrew S. Holliday. It was introduced in England in 1884 on Highgate Hill, London, and installations followed subsequently at Brixton Hill and at Edinburgh, Birmingham, and Matlock. All these have since been discontinued, but there is still a small cable undertaking in operation at Douglas, Isle of Man In cable systems haulage is effected by an endless wire rope continuously moving in one direction, supported on pulleys within a slotted conduit laid below the surface of the street or roadway, or between the rails of a surface or elevated railway The rope is driven by means of a steam engine or motor situated at a convenient place near the line, the motion of the cable being intermittently communicated to the cars for starting and stopping by means of a gripper attached to the car The tube is formed of concrete with cast iron yokes spaced at intervals of 4 ft. to support the slot beams The slot is usually ¾ in. wide and the conduit about 19 in. deep × 9 in. wide

Electric.—The history of the electric tramway is covered under ELECTRIC TRACTION. There also will be found a description of the engineering accomplishments that resulted in its supersedng all other forms of tramways.

Much controversy used to occur as to whether the overhead or conduit system should be installed Engineers and financiers advocated the former on grounds of economy of cost of construction as well as of operation. But the general public was loth to sacrifice the amenities of the streets by permitting the erection of poles and overhead wires, and demanded a less obtrusive form of construction. In the end the economy and merits of the overhead system prevailed, the exceptions being confined to capital cities such as London, Washington, New York, Paris, Berlin, Brussels and a few other places where financial considerations were subordinated to the aesthetic views In this system the trolley wires are usually hung about 21 ft. above the rails. The poles are placed not more than 40 yds apart

Surface Contact.—The high cost of conduit construction and the objectionable character of the overhead wires respectively were incentives to the invention of an alternative method of construction. Attention was given by engineering specialists to the surface contact systems and a number of designs were patented Among those put into practical use in England were the Lorain system at Wolverhampton, the Dolter system at Torquay, Hastings, and Mexborough, and the G B system at Lincoln. On all these systems current is supplied from iron studs laid in the roadway between the rails of the track to a skate carried on the car. The studs were placed every 10 ft. to 15 ft., and contained a movable switch or contact which was operated by a magnet carried under the car

Storage Batteries.—In theory storage batteries afford a simple and convenient form of electric traction, but extended trials have failed to justify their permanent adoption Cars operated by batteries prove costly to work and maintain

TRAMWAY CARS

The car operated on the pioneer lines in New York in 1832 was fashioned after the "voiture omnibus" of Paris, a vehicle designed by an English coachbuilder, George Shillibeer. The body had three compartments and was supported on leather springs. The four iron wheels, all of the same diameter and flanged, were placed centrally A dickey or elevated seat accommodated the driver and two passengers, and the foot-brake operated on one pair of wheels only. The standard horse-car of 1880–90 had seats for 18 inside passengers and 18 outside, the upper deck being approached by a straight staircase

Modern car bodies are mounted either on a single four-wheeled truck with a fixed or rigid base 6 ft. to 8 ft. long, according to the sharpness of the curves to be negotiated, or on bogies or swivelling trucks The truck may be described as a carriage or frame supported on the axleboxes, and supporting by another set of springs the car body Of bogie trucks two types are used: one the "maximum traction" truck, having a pair of wheels of standard size—about 30 in.—with another pair of smaller or "pony" wheels, and the other having four wheels of equal diameter. The single and maximum traction trucks are fitted with two motors, while the equal-wheeled bogies may have four motors. The trolley standard placed on the roof or upper deck of the car carries an arm which through a revolving wheel collects current from the overhead wires; instead of a wheel a frame shaped like a bow is sometimes used for the same purpose Controllers on the platform enable the motorman to stop, start and regulate the speed of the car by means of a handle on the upper surface of the controller frame which has notched divisions. The brake equipment comprises a powerful hand brake with a foot ratchet, operating shoes on each side of the wheels, and a magnetic brake forming part of the controller equipment

While the various forms of trucks are common both to British and American practice, car body construction differs in many respects The single-deck car is in general use outside Great Britain where, although many single-deck cars are worked, the greater number are of the double-deck type.

In addition to the types here mentioned other designs are to be found. Single-deck open cars of the "toast-rack" type with transverse seats are employed on many holiday lines: and the Californian type of car body, with the control part closed in and one or two double-sided transverse seats at each end, is sometimes used on routes where low bridges preclude the use of double-deck cars. The earning value of this type is, however, small when weather conditions are unfavourable.

GREAT BRITAIN

Legislation.—Statutory sanction is necessary for the construction and working of a tramway on public streets or highways. The earlier tramways in England were constructed by private enterprise under powers conferred by special acts of parliament. In 1870 parliament passed a general act "to facilitate the construction and to regulate the working of tramways" in Great Britain.

This 1870 Act of Parliament which is still in force, confers upon local authorities powers to construct and alternatively the optional right to purchase, but not to work, a tramway undertaking established by private enterprise upon the expiration of 21 years, and at every subsequent period of 7 years, at the "then value" of the tramway, land, buildings, materials and plant suitable to and used for the purposes of the undertaking, exclusive of any allowance for past or future profits or any compensation for compulsory sale or other consideration whatever. In the meantime the undertakers are under the specific obligation to repair and maintain at their own expense the roadway between the rails and 18 in. on either side thereof, and are subject to numerous other onerous conditions relating to the method of construction and working: non-interference with Post Office, telephone and telegraph wires, gas and water pipes, electric cables; the services of carriages to be run for ordinary and work-people's traffic; and the maximum fares to be charged, including reduced fares to workmen, children, etc. The practical effect of the legislation was to constitute the local and road authorities sole arbiters of the tramway situation in the British isles, and promoters or lessees were frequently under compulsion to accept not only the statutory obligations of the act, but also burdens in regard to expensive street widenings and improvements, and otherwise, which were imposed upon them by local authorities. Promoters of new undertakings were deterred and in course of time lessees were difficult to find, in these circumstances some local authorities sought parliamentary powers to work the tramways in their districts. After about 1896 parliament permitted any local authorities that so desired to work tramways as well as own them.

The general tendency for British tramways to partake of a local, even parochial, character was thus accentuated. Within even small but populous areas having several local authorities, horse, steam, and cable tramways were worked as segregated undertakings under separate management. Moreover, there was no uniformity of gauge in the country; gauges of 4 ft. 8½ in., 4 ft. and 3 ft. 6 in were adopted without regard to the needs of the travelling public for interconnecting services between towns. The striking example of the adjacent cities of Leeds and Bradford, with gauges of 4 ft. 8½ in. and 4 ft. respectively, still exists.

The advent of electric traction in the nineties opened up new opportunities in Britain. With its dense industrial population in a small area, no country was at that time better suited or riper for electric traction on street tramways on a large scale. But this important industrial development suggested and, to some extent, initiated by private enterprise, was to a large extent frustrated by the territorial spirit of local government. However, the need for linking up urban tramway systems, the development of intermediate townships, and the consequent better distribution of population and industries in a manner similar to that of large and successful street railway systems in the United States, was strongly urged on the Government by Stephen Sellon, a prominent parliamentary engineer, and others; with the result that the Light Railways Act of 1896, avoiding many of the imperfections of the Tramways Act of 1870, was passed. The power given to local authorities to veto the promotion of a light railway or tramway disappeared, and the act did not give any option to the local authorities to purchase the undertaking. Section 7 of the act, however, provided that the commissioners who were appointed to administer the act were to satisfy themselves that all reasonable steps had been taken for consulting the local and road authorities affected, and the owners and occupiers of the land proposed to be taken. The commissioners seemed to interpret the Light Railways Act in the terms of the old Tramways Act (which is still in force) rather than in the spirit of the departure from it implied by the new act, and included in most of the orders they made an option to the local authorities to purchase the light railway undertaking within their area at the end of a period of 30 years and at subsequent intervals of 10 years, the terms of purchase and at subsequent intervals of 10 years, the terms of purchase generally to be the fair market value of the undertaking as a going concern. The more equitable provisions of the 1896 act removed some of the conditions in the Act of 1870 which had deterred capitalists, and the British Electric Traction Company, Ltd., and other companies, were formed with the object of providing and operating urban and interurban systems of tramways and light railways.

COMMERCIAL RESULTS

Tramways as public utility undertakings have undergone more changes than any other service of public utility, *e.g.*, water, gas, electricity supply, or steam railways. For more than 30 years improvements in rail and track design followed one upon another, each accompanied by some loss of capital and dislocation of working routine. Rolling stock, too, was remodelled, and many alternative methods of traction were tried and improved or superseded. The greatest change of all—the adoption of electric traction—involved the writing off or replacement of many millions of capital in the abandonment of existing horse and steam plant equipments, as well as in the provision of central generating plant, reconstruction of track, and erection of overhead electric lines.

The following table (see *Garcke's Manual*, 1906, vol. x.) illustrates the relative values of electric, steam, and horse operation in Great Britain.—

	Horse period 1879	Steam period 1898	Early electric period 1904–5
Length of route: Mileage open	321	1,064	2,117
Total number of passengers carried	150,881,515	858,485,542	2,068,913,226
Capital expenditure per mile of single track open:			
Lines and works	£7,840	£7,770	£11,799
All items	£9,877	£10,469	£15,599
Percentage of net receipts to total capital outlay	3 97	6 38	6·36
Percentage of working costs to gross receipts	84	77	66
Passengers carried per mile of route open	469,641	806,703	977,386
do. per car mile	7·77	9·48	9·10
Average fare per passenger	1 84d.	1·23d	1 10d.

The benefits arising from the adoption of electric traction have inured more to the advantage of the travelling public than to the promoters and owners of the undertakings. To some extent the comparatively small return of 6·36% on the capital outlay was owing to the heavy cost of construction, but to a larger extent it was in consequence of the policy of reducing the fares to a non-profit standard of municipal service. In the matter of fares British and American practice has always differed materially. British fares are usually based on stages or traffic points. The fares are charged at a given rate per mile—pre-war 1 to 1½ miles for a penny; post-war 1 to 1½ miles for 1d.—with a reduction for longer distances; thus producing differential fares according to distances travelled.

The earlier estimates of the cost of construction and working of electric tramways in Great Britain were based largely on the experience of the American and European undertakings then in operation. Some of the pioneer lines were built and worked within the estimates. But as time went on the original estimates were largely exceeded. The overall cost of £9,500 per mile rose to £12,500 per mile, due to superior track construction, more elaborate overhead equipment, use of larger cars, street widenings, and higher cost of road paving imposed upon tramway undertakings. The operating costs instead of being 5·30d. per car mile, began to average over 6½d. per car mile, by reason of increased rates of wages and of greater wear and tear of track and equipment than was contemplated.

Subjoined are financial and statistical data relating to electric tramways and light railways in Great Britain in 1913–14 and 1926–27, taken from official sources:—

	Municipalities		Companies	
	1913–4	1927–8	1913	1927
Number of undertakings	170	167	94	66
Miles of lines open: Total route length	1,798	1,850	731	664
Equiv single track	3,047	3,249	1,092	1,052
Capital expenditure	£54,298,188	£84,318,151	£22,371,533	£19,601,626
Gross receipts	£11,396,710	£23,860,767	£3,763,766	£3,890,737
Working expenses.	£7,436,884	£18,663,222	£2,342,679	£3,279,025
Net profit	£3,959,826	78 2%	£1,421,087	84 3%

Note—A number of undertakings belonging to companies were acquired by local authorities between the periods covered by these statistics.

TRAMWAYS AND OTHER FORMS OF TRANSPORT

Since the advent of electric tramways—and especially during the past two decades—other forms of road transport, namely, trackless trolley buses, petrol (gasolene) motor omnibuses, and light railways, also the electrification of suburban railways, have been developed to provide increased travelling facilities for the ever-growing requirements of the public In the absence of any comprehensive scheme for the co-ordination of these different forms of services there has been much overlapping and wasteful competition between them, and reference is made below to proposed legislation with the object of co-ordination of the various services. Every form of transport possesses special merits for certain conditions and characteristics of traffic

In the case of *tramways*, these were originally established to provide a better track than that offered by the then inadequate or bad state of the roads. Legislation authorizing the construction of tramways gave their owners a monopoly in the form of the exclusive right to operate vehicles with flanged wheels over the lines. For these rights many onerous obligations were imposed, indicating that electric tramways are expensive to establish and to operate, because they have been saddled with costs and obligations by obsolete legislation passed before the advent of the electric tramway; but in spite of this the operating costs per seat mile are less than those for any other road passenger transport.

Light railways are very similar to tramways. The procedure in obtaining powers to establish and operate them is different, and the terms on which they can be acquired by the local authorities of the districts served may in some cases be more favourable to the promoters than is the case with tramways. They are, like railways, chargeable with only one-fourth of the district rates; but for all practical purposes where they have been constructed along roads as a means of passenger transport, they fall into the same category as tramways. In passing the Light Railways Act 1896, parliament clearly indicated tramway lines constructed under this act being built with a cheap form of construction with rails laid on sleepers like railways, and used for urban and interurban work, connecting up hamlets and villages, and to encourage general agricultural, fishing and freer intercourse between neighbouring small towns.

Trackless trolley buses were designed to serve specific routes with road transport facilities, and are suitable for dealing with traffic features similar to those which modern tramways are designed to provide, though in less densely populated districts. They have the advantage over tramways of costing less to establish and run, and are more flexible in operation inasmuch as they are free to deviate from a fixed path. They cannot, however, be reversed at the termini of routes with the same ease as tramcars. While such services have not been developed much compared with other forms of road transport, they have been established by several municipalities and companies in this country and on the Continent to deal with moderately dense traffic Their sphere of usefulness is in cases where there is a moderate flow of traffic along a specific route having a good road surface. Like tramways and light railways they are very suitable for short-distance traffic For the year 1926–27 nineteen local authorities and one company operated trackless trolley undertakings in Great Britain, while twenty-one local authorities did not exercise their statutory powers The following are some particulars of the operating results abstracted from the return issued by the Ministry of Transport:—

Miles of route operated	84·13
Capital expenditure	£714,277
Total income	£286,391
Total working expenses	£249,955
Net revenue	£36,436
Car miles run	5,092,956
Passengers carried	50,382,193

Suburban railways also serve local traffic requirements in a very efficient manner, although the class of traffic for which they are pre-eminently designed is somewhat different from that particular kind of local traffic which forms so large a proportion of that served by tramways, light railways and trackless trolley buses. The three latter forms of road transport are designed primarily for frequent stops at short intervals—a continual picking up and setting down of passengers along their routes—whereas the passenger traffic on suburban railways consists chiefly of large numbers of passengers conveyed from the centre of one locality to another, with comparatively short journeys to and from the railway stations.

Omnibuses.—The comparatively rapid development of omnibus services is perhaps the outstanding feature of modern land transport. This development is due primarily to (*a*) the provision of good roads at the cost of other industries and the community at large; (*b*) the skill of the automobile engineer in producing so efficient a machine; (*c*) the improvements made in the manufacture of pneumatic tyres, (*d*) the comparatively low cost of establishing and operating an omnibus service; and (*e*) the fact that unlike other forms of transport referred to, parliamentary powers are unnecessary to establish a service except in the case of omnibuses owned by municipalities or statutory companies Motor omnibuses (single- and double-deck types) as at present evolved are now being used to cater for road passenger traffic of practically all classes. The single-deck types are used chiefly for urban and interurban services where the density of traffic is not great, and for touring work, and many regular high-speed services for long distances (50 to about 100 miles) have been established between large towns. They are also used in districts where the height of bridges precludes the use of the double-deck type. Generally speaking the double-deck types are used for town services where the traffic density calls for a vehicle with larger seating capacity than can be given by a single-deck vehicle. This is conspicuously so in London where no tramways are laid in the large central area which comprises the chief commercial and shopping districts, the chief amusements, and some important residential districts within the metropolis. On this account the London road transport services are quite special. The economic competitive aspect of omnibuses compared with other forms of road transport is to some extent influenced by the limitations as to dimensions and weights of vehicles as imposed by the Heavy Motor Car (Amendment) Order, 1927.

Comparisons of Systems.—Having briefly indicated the special features of each form of traction referred to, it is not difficult to visualize the character of the traffic which they are especially suited to provide, and generally speaking there is no very great difference of opinion among transport experts on this important question But experience has shown that in cases where omnibuses are permitted to run and ply for hire indiscriminately over tramways, the tramway revenue can be so depleted as to reduce the undertakings to insolvency, although the motor omnibuses themselves would not be the most suitable form of transport for dealing with the traffic, and it is on this point that confusion of thought among non-transport experts exists. A motor

omnibus, being a self-contained vehicle, is a comparatively inexpensive vehicle to provide and operate, and is admirably suitable for dealing with many kinds of traffic characteristics It is extremely mobile and can be operated in different districts at different parts of the day, in this manner depleting the tramway revenues just when it was earning a profit.

Apart from the merits of the two forms of traction for dense traffic conditions, the question of the capacity of the roads in large towns is a very important factor to be studied. Another important question—national in its bearing—is the fact that practically the whole of the motor spirit used to propel motor omnibuses is imported It is difficult to realize what the position of road transport in this country would be if there were no electric services and omnibus fuel supplies were for any reason cut off for a prolonged period. The French Government is so concerned at the undesirability of having to depend on imported fuel for transport purposes that they have given much encouragement to the discovery and use of petrol substitutes On the other hand, the omnibus has the advantage over tramcars in that it can draw up to the side of the road for the convenience of picking up and setting down its passengers. Much confusion of thought on the merits of tramways has been created owing to several tramway systems having been discontinued and superseded by omnibuses or trackless trolley buses. These changes were made mainly because the tramways were established to deal with traffic which in these cases never was and probably never would have been sufficiently dense to justify their establishment and continuance Nevertheless these matters do not detract from the value of tramways for dealing with dense city and suburban traffic, where the requirements call for permanent way with double track and large-capacity tramcars operated at frequent intervals at high speeds. Many of the managers of large road passenger transport undertakings, some of whom are responsible for both tramways and omnibuses, have recently expressed the view that on their true merits tramways for dealing with dense city traffic have nothing to fear from omnibuses. Some figures recently published in connection with the Manchester Corporation tramways and omnibus services give the working costs per seat mile as being 0·21d. for the tramways and 0·46d. for the omnibuses. In London the cost of operating a double-deck omnibus averages 0·263d per seat mile, and 0·190d. for tramways. It is obvious that if tramways were relieved of their onerous obligations referred to above, the cost of operation per seat mile would be still more favourable to them

Summary.—Much evidence has recently been given by officials responsible for large combined tramway and omnibus undertakings, to indicate that tramways form an indispensable part of road transport required to cope with the ever-increasing traffic in large cities where, in most cases, by far the greatest proportion of the whole passenger traffic is still carried by tramways The London and Home Counties advisory committee, which was set up under the London Traffic Act, 1924, to bring about co-ordination of transport systems, confirmed this by expressing similar views. They "consider that tramways are an essential part of the passenger transport system in the metropolis" Several large municipal tramways are being extended into the suburbs with special track construction along new and modern thoroughfares.

Summarizing the above it may be said generally that·—

(1) Tramways are pre-eminently suitable for main city routes where the traffic is dense

(2) Trackless trolley buses are suitable for traffic of moderate density, cross-town work, and feeders to tramways, where the roads are suitable for their use

(3) Motor omnibuses have a wide range of usefulness for dealing with traffic varying from light to heavy. They are more mobile than other forms of public transport vehicles, but create more congestion than tramways and reduce the capacity of the roads, especially at city termini, when used for dealing with heavy traffic. They are dependent on imported fuel. There are cases where their use to augment tramway services during the heavy peak loads is well worth consideration.

(4) Light railways, as developed for road traffic purposes in Great Britain, are similar to tramways. Powers authorizing their construction have not been used to a large extent for the express purpose intended by legislation, although the comparatively cheap form of construction (sleeper track) is being used to extend into the suburbs some large city tramway undertakings.

(5) Suburban railways are used in large cities for the transportation between localities as contrasted with pick-up traffic along the routes. The services are frequently superimposed on main line railway services.

Even with the best of co-ordination of the various forms of transport, there is bound to be a certain amount of direct or indirect competition between them, and to organize the best scheme for any particular conditions on their merits as transport agencies, calls for high degree of experience and expert transport knowledge The desirability of the co-ordination of the various forms of transport to enable all to function according to their respective merits was appreciated by the Government, and a royal commission was appointed in 1928 to consider the matter. The evidence given before the joint committee of both houses of parliament in connection with the omnibus powers being sought by the railway companies indicates the urgent necessity of legislation to deal with this important question. There is a growing feeling that legislation in this connection is vital to the co-ordination of this country's transport services, and to protect and encourage them in such a way as to ensure healthy expansion and improvements in these services on which England depends for its industrial welfare *See also* LONDON: *Communications*.

(E GAR)

UNITED STATES

Early History.—Mass transportation of passengers in cities had its origin in the omnibus service established in Paris in 1819, but 12 years elapsed before the first omnibus made its appearance in the United States in 1831. This was a vehicle constructed by the famous carriage builder, John Stephenson, and operated on Broadway, New York, between Bond street and the Battery. The fare was 12½ cents Previous to that, stage-coaches had been in operation between New York and other cities for some 75 years The omnibus service, however, was a novelty. Briefly, the idea was to operate passenger-carrying service at relatively frequent intervals over a short route wholly within the city in contrast to the less frequent stage-coach service operated over relatively long routes between cities. This new idea took hold rapidly and it was not long before New York was literally filled with horse-drawn omnibuses clattering up and down the streets.

It so happened, however, that another new idea, which was eventually to put the horse-drawn omnibus out of business, was developed at almost the same time. This second new idea was to build a track of iron rails laid on stone ties in the centre of the street and to equip vehicles with flanged wheels so that they could be drawn faster and more easily over the smooth metal right-of-way than the omnibuses could be drawn over the rough cobblestones. Some 56 years earlier the first railway using iron rails had been built at Sheffield, England, but it had been utilized only for the transport of freight. The carrying of passengers by rail did not begin until 1825, when the Stockton and Darlington railway started service on a 12mi. line between those two English cities In the United States, a somewhat similar service was started a few years later by the Baltimore and Ohio railroad between Baltimore and Ellicotts Mills, a distance of 14 miles. Shortly after this, the remarkable performance of George Stephenson's locomotive "The Rocket" in England and the successful trial of the American-built locomotive "De Witt Clinton" greatly stimulated interest in railroading on both sides of the ocean.

New York was then a city of some 200,000 people Catching the railroad fever, a group of prominent business men headed by John Mason, president of the Chemical Bank, obtained permission from the State legislature to incorporate the "New York and Harlaem Railroad Company" and to construct a single or double track railroad between 23rd street and the Harlem river on any route which the city should approve. Their idea was to connect at the Harlem river with a railroad north to Albany. Scarcely had this permission been granted, however, when the incorporators conceived the idea of extending the line further down into the city and furnishing local transportation. Two cars of stage-coach design were built for the company by the same John Stephenson who built the first omnibus. Each had a seating capacity of 30 passengers. Service began on Nov. 14, 1832, on a mile-and-a-half route from Prince street to 14th street along the Bowery This New York and Har-

lem railroad was the first company in the world to provide local passenger transportation on rails So popular did its service become that in a year the length of the route was extended to four miles and additional cars were purchased In the beginning a 15 min. service was given at a fare of 12½ cents, the same as on the first omnibuses By the middle 1840's, the service was operating on a 6min headway from City Hall to 27th street

The advantages of street railway service, however, were slow to be appreciated by people in other cities One short line was started in New Orleans in 1835 Then nothing happened until 1853, when a street railway was built in Brooklyn The first street railway in Massachusetts commenced operation between Boston and Cambridge in 1856. Two years later the idea spread to Philadelphia. Cincinnati, Baltimore and Chicago tried the experiment in 1859 From that time the progress of the industry was rapid. By 1890, according to the best available figures, there were approximately 105,000 horses and mules engaged in pulling 28,000 street-cars on about 5,700mi of track in the United States.

Cable and Early Electric Lines.—Already, however, two competitors of the horse-car had sprung up The cable-car system had been established in San Francisco in 1873 and the electric railway had demonstrated its practicability in Richmond in 1888. In many respects the development of the cable system represented an engineering achievement as great as any in the history of transportation Moving the long heavy cables through the slots beneath the street pavement required massive and intricate machinery. The design of satisfactory apparatus on the cars to grip the constantly moving cable presented many difficulties Braking, too, was more of a problem than with the slower and lighter horse-cars

Because its development was followed closely by that of the electric railway, the cable system never came into wide use Besides San Francisco, it was tried in Washington, New York, Chicago and a few other cities The expense of installing the system was very high and its operation presented great difficulties To keep miles and miles of heavy cable running smoothly required unremitting care A break in the cable caused long delay and heavy expense. Improved "grips" were devised but the best of them were none too satisfactory The peak period of the cable railway was about 1890, when a total of 488mi. of track were operated in this way. With the development of the electric car the street railway industry became possessed of a far better means of rendering its service to the public. Today, cable-cars survive only in San Francisco, where they have been thought to have special advantages on account of the unusually steep hills.

The demonstration at Richmond of the practicability of street railway operation with electricity as a motive power followed a long series of experiments (*see* ELECTRIC TRACTION) Compressed-air cars, storage-battery cars, and electric systems with contact plates on the surface of the ground had all been tried and found unreliable. Once a practical method of electric operation had been developed, expansion was rapid By 1890 some 1,300 electric cars were being operated on 1,261mi. of electrified street railway track This, however, represented less than one-sixth of the total street railway trackage then in operation in the United States But the following decade witnessed a sweeping transformation The U.S Census of Street and Electric Railways for 1902 showed nearly 22,000mi. of electrified track, while the horse-car and cable lines had dwindled to approximately 250mi. each. In New York and Washington an underground current collection system was used. Cincinnati used a two-wire overhead system. Everywhere else the single overhead wire system was used in substantially the form originally developed at Richmond

Period of Expansion.—From 1902 to 1917 was the great period of expansion of the electric railways. Many new lines were built not only in the larger cities but also in the smaller cities and in suburban areas. Future developments were to show that much of the expansion of the last mentioned types was unwise, but this was not evident at the time. Electrification of the street railways at first appeared promising from the standpoint of financial results. Whereas the cost of operation took about 68 cents of every dollar of revenue collected by the horse-car lines in 1890, operating expenses of the electric railways in 1902 took only 57 cents out of every dollar of revenue This reduction in operating expenses seemed encouraging, though actually the gain was more than offset by the fact that the fixed charges on the investments in electric railways absorbed 31 cents of every dollar of revenue as compared with only 15 cents with the horse-cars Nevertheless, it was felt that the greatly improved service rendered by the electric cars would attract enough patronage to enable the operating companies to meet their fixed charges without much difficulty. Hence the expansion of electric railway operations continued steadily By 1917, the industry had about 80,000 passenger cars and 45,000mi of track

In the early days of the street railway industry the ease with which franchises could be obtained in most cities gave great encouragement to promoters. Usually, each line was organized as a separate corporation and operated under its own franchise Fares were almost universally fixed at 5 cents regardless of the length of ride, which usually was short Because individual routes were operated by separate companies, there were no free transfers and the actual cost of travelling from place to place within a city was frequently much greater than 5 cents. Then came a period of mergers of independent lines into larger systems, with the result, in most instances, that each community had a single unified system with free interchange between routes. This added greatly to the attractiveness of the service and reduced the total cost of any trip involving the use of more than one route. The mergers undoubtedly permitted some economies in operation On the other hand, they resulted in a considerably longer average haul for each cash fare paid. This trend was accentuated by the demands for service to outlying districts which resulted in lengthening the existing lines by substantial amounts As a result, the number of passengers carried per mile of track was actually less in many instances than it had been in earlier days when the systems were smaller.

At the same time that the lines were being extended, the cost of labour and materials was increasing. By 1915, the situation had become serious, and it was greatly aggravated by the unusual conditions brought about by the World War. Shortly after the war, President Wilson appointed a Federal Electric Railway Commission to study the situation and suggest measures for their relief The commission attributed the difficulties of the railways largely to three things: (1) high cost of labour and materials, (2) early financial mismanagement and (3) inadequacy of the existing fare system. In general terms the commission recommended that energetic efforts be made to effect economies in operation and to improve service, that some relief be given to the companies in the way of elimination of special assessments and taxes, and that regulation be imposed upon the independent motor-bus operators who had recently commenced to compete with the electric railways.

Comparatively little actual result came from these recommendations Efforts to effect economies were, indeed, made, but they were offset by the continued rise in the cost of labour and materials. In the course of time most electric railways succeeded in obtaining higher rates of fare, though not in proportion to their higher costs. Eventually, too, the operation of motor-buses came under regulation similar to that of the electric railways. With respect to the elimination of special assessments and taxes, however, no great progress has yet been made and a large majority of electric railways are still burdened with paving charges, snow removal charges and the like, in addition to franchise and other taxes

Jitney and Bus Competition.—Shortly after the outbreak of the World War, there appeared on the streets of many American cities great numbers of privately owned automobiles, the drivers of which solicited riders at 5 cents a head Almost all of these operators confined their activities to the established routes of street railways where the traffic was the heaviest and the chances of securing patrons was the greatest. Because of the 5-cent fare, these vehicles became known as jitneys

Jitney operation spread rapidly. All sorts and conditions of vehicles were brought into use It seemed as if every man who had no steady job and could get the use of an automobile went into the business. At this time the jitney did not come within

the purview of the statutes that had been enacted for the regulation of public utilities in most States. Nor were there in existence any municipal ordinances to control or curb its activities. Thus, the jitney operators were permitted to do pretty much as they pleased. Street accidents increased tremendously and few of the persons injured were able to secure financial redress because of the financial irresponsibility of the jitney owners and their lack of accident insurance

Despite the poor quality of its service, this makeshift transportation facility cut heavily into the revenues of the street railways. Had the unregulated competition been allowed to continue it would eventually have created complete chaos in the field of local transportation After a few years, however, the public authorities were forced to take cognizance of the situation and legislation was enacted to improve operating conditions and provide protection for the public.

The real significance of the jitney was that it was the forerunner of a new type of transportation vehicle which was to have a far-reaching effect on street railways everywhere The original nondescript small automobile gave way to a vehicle with a box-like body on a light truck chassis, seating about 12 passengers This, in turn, was superseded by more substantial vehicles using heavy truck chassis upon which were built bodies capable of seating 20 or more passengers From these beginnings came the modern motor-bus

Naturally enough, the street railway industry was bitterly opposed to the jitneys Even when this vehicle evolved into the early type of motor-bus most street railways continued their opposition. Their attempts to legislate the motor-bus out of existence, however, proved unsuccessful, as the new vehicle had some points of operating superiority over the street-car which offset its physical shortcomings As bus operation became subjected to more and more regulation, however, many street railway companies changed their attitude and decided to enter the bus business themselves

The effect of this decision was far reaching The street railways soon discovered that bus service, properly regulated and operated, could meet many transportation demands more efficiently and economically than could the street-car. Extensions of street railway lines virtually ceased, and substitutions of buses in place of cars began As a result, the electric railway trackage in the United States shrunk from approximately 45,000mi. in 1917 to 25,000mi in 1937. Similarly, the number of electric railway passenger cars declined from 80,000 to approximately 35,000 In this connection, however, it should be noted that many electric railway companies formerly had duplicate equipment, open cars for summer and closed cars for winter, and a substantial part of the reduction has been due to abandonment of open car operation.

Since the time that the street railway industry decided to enter the bus business, it has succeeded in co-ordinating a very large part of the city bus operation with its rail operation. Thus, the competition between the motor-bus and the street-car has become one of cost and quality of service under one management rather than one of separate companies competing with each other At the present time, the street-cars are carrying slightly more than half of all the passengers carried in urban and suburban transit service Motor-buses are carrying approximately 27%; subway and elevated lines, approximately 18%; and other vehicles, 3% Indications are that substitution of buses in place of street-cars will continue, although the competitive portion of the two vehicles has been somewhat altered by recent improvements in street-car design.

New Type Street-Car.—Recognizing the need for a better type of street-car a group of leading operators got together in 1930 and formed the Electric Railway Presidents' Conference Committee. Five years of effort and approximately $750,000 were spent in a program of research Upon this has been based the design of a car with performance characteristics far surpassing those of any previous street-car. Using rubber extensively in the construction of trucks and wheels, a vehicle has been developed which operates with almost no noise or vibration. To give the new car faster acceleration and retardation, new types of control, motors and brakes were developed More than 1,000 cars of this type have been purchased in recent years by the street railway companies in Chicago, Philadelphia, Los Angeles, Brooklyn, Baltimore, Washington, Toronto, Pittsburgh, Cincinnati, San Francisco, St Louis and San Diego Wherever these cars have been introduced revenues have increased and operating expenses have been reduced While it is not anticipated that these improved vehicles will restore the street railway to the position it occupied in the local transportation field 20 years ago, many experienced operators feel that the new type of car represents such an effective combination of efficient performance and passenger appeal that it has no superior among transit vehicles where heavy loads are to be carried

Trackless Trolleys.—In recent years, an entirely new type vehicle has entered the transit field to a notable extent in the United States and England and to some extent in a number of other countries This is the so-called "trackless trolley" or "trolley-bus," which is, in effect, a vehicle midway between the electric street-car and the motor-bus, operating on rubber tires but utilizing electrical energy from overhead wires as its source of power.

As far back as 1882 experiments were being made with a two-wire overhead electric system for omnibuses Between 1900 and 1914 a number of systems of this kind were established in the United States and England While their theoretical advantages were clearly seen, the practical aspects of design had not been satisfactorily mastered. Following the World War these experiments were continued It was not until 1928, however, that successful results were achieved By that time many advances had been made in the design of automotive vehicles so that it was possible to build a trolley-bus of far more efficient and commodious design than the earlier vehicles Salt Lake City was the first city in the United States to install a trolley-bus system with vehicles of the new type Compared with the older street-cars, the new trolley-bus had the advantages of being quieter in operation and more modern in appearance, as well as being cheaper to operate Compared with the gasoline motor-bus, it had the advantage of being able to draw upon an unlimited supply of electric power

From 1929 to 1939, this type of transportation made great strides. There are more than 2,000 of these vehicles in operation over 1,500mi of route in the United States Even greater popularity has been achieved by this vehicle in England, where some 2,600 are in operation. Elsewhere throughout the world, there are about 1,300 others More than 60 cities of over 25,000 population in the United States are now served wholly or in part by trolley-buses. Since this type of service utilizes a power supply and distribution system similar to those of the electric railway, it is natural to find that all trolley-bus operations are conducted by electric railway companies.

Rapid Transit Lines.—Early in the history of urban transportation it was recognized that great advantage from the standpoint of speed could be obtained by removing transit vehicles from the congestion of city streets Experiments began as far back as 1867 when an elevated railway with cable drive was built on 9th avenue, New York city The cable method of propulsion proved a failure, however, and permission was secured to substitute steam locomotives Operation began on April 20, 1871. In the following year this line was extended and various connecting lines built. Following the success of the initial elevated railway in Manhattan, Brooklyn soon undertook the construction of similar lines.

Steam operation, however, had obvious disadvantages After the practicability of the surface electric railway had been demonstrated at Richmond, Frank J. Sprague proposed the electrification of the elevated railways (*see* ELECTRIC TRACTION). The first elevated to be so equipped was the Metropolitan West Side line in Chicago in 1895 In subsequent years all of the elevated railways were electrified.

Authorization for the construction of the first subway in New York was granted in 1891 but it was not until 1900 that the numerous objections to the plan were finally overcome and bids for construction and operation were invited. Operation commenced on Oct. 27, 1904 Boston had already opened in 1897 a short subway which was first operated with street-cars and later with rapid transit trains. This was really the beginning of underground

electric railway operation as a factor in urban transportation, but the Boston system has since been overshadowed by the much larger system in New York. Since 1904, the expansion of subways in New York city has been continuous and rapid. Boston has constructed some additional subways, too. So also has Philadelphia. Construction of a subway in Chicago was started in 1938. All of these cities also have elevated railway service. For the most part the operation of all these rapid transit lines has been coordinated with the operations of the surface railway and bus lines.

Future Prospects.—When the private automobile first came into wide-spread use in the United States, it was thought by many people to spell the doom of the street railways. Actually, it has had a much smaller effect than was popularly anticipated. The total demand for public transportation service in American cities has not been reduced materially by the tremendous development of private transportation. Today, the number of passengers carried is substantially greater than it was 25 years ago when private automobiles were few and far between. Two things account for this situation. In the first place, the lower cost of public transportation influences a great many people to use it in preference to private transportation. In the second place, there is neither roadway space nor storage space enough to permit the majority of people to use private automobiles in congested districts. Undoubtedly the need for transit service will continue. To what extent this service will be rendered in the future by surface street railways, motor-buses, trolley-buses or rapid transit lines, however, can be determined only with the passage of time.

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(J. A. MI.)

TRANCE, a term used very loosely in popular speech to denote any kind of sleeplike state that seems to present obvious differences from normal sleep; in medical and scientific literature the meaning is but little better defined. In its original usage the word no doubt implied that the soul of the entranced person was temporarily withdrawn or passed away from the body, in accordance with the belief almost universally held by uncultured peoples in the possibility of such withdrawal. But the word is now commonly applied to a variety of sleeplike states without the implication of this theory; ordinary sleep-walking, extreme cases of melancholic lethargy and of anergic stupor, the deeper stages of hypnosis (*see* HYPNOTISM), the state into which many of the mediums of modern spiritualistic séances seem to fall almost at will; all these are commonly spoken of as trance, or trance-like, states. There are no well-marked and characteristic physical symptoms of the trance state, though in many cases the pulse and respiration are slowed, and the reflexes diminished or abolished. The common feature which more than any other determines the application of the name seems to be a relative or complete temporary indifference to impressions made on the sense-organs, while yet the entranced person gives evidence in one way or another, either by the expression of his features, his attitudes and movements, his speech, or by subsequent relation of his experiences, that his condition is not one of simple quiescence or arrest of mental life, such as characterizes the state of normal deep sleep and the coma produced by defective cerebral circulation by toxic substances in the blood or by mechanical violence done to the brain.

If we refuse the name trance to ordinary sleep-walking, to normal dreaming, to catalepsy, to the hypnotic state and to stupor, there remain two different states that seem to have equal claims to the name; these may be called the ecstatic trance and the trance of mediumship respectively.

The ecstatic trance is usually characterized by an outward appearance of rapt, generally joyful, contemplation. The subject seems to lose touch for the time being with the world of things and persons about him, owing to the extreme concentration of his attention upon some image or train of imagery, which in most cases seems to assume an hallucinatory character (*see* HALLUCINATION). In most cases, though not in all, the subject remembers in returning to his normal state the nature of his ecstatic vision or other experience, of which a curiously frequent character is the radiance or sense of brilliant luminosity.

In the mediumistic trance the subject generally seems to fall into a profound sleep and to retain, on returning to his normal condition, no memory of any experience during the period of the trance. But in spite of the seeming unconsciousness of the subject, his movements, generally of speech or writing, express, either spontaneously or in response to verbal interrogation, intelligence and sometimes even great intellectual and emotional activity. In many cases the parts of the body not directly concerned in these expressions remain in a completely lethargic condition, the eyes being closed, the muscles of neck, trunk and limbs relaxed, and the breathing stertorous.

Traces of these two types seem to have occurred sporadically (occasionally almost epidemically) amongst almost all peoples in all ages. And everywhere popular thought has interpreted them in the same ways. In the ecstatic trance the soul is held to have transcended the bounds of space or time, and to have enjoyed a vision of some earthly event distant in space or time, or of some supernatural sphere or being. The mediumistic trance, on the other hand, popular thought interprets as due to the withdrawal of the soul from the body and the taking of its place, the taking possession of the body, by some other soul or spirit; for not infrequently the speech or writing produced by the organs of the entranced subject seems to be, or actually claims to be, the expression of a personality quite other than that of the sleeper. It is noteworthy that in almost all past ages the possessing spirit has been regarded in the great majority of cases as an evil and non-human spirit; whereas in modern times the possessing spirit has usually been regarded as, and often claims to be, the soul or spirit of some deceased human being. Modern science, in accordance with its materialistic and positive tendencies, has rejected these popular interpretations. It inclines to see in the ecstatic trance a case of hallucination induced by prolonged and intense occupation with some emotionally exciting idea, the whole mind becoming so concentrated upon some image in which the idea is bodied forth as to bring all other mental functions into abeyance.

Science regards the mediumistic trance as a state similar to deep hypnosis, and seeks to explain it by the application of the notion of cerebral or mental dissociation in one or other of its many current forms; this assimilation finds strong support in the many points of resemblance between the deeper stages of hypnosis and the mediumistic trance, and in the fact that the artificially and deliberately induced state may be connected with the spontaneously occurring trance state by a series of states which form an insensible gradation between them. A striking feature of the mediumistic trance is the frequent occurrence of "automatic" speech and writing; and this feature especially may be regarded as warranting the application of the theory of mental dissociation for its explanation, for such automatic speech and writing are occasionally produced by a considerable number of apparently healthy persons while in a waking condition which presents little or no other symptom of abnormality. When, as in the majority of cases, such speech or writing merely gives fragmentary expression to ideas or facts that have been assimilated by the subject at some earlier date, though perhaps seemingly completely forgotten by him, the theory of mental dissociation affords a plausible and moderately satisfactory explanation of them.

But in recent years a new interest has been given to the study of the mediumistic trance by careful investigations (made, mostly by members of the Society for Psychical Research, with a competence that commands respect) which tend to re-establish the old theory of external possession, just when it seemed to have become merely an anthropological curiosity. For this aspect of mediumistic trance the article on *Psychical Research* should be consulted.

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TRANENT, small burgh of East Lothian, Scotland. Pop. (1951), 5,639. It lies 9½ mi E. of Edinburgh by road and 1 mi. S.E. of Prestonpans station on the L N E. railway. The town possesses the oldest coal-mining charter (1202–18) in Great Britain, and the mines in the neighbourhood provide the staple industry. A fragment of a parish church, said to have been built in the 11th century, still stands. The palace of the Setons was demolished towards the close of the 18th century and a modern mansion was erected on its site.

In the neighbourung village of Ormiston, in 1885, a granite obelisk was erected in memory of Robert Moffat (1795–1883), a native, the South African missionary and father-in-law of Livingstone. At Ormiston hall, a seat of the marquess of Linlithgow, there is a yew tree, beneath which the reformer George Wishart (1513–1546) used to preach. Hard by is the village of Pencaitland, divided into an eastern and a western portion by the Tyne. The parish church in eastern Pencaitland probably dates from the 13th century. The aisle may belong to the original building, but the rest is of the 16th century, excepting the small belfry of the 17th century. The old house of Pencaitland stands in the grounds of Winton castle, which was erected by the 3rd earl of Winton in 1620 but forfeited by the 5th earl, who was involved in the Jacobite rising of 1715. Five miles southeast of Tranent is the village of Saltoun (or Saltown), where Gilbert Burnet, afterward bishop of Salisbury, had his first charge (1665). At his death he bequeathed the parish 20,000 marks for the clothing and educating of poor children. He was tutor to Andrew Fletcher, who was born at Saltoun in 1655 and buried there in 1716. At Fletcher's instigation James Meikle, a neighbouring millwright, went to Holland to learn the construction of the ironwork of barley mills, and the mill which he erected at Saltoun after his return not only gave Saltoun barley a strong hold on the market but was also for 40 years the only mill of its kind in the British Isles. Meikle's son Andrew (1719–1811), inventor of the threshing machine, carried on his trade of millwright at Houston Mill near Dunbar. Andrew Fletcher, also of Saltoun (1692–1766), nephew of the elder Andrew, became lord justice clerk in 1735 under the style of Lord Milton. By his mother's energy the art of weaving and dressing Holland linen was introduced into the village. She travelled in Holland with two skilled mechanics who contrived to learn the secrets of the craft. The British Linen company laid down its first bleachfield at Saltoun under Lord Milton's patronage. Saltoun also lays claim to having been the birthplace of the poet William Dunbar.

TRANI, a seaport and episcopal see of Apulia, Italy, on the Adriatic, in the province of Bari, and 26 mi. by rail W.N.W. of that town, 23 ft. above sea-level. Pop. (1936), 29,962 (town), 31,175 (commune). The cathedral (dedicated to St. Nicholas the Pilgrim, a Greek who died in 1094 and was canonized by Urban II) on an open site near the sea, was consecrated, before its completion, in 1143; it is a basilica with three apses, a large crypt and a lofty tower, the latter erected in 1230–39 by the architect whose name appears on the ambo in the cathedral of Bitonto, Nicolaus Sacerdos. It has an arch under it, being supported partly on the side wall of the church, and partly on a massive pillar. The arches of the Romanesque façade are ornamented; the bronze doors, executed by Barisanus of Trani in 1175, rank among the best of their period in southern Italy. The capitals of the pillars in the crypt are fine examples of the Romanesque. The interior of the cathedral has been barbarously modernized, but the crypt is fine. Near the harbour is the Gothic palace of the doges of Venice, which is now used as a seminary. S. Giacomo and S. Francesco also have Romanesque façades and the latter and S. Andrea have domes. The fine castle was begun by Frederick II. (1233) and enlarged in the 15th and 16th centuries. The Palazzo Caccetta (1458) is a fine Gothic building. Trani produces wine (Moscato di Trani). Trani is the *Turenum* of the itineraries. It first became a flourishing place under the Normans and during the crusades but attained the acme of its prosperity as a seat of trade with the East under the Angevin princes. Its code of maritime law (the *ordinamenta maris*) is the first of mediaeval codes (1063).

TRANQUEBAR, a town of India, in the Tanjore district of Madras, on the sea-coast, 18 m N. of Negapatam. Pop (1941), 11,111. A railway line from Mayavaram was planned in 1924. A Danish factory was opened here as early as 1620. It was taken by the British in 1801, but restored in 1814, and finally purchased, with the other Danish settlements in India, in 1845. In Danish times Tranquebar was a busy port, but it lost its importance when the railway was opened to Negapatam. It was the first settlement of Protestant missionaries in India, founded by Ziegenbalg and Plutschau (Lutherans) in 1706; and there is still a Lutheran mission high school and mission press, equipped for printing the native languages.

TRANSATLANTIQUE, COMPAGNIE GÉNÉRALE, a maritime steamship line, popularly known as "The French Line," was formed as the Compagnie Générale Maritime in 1855. It controlled a fleet of 75 sailing ships, of which many were engaged in the cod-fishing industry off the Newfoundland Banks, and 10 steamers. In 1860 the company was awarded the postal contract for a service between Havre and New York. The next year the company adopted its present name.

The first steamships for its New York service had a gross tonnage of 3,000 tons and a speed of about 8 knots. "La Touraine," a twin-screw vessel of 18 knots, built in 1890, held the blue riband of the Atlantic for some time. In 1906 the company ran another very fast vessel for her day—"La Provence" (21·5 knots on trials), and six years later operated the "France" (24 knots). Recent additions were the "Ile de France" (1927), "Champlain" (1932), and "Normandie" (1935), which held for a time the Hales Blue Riband Trophy.

The company maintains also regular passenger and freight services to the West Indies, Spanish Main, Mexico, and to the North and South Pacific coasts of America. Morocco, Algeria and Tunisia are served by its Mediterranean postal services from France In 1939 the fleet consisted of 79 vessels with a gross registered tonnage of 580,353. The gross tonnage of the "Normandie" is 83,423. In 1939 a sister ship was ordered. (G. C. Rsh.)

TRANSBAIKALIA: *see* BURIAT MONGOL REPUBLIC and FAR EASTERN AREA.

TRANS-CANADA HIGHWAY, a highway crossing Canada from ocean to ocean. Starting at Halifax, N.S., it passes through the Maritime Provinces and along the St. Lawrence river, through Ottawa, to Lake Superior, a distance of about 1,500 miles. It is a graded road from Halifax to Quebec. From Quebec to Ottawa the roadway is paved or hard surfaced; the balance improved, graded or dirt. Its central division is not yet completed and the traveller must therefore pass through U.S. territory from Sault St. Marie, to Emerson, south of Winnipeg, Manitoba. The distance from Winnipeg to Vancouver is about 2,000 miles. This western section has some semi-hard surfacing but is mostly dirt roadway. It passes through Brandon, Man., Regina, Sask., Medicine Hat and Calgary, Alb.

TRANSCASPIAN REGION: *see* TURKMEN REPUBLIC and KAZAKSTAN.

TRANSCAUCASIA, a general name given, before the Russian revolution of 1917, to the governments and provinces of Russian Caucasia, excluding the steppe provinces of Kuban and Terek and the steppe government of Stavropol. It thus included the governments of Baku, Elisavetpol, Erivan, Kutais and Tiflis; the provinces of Batum, Daghestan and Kars; and the military districts of the Black Sea (Chernomorsk) and Zakataly. It is now applied to the three Soviet Republics of Georgia, Azerbaijan and Armenia, which from 1922 to 1936 constituted the single Transcaucasian S.F.S.R. Kars is now included in Turkey.

See ARMENIA; AZERBAIJAN; GEORGIA; DAGHESTAN; ADZHARIA; and NAKHICHEVAN. All these except Daghestan joined the Transcaucasian S.F.S.R in 1922.

History.—On Sept. 20, 1917, a council of Transcaucasian peoples met at Tiflis and declared Transcaucasia to be a Federal republic within the Russian dominions. In May it opened peace negotiations with the Germans and Turks, the latter having invaded the country and captured Batoum and Kars. The Federal Council dissolved, however, on May 26, 1918, Georgia declaring its complete independence and National Councils of Armenians and Tatars taking over the administration of Armenia (Erivan) and Azerbaijan. Separate treaties were signed by Georgia with Germany on May 28 and by the three republics with the Turks and Germans on June 4, which resulted in the "friendly" occupation of Armenia by the Turks and of Georgia by the Germans. In the following month the Bolshevik administration at Baku established in March was overthrown and on Aug. 4 a British force under Maj.-Gen. L. C. Dunsterville occupied the town. On Sept. 14 they evacuated Baku, which was then occupied by the Turks and became the seat of the Azerbaijan Government. The Turks, however, were compelled to evacuate the whole of Transcaucasia by the terms of the Armistice with the Allies of Oct. 30, and in the middle of November, Baku was reoccupied by a British force which administered the district on the collapse of the existing Azerbaijan Government.

During 1919 the three Governments gradually established themselves under the protection of the British forces, though Armenia opened hostilities in January against Georgia and in August against Azerbaijan In both cases the disputes (territorial in origin) were settled by British mediation. The British forces evacuated the whole of Transcaucasia except Batoum on Aug. 28, 1919. In Jan. 1920, the Supreme Council sitting in Paris accorded *de facto* recognition to the three Governments. On April 27–28 there was a revolution at Baku and the Azerbaijan Government was replaced by a Soviet republic which invited the Russian Soviet forces to occupy the country Georgia and Armenia, however, retained their independence for a time, and the former signed treaties with the Soviet Governments of Azerbaijan (May 7) and Russia (June 6), a step which Armenia refused to take On July 7 the British forces evacuated Batoum and handed over the district to the Georgian Government whose independence was recognized by Soviet Russia in a second treaty signed in August. An Armenian Soviet Government was established in November whose independence was recognized by Soviet Russia.

On Jan 27, 1921, the Supreme Council sitting in Paris accorded *de jure* recognition to the Menshevik Government of Georgia, but on Feb. 12 there was a rising against this Government in the country and a week later the Russian Soviet troops crossed the frontier Turkish forces then occupied Batoum at the invitation of the Mensheviks, but withdrew on the signature of peace and the proclamation of a Georgian Soviet republic (March 19). In the following May a treaty of Alliance was signed between the Georgian and Russian Soviet Governments. Meanwhile the three refugee Governments from Georgia, Azerbaijan and Armenia had fled to Paris and there proclaimed a Caucasian Federation, asserting that the respective Soviet Governments did not represent the wills of the three peoples. The three Soviet Governments regulated their relations with Turkey in a treaty signed at Kars on Oct. 13, the provisions of which followed the lines of the treaty concluded in Moscow between Russia and Turkey, March 16. On March 12, 1922, the three Soviet Governments signed an agreement leading up to the Transcaucasian S.F S R. which, though in close alliance with the Russian Soviet republic, retained independence until the creation of the Union of Socialist Soviet Republics, July 6, 1923, of which it then became a constituent member. (*See* RUSSIA.)

TRANSCENDENTALISM is an expression introduced by Kant for "the idea of a science for which the critique of pure reason is to outline the whole plan architectonically, *i.e.*, according to principles, with full guarantee of the completeness and security of all the pieces composing this structure." In this sense, it is the system of all principles of pure reason. More precisely, the task of transcendentalism consists in the solution of the question: how are synthetical propositions *a priori* possible, *i.e.*, how can pure intuitions and pure concepts, which are entirely *a priori* and not derived from nor founded on experience, refer to objects of experience and claim for these objects universal and necessary validity? (*Kritik der reinen Vernunft*, 2nd ed. p. 73.) Transcendentalism, according to Kant, is possible only as a system, *i.e.*, it has to seek its concepts according to a principle because they must issue pure and unadulterated from the understanding as an absolute unity, and must, therefore, themselves cohere with one another according to an idea (*ibid.* p.92). As this idea, which establishes and guarantees the coherence between all single cognitions, Kant designates the idea of "possible experience" and an "object of experience." Synthetical judgments *a priori*, whether they belong to the sphere of pure intuition or to the sphere of pure understanding, have the common characteristic that they form those basic functions by which alone it is possible to refer our images to an object and thus to secure for them objective validity. In the section "on the supreme principle of all synthetical judgments" Kant shows that this reference to an object is not characteristic of sense impressions as such, but that it is founded on a "synthesis by concepts," *e.g.*, the concepts of magnitude, persistence, causality, etc. Without such concepts, experience would not be cognition but a mere rhapsody of perceptions which would not enter together into any context of a coherently connected consciousness. Cognition *a priori*, accordingly, has truth (*i.e.*, conformity with the object) only because it contains nothing but what is necessary for the synthetic unity of experience in general. The intuitions and concepts *a priori*, set forth systematically within transcendentalism, are, as conditions of the possibility of experience, at the same time conditions of the possibility of the objects of experience and hence applicable to these objects without any restriction (*ibid.* p 196 *seq.*).

The *term* "transcendental" was not created by Kant. The expression goes back to the scholastic philosophy (Knittermeyer *Der Terminus transcendental*, 1920). Here it is synonymous with "transcendent." Transcendental or "transcendent" concepts are such as transcend the realm of finite, conditioned being, and lead on to the Infinite and Unconditioned. Only by such a transcendence is metaphysical and religious cognition possible. It is necessary to go beyond the variability of finite things and the limits of empirical self-consciousness, if a true knowledge of God is to be reached. This use of the word is found already in *Augustine*. In scholasticism, those concepts are called *transcendentia* which are not confined to a specific type of being, but are valid for *all* types. Thus the concepts Thing (*res*), One (*unum*), Something (*aliquid*), can be applied to any being. Scholasticism gradually developed a fixed order of the *transcendentia*. In the *Summa Theologiae* of Albertus Magnus One, True and Good (*unum, verum, bonum*) are introduced as the first essential determinations of being. With Thomas Aquinas, Being is first determined as Thing (*res*) which expresses the "quiddity" or "essence" (*quiditas sive essentia*) of Being; to this are added the concepts One and Something, True and Good (*De Veritate*). *Ens, res, unum, aliquid, verum, bonum*, thus became the "transcendental" concepts of tradition. Kant, himself, in the *Critique of Pure Reason*, makes occasional reference to this tradition (2nd ed, p. 113).

The new meaning given by Kant to the terms "transcendental" and "transcendentalism," is closely connected with his "revolution in the mode of thinking." In the preface to the second edition of the *Critique of Pure Reason* (p 16) Kant compared this revolution with the change in cosmology effected by Copernicus. "The condition is here the same as with the first idea of Copernicus who, having found that the explanation of the celestial motions did not progress well when he supposed the whole host of stars to turn round the spectator, tried whether it might not succeed better if he made the spectator turn, and left the stars at rest." Thus, in metaphysics, we must not start from a dogmatic assumption about the constitution of *objects* and then determine the mode and character of *cognition*, but, on the contrary, the insight into cognition, into its regularity and structure, must *precede*, and supply the basis for putting and answering the question as to what kind of objects corresponds to that mode of cognition. "If intuition had to follow the constitution of objects, I do not see how one could know *a priori* anything about it; but

if the object (as object of the senses) follows the constitution of our faculty of intuition, I can quite well imagine that possibility." This start from the *mode of cognition*, with the intention of determining the corresponding mode of objects, forms, according to Kant, the basic character of transcendentalism He calls (*Kritik der reinen Vernunft*, 2nd ed., p 25) all cognition transcendental which is concerned not with objects but with our mode of knowing objects, insofar as the latter is to be possible *a priori*.

Transcendentalism, accordingly, does not start with some assumption regarding the essence and constitution of "absolute space," in order to explain the peculiarity of geometrical cognition, but it begins with an analysis of geometry; it shows that all geometry comprises propositions of universal and necessary validity; and it enquires into the "possibility" of these synthetical judgments *a priori*—it investigates "what the conception of space must be, if such a cognition of it is to be possible " (*Transcendental Aesthetic*, §3.) The answer to this question is that only if we think of space as an intuition *a priori* can the possibility of the apodictic cognitions of geometry become intelligible. Kant emphasises that neither space itself nor any geometrical determination thereof can be called "transcendental"—the term "transcendental" applies rather only to the recognition of the fact that these notions have no empirical origin, and of the possibility by which they can nevertheless refer *a priori* to objects of experience (*ibid.* p. 80 *seq*). This possibility follows, according to Kant, from the fact that the objects in question are not "things-in-themselves"—not "transcendent" in the sense of dogmatic metaphysics—but phenomena. The order and regularity of these phenomena, which we call "nature," does not belong to them independently of the form of our intuition and understanding; but the understanding itself produces this order by connecting the phenomena according to its own laws.

Transcendental idealism, therefore, does not reach beyond the sphere of cognition by experience, beyond the realm of the empirical objects, it rather tries to exhibit the foundation of empirical cognition itself In this respect, its use of the word "transcendental" differs, as Kant emphasises, from its older scholastic significance, although even in the *Critique of Pure Reason* it is frequently used in a sense which corresponds to the older view attacked by Kant (A. Gideon, *Der Begriff transcendental*, 1903). With particular clearness and pregnancy, the difference appears in Kant's *Prolegomena to any Future Metaphysics*. The word transcendental—it is there declared—does not mean anything which goes beyond experience, but that which, although preceding it (*a priori*), is, nevertheless, only designed to make knowledge by experience possible When these concepts supersede experience, their usage is called *transcendent*. The pure forms of intuition, space and time, as well as the categories, as basic concepts of pure understanding, are, therefore, of transcendental *significance*, but not of transcendental *application;* their *validity* is strictly universal and transcends merely empirical incidents; but they extend only to the totality of experience *itself;* they determine its "form," but do not apply to non-empirical, absolute objects. In the same manner, Kant determines the concept of "transcendental truth." "In the whole of possible experience lie all our cognitions, and in the general reference to this whole consists the transcendental truth which precedes and makes possible all empirical truth" (*ibid.* p. 185). (E. Cr.)

TRANSCRIPTION, in music, is the arrangement of a composition written for one instrument (or group of instruments) for performance by one of another kind, as of an organ work for the piano, of an orchestral work for the organ, and so on

TRANSEPT, in architecture, a transverse section or portion of a hall or building, of considerable relative size, its main dimension being at right angles to the long dimension of the building or hall proper, thus developing a plan of either cruciform or T shape, especially in ecclesiastical architecture, the arms of the church, at right angles to the nave. Transepts are found in several of the large early Christian basilicas of Rome, taking the shape of a large, unbroken, transverse hall, whose length is equal to the combined width of nave and aisles, and separated from the nave by a great arch known as the triumphal arch. In the opposite wall an arch of similar size leads into the aps In later basilicas the transept became reduced in importance ar the nave ran through unbroken to the apse.

The typical basilica plan, however, has no transept at a and the transept became a common feature only in Byzanti work from the 8th century, as in S. Mark's at Venice (*c.* 1063 It is perhaps due to Byzantine influence that the transept came to be universal in the Romanesque work of France and, less con monly, in Italy. In Norman work, both in France and Englan transepts were highly developed, frequently designed exact like the naves, with their own side aisles, triforia and cler storeys, as in Winchester cathedral (1079–93). These Norma transepts are long; in S. Georges at Boscherville (11th century the north, east and south arms are all equal in length. It wa probably the opportunity which the transepts furnished for ac ditional altars or for chapels opening out of their eastern side as in many Cistercian abbeys, such as Buildwas abbey (1135 that accounts for the universality of the transept. In French ex amples, outside of Normandy, the projection is frequently le marked, and the transept without side aisles. This became th rule in French Gothic work, in which the transepts often do no project beyond the outer walls of the church, or project slightl

In England, however, long transepts remained the rule unt the Perpendicular period, the west transepts at Lincoln (*c* 1200 being 225 ft. long, the transepts of York (1230–60) 220 ft. an those of Lichfield (1220–40) 145 feet. In the further effort t increase the number of altars, smaller transepts placed east o the main transept had already appeared in the abbey churc at Cluny (1089), and became common in the great abbey churche in England, appearing first at Canterbury (*c.* 1170). Othe characteristic examples are the eastern transepts of Lincol (1192), Rochester (*c.* 1210). The most beautiful of all are th double transepts of Salisbury (begun 1220) Although the greate number of transepts are square ended, certain occasional example are apse ended, as in the early basilica at Bethlehem (4th cen tury), S. Maria in Capitol and the Holy Apostles (both 12t century, both in Cologne), and the early French Gothic cathedra at Soissons (1175), and that of Noyon (1150). (T. F. H.)

TRANSFER, the handing over, removal or conveyance o anything from one person or place to another; also the form o method by which it is effected (*see* articles Land Titles, Lan Tenure, etc.). For the transference of designs, drawings, etc., b means of transfer-paper to the surface of pottery and porcelai *see* Chinaware; for their transfer to stones for printing, *se* Lithography.

TRANSFER OF STOCKS AND SHARES

Great Britain.—Stocks and shares define the extent of an in vestor's holding either in a loan to a company, municipality or government, or in the capital of a company. The transfer o stocks and shares is concerned with the formalities that have t be gone through when stocks or shares are bought or sold Usually, this is a question of purchase or sale, but this is not alway the case.

Three people are directly concerned in every transfer. Thes are the buyer, the seller and the company or other body whic has issued the stock. The buyer has to be assured that the titl he acquires is recognized by all concerned; the seller has to b able to prove that he has duly delivered the stock or shares, an the company has to be satisfied that the transfer is a legitimat one, executed in good faith and beyond dispute. Other peopl are concerned indirectly. Thus the buyer and seller always ac through agents, such as their solicitor, banker or stock-broker and the company often employs an agent, such as its bankers, t keep its register of stockholders. Furthermore, when securitie are bought and sold on the stock exchange, they may pass throug the hands of several intermediaries before they reach the ultimat buyer Finally, the Inland Revenue authorities are concerned, fo certain kinds of transfer are liable to duty.

The machinery of transfer is designed to meet the needs of al those mentioned above and to leave no room for dispute. It take three main forms to suit the three main classes of stocks anc shares.

(1) **Inscribed Stock.**—Here the names of all stockholders are inscribed in the books kept by the company's or Government's registrar, which is usually a big bank, such as the Bank of England (for British Government stocks) or the Westminster Bank (for certain colonial and corporation stocks) When stocks are bought and sold, the buyer's name is substituted for that of the seller in the registrar's books, which are the sole evidence of possession It is true the buyer gets a "stock receipt," but this is so much "waste-paper." The registrar, of course, has to be satisfied that the transfer is in order Hence he will only act on the instructions of persons known to him Usually the seller gives his brokers a power of attorney, and as these brokers are known to or can be identified to the registrar, all they have to do is to produce their power of attorney to the registrar as their authority and then the transfer is effected without difficulty In addition, the seller is notified by post that a power of attorney in his name has been lodged, and is given time to protest if everything is not in order.

(2) **Registered Stock.**—Here the stock-holder or share-holder has a certificate showing the nature and extent of his holding, and his name, address and the size of his holding are also entered in the company's share register. The procedure of transfer is different. On a sale being made, the seller's brokers send him a "transfer form," stating the amount and nature of the stock and the price at which it has been sold, and also containing a legal form of agreement as to the sale and purchase. This the seller signs in the presence of a witness and returns to his brokers, together with the share certificate. It is then passed on to the buyer's brokers and so to the buyer, who similarly signs it in the presence of a witness. It is finally sent with the share certificate to the company's registrar, who, accepting the completed transfer form as his authority, records the transfer and amends the certificate in accordance with the provisions for recording transfers laid down by the company's articles of association

(3) **Bearer Stock.**—Here the possession of the stock or shares by the holder is the only evidence of title required, and so delivery of the stock or shares in question is all that is needed

Certain general points arise. The first is that dealings on the London Stock Exchange are usually "for the account," *i.e.*, for settlement on every alternate Thursday. On this day, stocks and shares must be delivered by the seller to his broker, and the buyer in his turn must pay cash to his broker. Should the seller delay in delivering his certificate and the completed transfer form, his broker may "buy in" the stock against him, and charge the seller with any loss on the repurchase. Next, the buyer must not be impatient for his transfer form or share certificate. Even after settling day, the form has to come back from the seller, be completed by any intermediaries and finally come to him, while many companies provide that transfers have to be passed at the next board meeting before they take effect. Next, the transfer form must be filled in and witnessed correctly and without delay, and while, for most stocks and shares, a common form can be used, for some a special form is necessary.

Finally, there is the question of transactions "cum" and "ex dividend" A dividend is payable to all stock-holders on a given date, and the purchaser who acquires the stock after that date does not receive the dividend. Hence on that date, the price ceases to be "cum" and becomes "ex div." The same applies to bonus share issues and other privileges or rights belonging to shareholders on a given date, and then the price "goes ex rights." Now the purchaser who buys "ex div." will clearly deduct the dividend from the price he was prepared to pay if he bought "cum div."; thus, if "cum div." price is 88, and the dividend, allowing for income tax, is worth 2½, the "ex div." price will be 85½. Now it often happens that a holder will sell "cum div." and that the dividend will be paid before the transfer is registered. Then the dividend will be remitted to the seller, but the seller is bound to send it on through his brokers to the buyer.

Stamp duties are borne by the buyer. Bearer stocks and shares are transferred free of duty, but on issue are subject to a duty three times the duty chargeable upon their transfer at par. Inscribed stocks are usually transferable free of duty, as the issuers can and usually do compound the duty by paying a tax of 2s.% per annum on the nominal value of the stock. The duty on the transfer of registered stocks and shares is normally according to a scale based on a rate of duty of 1% of the price paid, the "price paid" being that paid by the final buyer and inserted on the transfer form in the space "consideration money." When stocks and shares are transferred for a "nominal consideration," *e.g.*, from a trustee to his successor or from the holder to his bank who requires them as security for an overdraft or, in certain cases, under the terms of a will, the duty is a fixed one of ten shillings Gifts or exchanges or bequests, where the legatee agrees to accept stock in place of cash, are subject to duty at the normal rate

(N. E. C.)

United States.—In the United States the transfer of stock (and it must be remembered that here stock does not signify exactly the same thing that the term does in England, but more nearly has the meaning of the English term "shares") is accomplished quite simply by the transfer of the certificate of stock. (*See* STOCK; SHARES.) Such transfer is governed by the Stock Transfer Acts of the several States, most of which have adopted the Uniform Stock Transfer Act Stock certificates may pass from hand to hand by simple assignment, but in case of sale the purchaser is not a legal stockholder until the stock has been transferred on the books of the issuing company. When such a transfer is made the old certificate is cancelled and a new one issued. The seller of stock, whose name appears on the face of the certificate, or his authorized representative, must endorse an assignment, which is usually printed on the back of the certificate itself. Such endorsement may be in blank or to a particular person In all such transfers made on the New York Stock Exchange, it is required that a member of the exchange guarantee the signature of the assignor. A bank, trust company or individual may be designated by the issuing corporation as its transfer agent, or its secretary or a special clerk may be given the duty and responsibility of seeing that all transfers are properly made. The several States generally levy a tax upon the transfer of stock The New York State stock transfer tax, which is representative, is 2 cents for each $200 or fraction thereof of stock which has a par value; and a flat tax of 2 cents per share for stock of no par value unless the actual selling value of such stock is in excess of $100 per share, in which case the tax is 2 cents on each $100 or fraction thereof of such selling value

(J. H. B.)

TRANSFER OF TRAINING. One of the smaller consequences of the entry of the United States into World War II was that, for the first time, large numbers of men who drove military vehicles, such as trucks, tanks, etc., were subjected to what were for them new driving conditions. In the United States for many years they had been accustomed to driving on the right-hand side of the road, but upon being transferred to England for military purposes, they now had to drive on the left. Many of these men suddenly discovered themselves automatically driving on the right, to the danger of all others using the road at the time. This is an example of negative transfer of training; *i.e.*, what had been learned previously had transferred in a negative way, or as a handicap, in a second situation. There is also positive transfer, as is exemplified by the mother who knows fairly well what to do for her second child during each stage of its development, whereas she often did not know what to do in caring for the first.

The fact of transfer, either positive or negative, has never been challenged, but many questions have been raised concerning how it occurs, under what conditions and to what degree.

Formal Discipline.—Historically speaking, the first important attempt to explain how transfer occurs was the doctrine of formal discipline. According to this belief, the mind of an individual was something like a muscle in that rigorous exercise of certain kinds would "strengthen the mind." Certain kinds of exercise such as the study of Latin, the study of mathematics or the playing of chess were supposed to be especially helpful in this strengthening process. Indeed, it was discovered that school pupils who had studied Latin or mathematics were superior in other subjects to those pupils who had not studied Latin or mathematics. But it was further discovered, by means of ability tests, that the pupils who did study Latin or mathematics (generally considered to be

difficult subjects) were the pupils who were more gifted intellectually, so that their superior performances in other subjects might well be expected for this reason, and not because of positive transfer.

Two general objections to the doctrine of formal discipline have led to its rejection by all serious students of the transfer problem. First, transfer is often negative, as mentioned earlier, and there is nothing in the formal discipline idea to cope with this fact. Second, the implication of the notion of exercise and strengthening is that transfer should be general, *i.e.*, the mind, once strengthened, like a muscle once strengthened, should be more capable of coping with any problem. Upon examination, transfer turns out to be not general, but quite specific. That is, if there is any element in what a person does now which is related to a previous activity, the previous activity will affect what is done now But, if the two activities have nothing specifically in common, the first activity will have no influence on the second It seems then that the question of how transfer occurs may be answered by saying that transfer consists merely of doing what one has learned to do previously, in so far as the situation calls for this. It should be expected that there will be more transfer, whether negative or positive, the greater the resemblance between any situation and one which has preceded it.

Procedure for Studying Transfer.—The scientific study of transfer involves certain controls over factors other than previous learning which might influence the present behaviour of an individual One of the most important of these, as suggested by the findings concerning the disciplinary value of Latin or mathematics, is the ability of the learner. Another is motivation. Such factors may be controlled by doing an experiment in which two groups of learners are first given a brief practice period at what may be called task II, in order to ascertain if the two groups are initially equal in the level of performance. (If they are, it is assumed that their abilities, motivation, etc, are equal on the average.) Then one of these groups practises task I, while the other (the control group) has no practice at task I. Finally, the two groups work at task II. Any differences now appearing on task II may be attributed to the presence or absence of practice at task I, since the opportunity to experience task I is the only important difference between them as they attack task II. Following this general procedure, an investigator may introduce any factor he pleases into the study of task I, to see how much difference it makes in performance at task II. He may, for example, employ literally different tasks I in different experiments, or vary the practice conditions for task I, or may even study the characteristics (*e.g.*, the age) of the learner who practises at the tasks. With this general design it is possible to evaluate the conditions of transfer; that is, what conditions lead to negative or to positive transfer, and to what degree.

Some of the Determiners of Transfer.—There is a great deal of technical information on the conditions conducive to transfer, but discussion of a few of these conditions will exemplify the nature of this information. The principal determining condition of transfer is the amount of similarity between the first situation and the second; *i.e.*, between task I and task II. Positive transfer from the game of tennis to the game of badminton, for example, is great, since both are games played with rackets, they are played on courts marked in a similar way, both involve knowledge of how to manoeuvre an opponent out of position, when to attack or when to play a defensive game, etc. In experiments, where it is possible to define exactly what is meant by great similarity (as where task I is the learning of a list of adjectives and task II is the learning of another list of adjectives where each one is synonymous with the word in that position in the first list) it is discovered that transfer is great.

On the other hand it has been discovered that in the learning of lists of words, where task I and task II are only moderately similar, sufficient confusion occurs as between the two tasks that responses from task I are intruded into task II, thus handicapping the performance or leading to negative transfer Then again, if the two lists of words are very dissimilar, there will be little evidence of negative transfer, suggesting that if there is any confusion as between the two specific tasks, there may also be a compensating positive transfer (perhaps in skill at memorizing) such that the positive and negative effects cancel one another. In summary, where two situations are similar (especially where one is merely a second experience of the identical situation), positive transfer may be expected. Where there is moderate similarity between the two situations, some confusion and handicap may be predicted. Where there is little or no similarity, little or no transfer will occur.

Another determiner of transfer, applying equally to situations in which positive or negative transfer is to be expected, is the degree of mastery of task I. If it has been practised very little, *i e*, if the individual has not yet learned much, the amount available for transfer to task II is obviously not great. The beginner at tennis simply does not have many skills which could be transferred to badminton, were he to take up the latter game. On the other hand, a man thoroughly trained at bookkeeping for a certain kind of business firm can readily master the bookkeeping procedures for another firm, since he has at his ready command most of the techniques which will be necessary. These are examples of positive transfer, and to complete the picture it must be noted that the degree-of-learning factor also influences negative transfer. As an example here, it would be expected that the military drivers referred to in the first paragraph of this article would find greater difficulty in driving on the left, the longer or more thoroughly they had fixed the habit of driving on the right.

From a practical point of view, a significant determiner of whether there will be transfer is the "set" or the intention of the individual. It is often remarked that there is little relationship between what happens in a classroom and what goes on in the everyday nonacademic life of a student. To some extent this occurs because the student in question, or his instructor, has not developed the intention of looking for common elements in task I and task II, *i.e.*, in classroom content and in everyday life Experimental evidence indicates that by intending to do so, an individual can exhibit greater amounts of positive transfer than he otherwise would, and can reduce the amount of negative transfer from what it might otherwise be. (C. E. Bu.)

TRANSFORMATION GROUPS: *see* GROUPS.

TRANSFORMER, an apparatus for changing electrical energy from a given pressure into a higher or lower pressure. It is stationary, with no moving or rotating parts, and is operative only with alternating currents. It plays such an important part in the transmission and distribution of electricity that the present extensive electrical systems would have been impossible without it. Incidentally, since transformers are operative only with alternating currents, all extensive electrical systems have had to adopt the alternating current system so as to use transformers.

History and Place in Industry.—Very early in the art it was realized by electrical engineers that, while the generation and utilization of electrical energy are safer and more economical at lower pressures and larger currents, its transmission and distribution are more economical at higher pressure and smaller currents. Therefore, in order that a central powerhouse might economically serve even a small territory, it was necessary to have apparatus capable of stepping up the voltage at the point of generation and stepping it down at or near the points of utilization.

Before such an apparatus was invented, physical laboratories used induction coils, similar to automobile spark coils, for stepping up battery voltages to high values for experimental purposes, but these were too inefficient for power applications. These coils used an open magnetic circuit and required an interrupter, a make and break attachment, functioning similarly to the distributor in automobile ignition The necessity for this attachment arose from the fact that currents and voltages could be induced only by fluctuations in flux, and a fluctuating flux could be produced only by a fluctuating current. Therefore, since a battery tended to give a steady uniform current, an interrupter was necessary to produce abrupt changes in current.

It was early realized that if alternating currents are utilized, no interrupter is necessary; and, if the magnetic circuit is made completely closed, the performance characteristics of such a coil are remarkably improved.

The first successful transformer was demonstrated by William Stanley in the United States. It was put in service in Great Barrington, Mass., in the spring of 1886. Besides for transmission and distribution, transformers are used in a very great variety of services for converting alternating current energy from the pressure at which it is available to the pressure most suitable for the object in view: ringing doorbells, requiring very low safe voltages; welding ship plates, requiring very large currents; operating X-ray tubes or producing lightning bolts requiring enormous voltages. Their use in radio for coupling as well as for filament lighting and other power supply is well known.

General Principles of Operation.—*Voltage Transformation.* Fig. 1 is a simplified diagram of a transformer, showing a closed magnetic circuit M, a lower voltage winding L and a higher voltage winding H. If an alternating voltage is applied to the terminals of one of the windings, say L, leaving the terminals of the other winding, H, open, a small current flows into the excited winding L sufficient to produce a countervoltage equal to the impressed voltage. The apparatus is always so designed that the countervoltage is almost entirely one of self-induction, the voltage consumed in the resistance of the conductor usually being less than one-tenth of 1% of this self-inductive drop. The voltage of self-induction is produced by an alternating magnetic flux in the core, which in turn is produced by the alternating current flowing in L. The relationship between the total or maximum flux and the induced voltage, E_L is

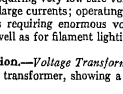


FIG. 1.—DIAGRAM OF TRANSFORMER WITH SECONDARY OPEN-CIRCUITED (SHOWING INSTANTANEOUS CONDITIONS)

$$E_L = 4.44 f N_L \phi \times 10^{-8},$$

where E_L is the effective (root-mean-square) voltage across L produced by self-induction, f is the frequency of the impressed voltage (periods or cycles per second), N_L is the number of turns in series in winding L and ϕ is the peak value of the alternating flux ϕ.

Obviously, the alternating flux ϕ, linking winding H as well as L, will induce a voltage in H proportional to its turns:

$$E_H = 4.44 f N_H \phi \times 10^{-8},$$

Comparing E_L and E_H, it is seen that

$$\frac{E_L}{E_H} = \frac{N_L}{N_H},$$

that is, the induced voltages of the two windings are directly proportional to their respective turns. Thus is obtained the voltage transformation from a given value to another value.

Current Transformation.—The transformer is now excited but as yet unloaded; that is, no current or power is drawn from it. If now a load, with impedance Z, is connected across the terminals of the second winding, H, fig. 2, the voltage appearing at its terminals will send a current I_H into the load, equal to

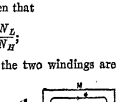


FIG. 2.—DIAGRAM OF TRANSFORMER WITH SECONDARY LOADED (SHOWING INSTANTANEOUS CONDITIONS)

$$I_H = \frac{E_H}{Z}.$$

This current tends to demagnetize the flux ϕ and thus to reduce the counter e.m.f. of induction. But since the voltage impressed on L is maintained at full value, an additional current, I_L, flows into L sufficient to maintain the flux ϕ. This additional current I_L, as also the current I_H, being produced by the load, are called the load currents of the windings, to distinguish them from the no-load current which flows only in the excited winding and which is called exciting current.

To neutralize the demagnetizing effect of I_H, it is necessary and sufficient that the magnetomotive force or ampere turns associated with I_L be equal and opposite to that associated with I_H.

$$I_L \times N_L = -I_H \times N_H$$

or

$$\frac{I_L}{I_H} = -\frac{N_H}{N_L}.$$

That is, the load currents in the two windings are inversely proportional to their respective turns, and thus is obtained current transformation. It may be noted that current and voltage transformation are in inverse ratio, so that when one is stepped up the other is stepped down in the same ratio.

Energy Relationship.—That winding of the transformer on which voltage is impressed and into which energy flows is called the primary; and the other winding, from which energy is drawn out, is called the secondary. Either the higher or the lower voltage winding may be used as the primary, and the other as the secondary, so that the operation of a transformer is reversible.

The energy flowing into a circuit being proportional to the product of current and voltage, for the load circuit it will be $I_H E_H$, and for the primary circuit $I_L E_L$. By the law of conservation of energy, these two must be equal to each other in an ideal transformer. Comparing the values of $I_H E_H$ and $I_L E_L$ from the foregoing, they are seen to be equal and opposite to each other; that is, as much additional energy flows into the primary as is drawn out from the secondary. In an actual transformer, some energy is lost within the transformer, so that the energy output is always slightly less than the energy input.

Rating of a Transformer.—The type of service for which a transformer is suitable is expressed by its rating, covering usually the following items: (1) kva. (*i.e.*, kilovolt-amperes), representing the power capacity; (2) voltages of the various windings; (3) frequency; (4) temperature rise. The rating plate usually gives information also with reference to the method of cooling, type of construction and the proper connections to make.

Performance Characteristics.—The degree of excellence of a transformer is indicated by its performance characteristics which usually appear in guarantee specifications as follows: (1) exciting current; (2) core loss; (3) copper loss, (4) leakage reactance or impedance; (5) voltage regulation; (6) efficiency; (7) temperature rise; (8) insulation strength. Item (5) is a function of item (4), and item (6) is a function of items (2) and (3), so that the controlling independent characteristics are items (1), (2), (3), (4), (7) and (8). The resultant characteristics that interest operators are (1), (5), (6), (7) and (8).

1. *Exciting Current.*—It has been indicated already that the voltages of the various windings of a transformer are induced by an alternating magnetic flux in its core, and that sufficient exciting current flows into the primary winding to produce the necessary flux from instant to instant. For a given frequency, terminal voltage and the number of turns, the necessary flux is completely determined by the formula given above. The necessary exciting current is then determined with the aid of the characteristic curve of the material used in the magnetic circuit. Thus, given the total flux ϕ and cross section A of the magnetic core, the flux density B in the core follows as:

$$B = \frac{\phi}{A}.$$

By referring to the characteristic curve of the core material, the value of the necessary exciting ampere turns corresponding to the flux density B is obtained. This divided by the turns of the excited winding gives the necessary exciting current in amperes. Finally, if this exciting current is multiplied by 100 and divided by the rated load current of the winding, the per cent exciting current is obtained. Obviously, the exciting current does not flow into a useful load, and is in a sense wasted. It is therefore desirable that it be limited to as small a value as possible. In commercial power transformers it is limited to between 1% and 10% of the rat-

useful load current of the transformer. In miniature transformers, it may greatly exceed the latter limit.

Low exciting current is obtained by using high permeability material for the magnetic circuit, low flux density, short length of magnetic circuit and greater number of turns per volt in the windings. Various alloys of iron (usually silicon steel) are used on account of their high permeability.

2. *No-Load Loss or Core Loss.*—The alternations of the magnetic flux in the transformer core wrste energy (in the form of heat) caused by (*a*) hysteresis and (*b*) eddy currents Both the hysteresis loss and the eddy current loss are found to be very much less in silicon steel than in many other kinds of iron alloys, and therefore this material is used exclusively for all power and distribution transformers It also shows superior permeability (lower exciting current) compared with common forms of iron at moderate flux densities. A further advantage of silicon steel is found in its nonaging quality, while common forms of iron increase in core loss with use. The eddy current loss is reduced by laminating the core and insulating the laminations from each other either by oxide scale or preferably by thin enamel. The thicknesses of laminations used commercially are: for 50 to 60 cycle frequencies about 0.014 in., for lower frequencies as much as 0.025 in., and for audio and radio frequencies 0.007 in. or smaller. Silicon steel being very hard and somewhat brittle, its rolling into thinner sheets than the above is difficult and expensive. In commercial power transformers, the core loss varies from a quarter of 1% to several per cent.

3. *Load Loss or Copper Loss.*—The load currents in the windings, flowing against the resistances of the conductors, produce an energy loss in them equal to I^2R. The resistance R is to be understood as the alternating-current resistance, which usually is higher than the direct-current resistance of the winding, because of skin effect or nonuniform distribution of current among the various filaments of the conductor The copper loss is tested or measured best by short-circuiting one winding of the transformer and putting excitation on the other winding sufficient to circulate the rated current in the windings This test is sometimes spoken of as the impedance test, as it makes possible the measurement of the impedance volts of the transformer, as well as its impedance watts, which is another term used for the alternating-current copper loss of the transformer.

4. *Leakage Reactance or Impedance.*—Although the magnetomotive forces in the primary and the secondary windings caused by the load currents are equal and opposite to each other, and therefore neutralize each other in any magnetic circuit common to both —for example the steel core—yet they produce leakage fluxes in the spaces between the two coils, giving rise to a leakage reactance. This reactance, combined vectorially with the effective resistance of the windings, constitutes the leakage impedance of the transformer. Ordinarily, the reactance is many times the resistance of the windings, and hence substantially equal to the impedance. The leakage impedance of a constant potential transformer serves a protective purpose in limiting the short-circuit current of the transformer. However, it produces an undesirable effect in reducing the secondary voltage (See *Voltage Regulation* below.)

The reactance voltage, expressed as a percentage of the rated circuit voltage, varies from 3 to 15%, the lower values occurring in distribution transformers, the higher in the larger power transformers. In order to hold the reactance of a transformer within the range indicated above, the primary and secondary windings have to be closely interlaced. If the windings were separated from each other the reactance would be prohibitively high and the voltage regulation correspondingly poor.

5. *Voltage Regulation.*—Reference to this has already been made With a constant voltage maintained on the primary of the transformer, the no-load voltage of the secondary is higher than its full-load voltage. If the excitation is so adjusted as to make the secondary terminal voltage the full rated value of full-load, and then, without changing the primary impressed voltage, the load is removed, the secondary voltage will rise above the full-load value. This rise is called the regulation drop and is usually expressed as a percentage of the rated full-load voltage.

The regulation is ordinarily calculated as follows: given %IR, the per cent alternating current resistance, or, better yet, the per cent impedance watts, of the transformer; %IX, the per cent reactance of the transformer; p, the power factor of the load, and, q, the reactive factor of the load; then,

$$\%\text{ regulation} = p\times\%IR + q\times\%IX + \left(\frac{p\times\%IX - q\times\%IR}{200}\right)^2.$$

This formula is an approximation but yields more accurate results than some absolute formulas in actual manipulation. Fig. 3

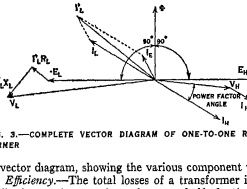


FIG. 3.—COMPLETE VECTOR DIAGRAM OF ONE-TO-ONE RATIO TRANSFORMER

is a vector diagram, showing the various component voltages.

6 *Efficiency.*—The total losses of a transformer in power and distribution service vary from about one-half of 1% to about 4%, depending on size, frequency, voltage, etc., making the efficiency vary from 96% to 99.5%. It is this fact of high efficiency, coupled with the further fact of the absence of any mechanical motion that has made the transformer a most valuable apparatus and has led to the adoption of alternating currents by most systems.

7. *Temperature Rise.*—The maximum load that may safely be put on a transformer is limited by its temperature rise. The insulations commonly used in transformers, being largely organic substances, are subject to rapid deterioration under overheat. Temperature limits vary in different countries, ranging from 50° to 65° C rise above the ambient (surrounding) temperature

8. *Insulation Strength.*—Transformers not only produce higher and lower voltages, but they also insulate one circuit from the other and from ground. The safety of both the transformer and the circuits which it links is therefore dependent on the strength of its insulation. For rules of various societies on this subject and for methods of making such tests reference may be made to the appropriate literature listed in the bibliography.

Transformer Connections.—For polyphase circuits, a great number of transformer connections have been developed; the standard connections for three-phase circuits being the Y and the delta connections. Various connections have also been developed for accomplishing transformation from a polyphase system of a given number of phases to one of a different number of phases, with or without voltage transformation.

Structural Classification of Transformers.—When the windings of a transformer surround the magnetic circuit the transformer is *core type;* and when the magnetic circuit surrounds the windings the construction is *shell type.* The windings may be either cylindrical and arranged one inside the other, in which case they are *concentric;* or they may be flat coils and sandwiched in with each other (to obtain reasonably low leakage reactance), in which case they are *interleaved.* The windings may be interleaved with either core or shell type of magnetic circuit. The coils may be wound on circular forms, in which case the transformer is said to be of *circular-coil construction;* or they may be wound on rectangular forms, as in the so-called *pancake* or *shell-type* coils.

Transformers may be oil-immersed or dry. The former is very desirable for the higher voltage and larger power units for improved insulation and cooling, while the latter is more desirable for miniature transformers for greater convenience. Sometimes considerations of fire risk lead to the use of dry transformers in even large sizes, which then are cooled by an air blast. Based on the method used for cooling, transformers may be. (1) *water-cooled,* in which case cool water is circulated in sealed tubes im-

mersed in the insulating oil filling the transformer case; (2) *air blast*, in which air is blown by fans through the air ducts of the windings; (3) *air-cooled* or *natural draft*, depending on natural radiation and convection from the exposed surface of transformer or its case, (4) *forced oil*, in which hot oil is pumped out into radiators, cooled and returned into the transformer, (5) *air-jet cooled*, in which jets of air are blown on the tank and its radiating pipes to break up the stagnant film of air adhering to them and thus to accelerate the cooling by convection of air currents

Autotransformers.—In cases where primary and secondary voltages of a transformer are not widely different from each other and insulation of the two circuits is not essential, economy can be effected by making some portions of the windings common to both circuits. Autotransformers used for starting motors at reduced voltage are called compensators (*See* ELECTRICITY, ELECTRICAL POWER TRANSMISSION; ELECTRICITY SUPPLY COMMERCIAL ASPECTS, ELECTRICAL SUPPLY· TECHNICAL ASPECTS, RADIO RECEIVER; INDUCTION COIL)

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(A Bov , F W P.)

TRANSIT CIRCLE or **MERIDIAN CIRCLE,** a telescope for measuring the time when a star passes across the meridian and at the same time measuring its altitude. These two measurements determine respectively the right ascension and declination, and hence the place of the star on the celestial sphere. Because of its fundamental importance in positional astronomy, and as the source of standard time furnished to the community, the transit circle is traditionally regarded as the leading instrument, at least in the great national observatories; but in modern times important observatories have grown up whose work lies wholly in other directions The transit circle looks rather like a big gun on a gun carriage, and to the stranger the surprising thing about this kind of telescope is that it cannot be turned to all parts of the sky; it only moves up and down in the north and south line, looking out through a slit in the walls and roof Nor can it be used for prolonged study; the observation is a snapshot as the object passes rapidly across the field of view.

Suppose that we are going to remeasure the exact position of some star. We choose from the catalogues a star which is due to pass across the north-south line in a minute or so; and by means of a setting circle we elevate the telescope to the proper angle to catch it The aperture of the objectglass is probably eight or nine inches and it will easily show stars to the ninth magnitude While waiting, let us examine the field of view. Turning on a faint artificial illumination, we see stretched across the field a number of wires which are actually made of spiderweb; there is one horizontal wire which we can move up or down by turning a micrometer screw, and a considerable number of vertical wires (perhaps ten). Our star now enters the field—at the extreme right since the telescope inverts—and is seen travelling rapidly toward the left. We shift the telescope slightly so as to bring the star almost onto the horizontal wire and then clamp the instrument at that altitude. Now the star is approaching the series of vertical wires; as it passes each, we press a key which records the instant on a chronograph on which the standard sidereal clock is recording the seconds.

Near the centre of the field there is an intermission which gives us a few moments for making the altitude observation. Turning the micrometer screw, we make the horizontal wire bisect the star, repeating this two or three times to reduce accidental errors. There is no time to read the micrometer head, but it is furnished with some printing or recording device which will keep a record of our settings. We now finish tapping off the passage over the vertical wires and the star disappears from view. We have next to go round to the side of the instrument and read four long microscopes which are viewing a graduated circle attached to the telescope. Their combined reading will ultimately tell us at what elevation the telescope was clamped; we must add onto that the reading of the micrometer head so as to include the extra displacement given to the wire to bring it on to the star.

The whole observation takes two minutes or less, but there is a great deal of work in store for the computer. He must sort out the taps on the chronograph belonging to this star, and also the records of the micrometer head. The error and rate of the standard clock must be worked up from the clock stars observed during the night The large correction for refraction must be computed and applied to the altitude. Various observations for adjustment will have been taken, and from these the collimation, azimuth, level and zenith point corrections must be deduced and applied There will be further corrections, not specially connected with the instrument, to be included before the final place of the star is obtained in the form of mean right ascension and declination. This typical procedure may be varied somewhat The most important modification is the use of the travelling-wire micrometer (*see* MICROMETER), which is now generally employed in first-rate work Attempts have been made to substitute some photographic or photoelectric method for visual observation

In olden times the altitude observation and the time observation were made with different instruments, called respectively the mural circle and the transit instrument. The mural circle is obsolete, but the transit instrument survives as a small portable instrument used for determining longitudes and for the most accurate determinations of time The transit instrument is virtually a transit circle shorn of its graduated circles and microscopes.

The transit circle is used for determining the positions day by day of the sun, moon and planets For stellar work its scope is limited to the brighter stars, roughly those brighter than mag. 9.0 (there are more than 100,000 of these) There is no advantage in observing fainter stars with it, since the work can be done more speedily and accurately by photography, but photographic measures are relative, and the positions can only be made absolute if the photograph contains some reference stars whose absolute positions are already known from meridian work. Thus transit circle observation is extended only so far as to provide accurate positions of a reasonable number of reference stars on all photographs

TRANSJORDAN, called JORDAN from 1946, is an Arab kingdom formerly part of the Turkish empire (area *c.* 37,110 sq mi.; pop. *c.* 1,320,000), bounded on the west by Israel, on the north by Syria, on the northeast by Iraq and on the southeast and south by Saudi Arabia.

The country is mainly a plateau, with a general altitude of 2,000–3,000 ft, sloping gently eastward to the synclinal depression of Wadi Sirhan (Saudi Arabia) and al-Azraq and more steeply westward toward the Mediterranean. It is abruptly cleft by the rift-valley fault (Jordan river, Dead sea and Wadi al-Araba) 3,000–4,000 ft below The surface is mostly limestone strewn with flint pebbles. The basalt in the north extends from the Jabal Druze in Syria; in the south are granitic mountains more than 5,000 ft. high and a sandstone area, cut by canyons 2,000 ft. deep, where lie the ruins of Petra.

The subtropical steppe and desert has wet, cold winters and dry, hot summers. Westerly winds bring winter and spring rains to the plateau west of the Jordan river and to the eastern escarpment of the rift (the western escarpment lying in the "rain shadow" of the plateau); Jerusalem and Hebron receive an annual average of 24 in. and Jenin 20 in. East of the Jordan rainfall decreases toward the south near the escarpment (*cf* averages of 26 in. at as-Salt and 11 in at ash-Shobak) and toward the east (13 in. at Amman and less than 5 in in the desert) At Amman rain falls on an average of 47 days, October to May, but has varied from 5.39 in to 13.70 in. In August maximum temperatures average 92° F., minimum 79° F.; in January, 46° and 39°. Snowfalls may occur in the winter months.

Most of the country is usable only for pasturing the sheep, goats and camels of the Bedouin tribes, which in the heat of midsummer migrate to Wadi Sirhan (Saudi Arabia) or to the edge of the cultivated lands, where water is obtainable. East of the Jordan river cultivated land is confined to a zone on the plateau

west of the Hejaz railway about 50 mi wide in the north and narrowing southward to end in the latitude of Ma'an. Of the estimated 1,122,500 cultivable acres in this zone, 65,000 are irrigated and 225,000 get more than 20 in. of rain.

Agricultural land is overcrowded; the average farm is 21 ac. and cultivation has extended into marginal areas. Settled villagers in the northwest grow crops of wheat and barley, beans and peas, there are also vineyards. The steep gorges of the wadies Yarmuk, Zarqa, Mojib and al-Hasa cut down to water-bearing strata whose springs irrigate some terraced fruits and vegetables. Irrigation centres in the rift valley in terraced lands growing bananas, oranges and the usual crops In the drier, cultivated parts of the plateau, the cultivators still live in tents and retain their tribal organization. Deposits of iron, manganese and ochre are known, phosphates and building materials are worked

Nearly all the population is Arabic-speaking and Sunni Moslem in religion. About 100,000 are native Christians, chiefly Orthodox There are about 10,000 Circassians, refugees from the Russian conquest of the Caucasus mountains The chief cities are Amman (ancient Rabbath-Ammon), the capital, with about 120,000 inhabitants, as-Salt, with about 14,800, and Ma'an, with about 8,000.

Jordan is a member of the sterling area, the dinar of 1,000 fils being equal in value to £1 sterling The influx of 500,000 refugees from Palestine and the Arab league's economic boycott of Israel greatly strained Jordan's economy. The balance of payments for 1951 showed debits of 17,500,000 dinars against credits of only 4,200,000 dinars; the deficit was partly filled by United Nations allocations for refugee relief and British subsidies for the Arab legion, estimated for 1952 at 4,000,000 dinars and 4,400,000 dinars, respectively. There are 202 mi of narrow-gauge railway from the Syrian frontier to Ma'an and good all-weather roads from Jerusalem to Amman, Mafraq and Baghdad. There are air services between Amman and the neighbouring Arab countries and Cyprus.

History.—Prehistoric remains are widespread on the plateau, which first enters recorded history at the time of Moses, when it was known as Edom south of Wadi al-Hasa and Moab (capital Kir Moab, now Kerak) to the north Later the Amorites of Damascus conquered the land. The Nabataeans, an Arabic-speaking but Aramaic-writing people from the east, in 312 B.C. conquered southern Edom from the Amorites and established an empire based on trading caravans. From their capital at Petra the Nabataeans expanded to rule Damascus, but were annexed in A.D 106 to the Roman province of Arabia, the nucleus of which was the Decapolis, a confederation of independent Hellenistic cities in the agricultural section. The Roman peace brought Transjordan its great period of prosperity and population growth. Later decline, accentuated by the Arab conquest in 633–636, brought depopulation and extensive soil erosion. Under the crusaders the principality of Outre-Jourdain (capital Le Krak, now Kerak) was the most important fief of the kingdom of Jerusalem

Conquered by the British in World War I, Transjordan was separated from the Palestine mandate in 1920; provisions for Jewish settlement in Palestine did not apply to it. In March 1921 it was put under the rule of the amir Abdullah, second son of King Hussan ibn 'Ali of the Hejaz and brother of Faisal, king of Iraq By the reforms of 1939, the amir ruled with the aid of a cabinet of department heads responsible to him and an elected legislative assembly of 20. He was advised by a British resident, whose powers were reduced in 1939. In the first years of World War II, when German and Italian forces threatened to overrun the middle east, Transjordan gained importance in the maintenance of military security and stability in that area. When in 1941 a pro-German government rose to power in the neighbouring kingdom of Iraq by a military coup, the amir of Transjordan not only kept the Arab tribes loyal to their alliance with Great Britain but also made his country the base for the advance into Iraq of a small British force which succeeded in restoring the legal government In reward for this important assistance, Britan terminated the mandate on March 22, 1946, and in a treaty of mutual assistance and alliance recognized Transjordan as an independent sovereign state. The amir adopted for himself the title of king and for the state the name of Hashemite Kingdom of Jordan (al-Mamlaka al-Hashimiya al-Urduniya). In order to make the alliance effective Jordan was to provide lines of communication through the country and to allow Britain to station forces there. Britain continued to maintain a royal air force detachment at Amman and, from Jan. 1949, a small military force at Aqaba. The treaty was revised in March 1948 in view of the impending termination of the Palestine mandate

The Jordan Arab legion, commanded by the British Brig J. B Glubb Pasha, played the principal part in the Arab states' intervention in Palestine in May 1948, frustrating the Zionist attempt to seize the Old City of Jerusalem. King Abdullah, who had concluded a pact of friendship with Turkey in 1947, had always regarded himself as his brother Faisal's rightful successor to the throne of "Greater Syria," and his propaganda to this end incurred him the enmity of the other Arab states, except Iraq. These states therefore opposed his incorporating the remnant of Arab Palestine (about 30% of the area of the mandated territory, with a population of about 700,000 including refugees) into his kingdom, although he was already in occupation In April 1950 a parliament elected from either side of the Jordan river voted for union under the Jordan crown, but this action, and Abdullah's apparent readiness to make a separate settlement with Israel, led to his assassination by extremists in July 1951. One year later, parliament terminated the reign of Abdullah's eldest son, Talal, because of his chronic mental instability, and the crown passed to his 17-year-old son, King Hussein The more advanced Palestinians continued to be restive under the conservative government of Tewfik Abulhuda, and the deteriorating economy added to the uncertainty of the future

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(J. A. TR.; G. E. K.)

TRANSKEI, one of the divisions of Cape Province of South Africa, east of the Kei river, being part of the country variously known as Kaffraria or the Native territories The majority of the inhabitants are Fingoes Area 2,504 sq mi.; pop. (1946) 256,028 (2,284 white).

TRANSMITTER: *see* MICROPHONE.

TRANSMUTATION OF THE ELEMENTS. The transmutation of one metallic element into another was one of the chief objects of the earliest chemists, or alchemists, and was notably unsuccessful Today, under the influence of modern views on the constitution of matter, transmutation into near-by elements in the periodic table has been successfully accomplished with respect to practically every one of the chemical elements. (*See* ALCHEMY; NUCLEUS, RADIOACTIVITY, ARTIFICIAL; RADIOACTIVITY, NATURAL.)

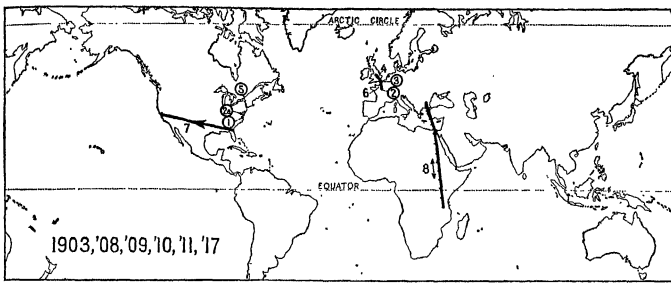
TRANSOCEANIC AND TRANSCONTINENTAL FLIGHTS. At Kitty Hawk, N.C., on Dec. 17, 1903, Orville Wright (*q.v.*) made the first aeroplane flight in history. It lasted only for the brief period of 12 sec., but later the same day Wilbur Wright (*q.v.*) flew for 59 sec. Improvements and constant practice enabled the brothers in 1905 to make 45 flights, the longest of which was for 38 min. At Le Mans, Fr., on Sept 21, 1908, Wilbur exceeded all previous records, flying 1 hr. 31 min. over 56 mi., and the same year several flights by Henri Farman and Louis Bleriot exceeded 30 mi. The first notable flight over water was the crossing of the English channel by Bleriot on July 25, 1909. At the opening of World War I flights of 200 or 300 mi. were being made frequently.

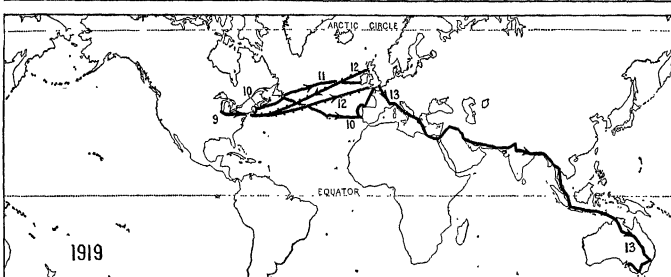
The war intensified aeronautical activity and provided much spectacular achievement, but distance flying was not of course the primary aim The postwar period beginning in 1919, however, witnessed the crossing of the Atlantic ocean by both aeroplane and dirigible The first successful flight across the Atlantic was made by men belonging to the U.S. navy flying boat NC-4, headed by Comdr. A. C. Read Two weeks later the two English airmen Capt. John Alcock and Lieut. Arthur Brown made the first nonstop flight across the Atlantic, flying 1,890 mi from St. Johns, Nfd., to Clifden, Galway, Ire., in 16 hr. 12 min. Within a month the British dirigible R-34 travelled from Edinburgh, Scot., to New York city in four days, returning in 75 hr. despite adverse weather conditions. Several other dirigibles also successfully negotiated the Atlantic one or more times, notably the German "Graf Zeppelin," which, after pioneering across the North and South Atlantic and around the world, inaugurated commercial service between Germany and South America, and the "Hindenburg," which made ten round trips in 1936.

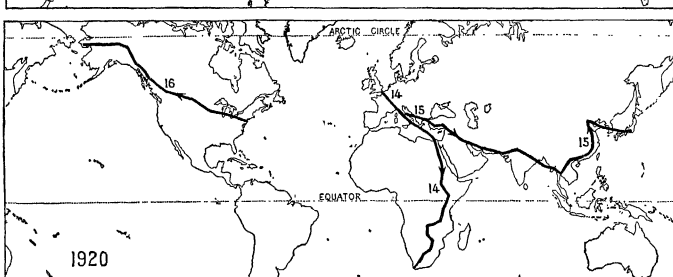
The flight of Ross Smith from London to Australia inaugurated a number of distance flights by British flyers which were to prove the eventual feasibility of air lines to distant parts of the empire, the speed record for this 10,000-mi. course being brought in 1934 to less than three days by C. W. A. Scott and T. Campbell Black.

Meanwhile, U.S and French pilots contributed to the shortening of time over national and international distances. In 1923 the United States was first spanned from the Atlantic ocean to the Pacific in a single flight; in 1926 Adm Richard E Byrd flew to the north pole from Spitsbergen and back, and the dirigible "Norge" crossed the pole In 1929 Byrd flew from Little America to the south pole and back to Little America.

Lindbergh's perfect flight in 1927 from New York city to Paris attracted world-wide attention. By 1930, Dieudonne Costes and Maurice Bellonte had made the first nonstop flight from Paris to New York city, and by 1934 Wiley Post had flown twice around the world, the second time in 7 days 18 hr. 50 min. for the

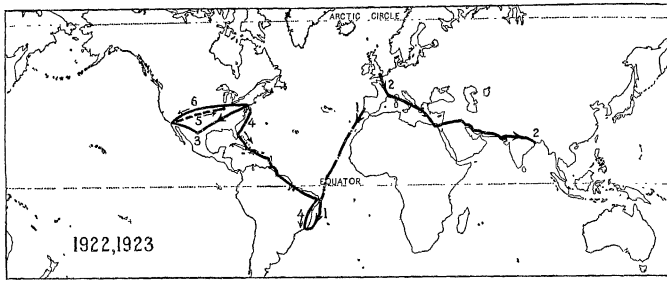


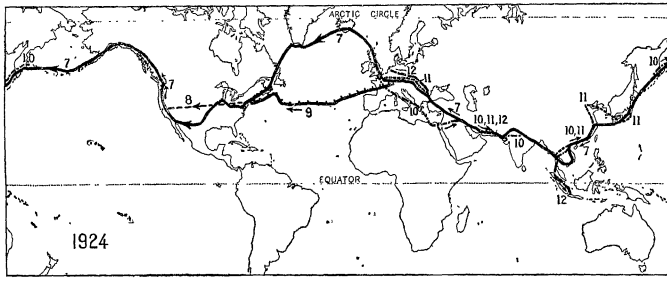


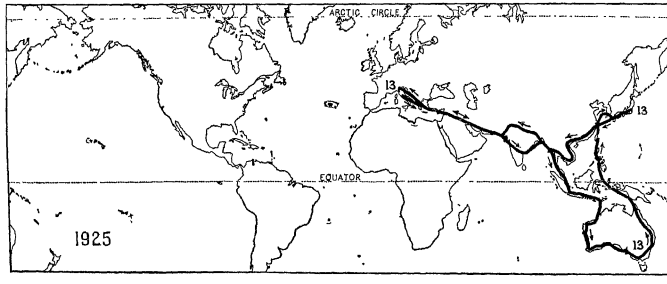


HISTORIC FLIGHTS FROM 1903 TO 1920

1. Orville Wright in first aeroplane, Kitty Hawk, N.C., 1903. 2. Henri Farman, first passenger flight, Ghent, France, 1908. (2a) Orville Wright, 9 minute flight with passenger, at Ft. Myer, Va., 1908. 3. Louis Bleriot, across English Channel, 25 miles, 1909. 4. Louis Paulhan, London to Manchester, 183 miles, 1910. 5. Glenn Curtiss, Albany to New York, 135 miles, 1910. 6. M. Prier, London to Paris, 290 miles, April 12, 1911. 7. R. G. Fowler, Jacksonville, Fla., to San Francisco, 3,391 miles, 1912. 8. German dirigible L.59, Bulgaria to Dake Oasis, German East Africa and return, 4,225 miles, 1917. 9. Capt. E. F. White, Chicago to N.Y., 727 miles, 1919. 10. U.S. Navy flight, Lieut. Cmdr. A. C. Read, Newfoundland to England, 3,925 miles, 1919. 11. Capt. John Alcock and Lieut Arthur W. Brown from Newfoundland to Ireland, 1919. 12. Dirigible R.34 under Major G. G. Scott, Scotland to New York and to England, 6,400 miles, 1919. 13. Capt. Ross Smith, London to Port Darwin, Australia, via Asia, 1919. 14. Major C. J. Q. Brand and Lieut. Col. P. Ryneveld, London to Cape Town, via Cairo, 12,000 miles, 1920. 15. Lieut. Arturo Ferrarin, Rome to Tokyo, 1920. 16. Flight of 4 O H. planes under Capt. St. Clair Street, Mineola, Long Island, N. Y., to Nome, Alaska, 9,000 miles, 1920

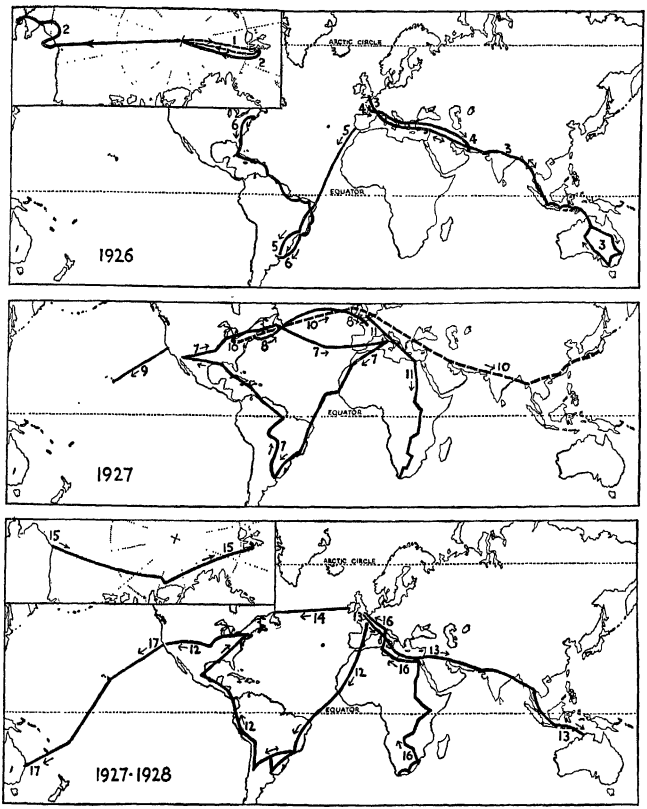






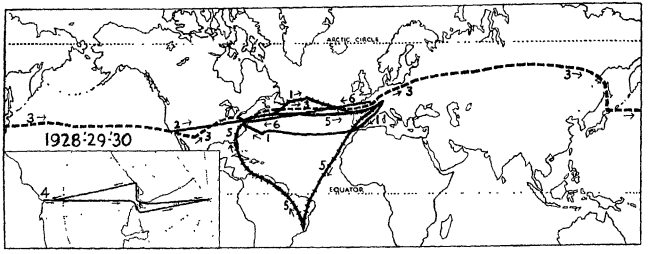
NOTABLE FLIGHTS FROM 1922 TO 1925

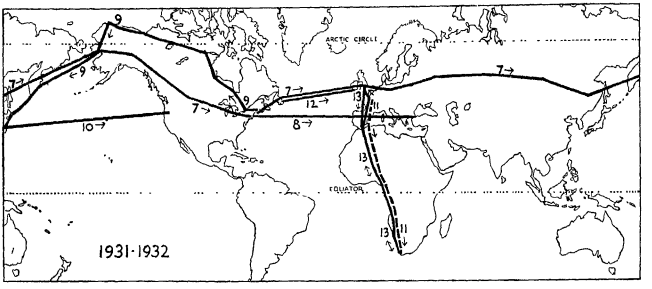
1. Capts. Sacadura and Coutinho, Portugal to Brazil, 1922. 2. Maj. Wilfred Blake and Capt. Norman Macmillan, Croydon to Calcutta, 1922. 3. Lieut. James H. Doolittle, Jacksonville, Fla., to San Diego, Calif., 1922. 4. Walter Hinton and companions, New York to Brazil, 1922. 5. Lieuts. Oakley Kelly and J. A. Macready, San Diego to Indianapolis, 2,060 miles, 1922. 6. Lieuts. Oakley Kelly and J. A. Macready, New York to San Diego, Calif., 2,516.35 miles, 1923. 7. U S Army, Round the World Flight, 27,553 miles, 1924. 8. Lieut. Russell Maughan, New York to San Francisco, 2,540 miles, 1924. 9. Dirigible Z.R.3, under the command of Dr. Hugo Eckener, Friedrichshafen, Germany, to Lakehurst, N.J., 5,066 miles, 1924. 10. Maj. Stuart MacLaren, England to Petropavlovsk, Komandorski Islands, North Pacific, 1924. 11. Lieut. Pelletier d'Oisy, Paris to Shanghai, 1924. 12. Van der Hoop, Amsterdam to Batavia, 15,000 miles, 1924. 13. Cmdr. De Pinedo, Rome-Tokyo-Melbourne-Rome, 34,000 miles, 1925

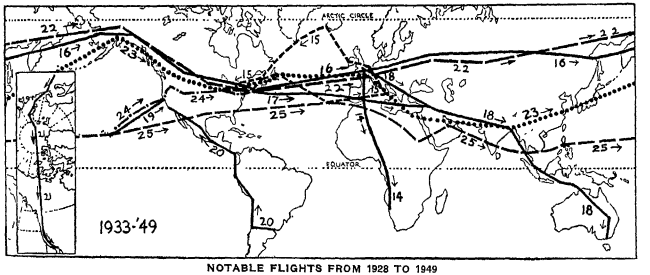


NOTABLE FLIGHTS FROM 1926 TO 1928

1. Cmdr. Richard Byrd and Floyd Bennett, North Pole flight, 1926. 2. Amundsen, Ellsworth and Nobile, Spitsbergen-Alaska flight, 2,700 miles, 1926. 3. Alan Cobham, England to Australia and return, 28,000 miles, 1926. 4. Capt. Costes and Rignot, Paris to Persia, 3,313 miles, 1926. 5. Cmdr. Franco, Spain to Argentina, 6,232 miles, 1926. 6. Bernardo Duggan and companions, New York to Buenos Aires, 9,376 miles, 1926. 7. Cmdr. de Pinedo, Italy to America and return, 25,000 miles, 1927. 8. Charles A. Lindbergh, New York to Paris, 1927. 9. Lieuts. Maitland and Hegenberger, San Francisco to Honolulu, 1927. 10. Edward Schlee and William Brock, Detroit to Tokyo, 1927. 11. Lieut. Bentley, London to Cape Town, via Cairo, 1927. 12. Dieudonne Costes and Joseph Lebrix, Paris to Africa, South America, Mexico, United States, 1927–1928. 13. Bert Hinkler, London to Port Darwin, Australia, 1928. 14. Capt. Herman Koehl, Baron Guenther von Huenefeld and Major James C. Fitzmaurice, Dublin to Greenley Island, Newfoundland, 1928. 15. Sir George H. Wilkins and Carl Eielson, Point Barrow, Alaska to Spitsbergen, 1928. 16. Lady Mary Heath, Cape Town to London, 1928. 17. Sir Charles Kingsford-Smith and companions, Oakland, Calif., to Brisbane, Australia, via Honolulu and Fiji Islands, 1928.







NOTABLE FLIGHTS FROM 1928 TO 1949

1. "Graf Zeppelin," Friedrichshafen, Germany, to Lakehurst, N.J., and return, 1928. 2. Frank M. Hawks, Los Angeles-New York, 1929. 3. "Graf Zeppelin," from Lakehurst around the world, 1929. 4. Richard E. Byrd, from Little America to south pole, 1929. 5. "Graf Zeppelin," Friedrichshafen-Rio de Janeiro-New York-Friedrichshafen, 1930. 6. Dieudonne Costes and Maurice Bellonte, Paris-New York, 1930. 7. Wiley Post and Harold Gatty, from New York around the world, 1931. 8. Russell N. Boardman and John Polando, New York-Istanbul, 1931. 9. Mr and Mrs. Charles A. Lindbergh, New York-Tokyo, 1931. 10. Hugh Herndon and Clyde Pangborn, Tokyo-Wenatchee, Washington, 1931. 11. Marcel Goulette and Jean Salel, Paris-Capetown, 3 days 18 hr. 15 min., 1932. 12. Amelia Earhart, Harbor Grace, Newfoundland to Londonderry, Ireland, 1932. 13. Amy Johnson Mollison, London-Capetown and return, 1932. 14. C. R. Gayford and G. E. Nicholetts, Cranwell, England, to Walvis Bay, Southwest Africa, 1933. 15. General Italo Balbo and Italian squadrons, Rome to Chicago and return, 1933. 16. Wiley Post, from New York around the world, 1933. 17. Maurice Rossi and Paul Codos, New York-Rayak, Syria, 1933. 18. C. W. A. Scott and T. Campbell Black, London-Melbourne, 2 days 22 hr. 54 min., 1934. 19. Amelia Earhart, Honolulu-Oakland, 1935. 20. Frank M. Hawks, Buenos Aires-Los Angeles, 1935. 21. Col. M. Gromov and companions, Moscow to San Jacinto, Calif., via north pole, 1937. 22. Howard Hughes and companions, from New York around the world, 3 days 19 hr. 8 min., 1938. 23. William P. Odom, around the world solo from Chicago, 73 hr. 5 min., 1947. 24. Odom, small plane nonstop, Honolulu to N.J., 1949. 25. "Lucky Lady II," U.S. bomber, first nonstop around the world flight, 94 hr. 1 min., 1949

flight of 15,596 mi. The nonstop distance record of 7,158 mi., set in 1938 by a group of British bombers flying from Ismailia, Egy., to Darwin, Austr., was extended in Sept. 1946 by a U.S. navy patrol bomber which was flown nonstop from Perth, Austr., to Columbus, O., a distance of 11,236 mi. In 1938 a round-the-world record of 14,824 mi in 91 hr. 8 min. was set by Howard Hughes and crew. William P. Odom flew solo around the world in 1947 (19,645 mi. in 73 hr. 5 min.). In 1949, a U.S bomber completed the first nonstop round-the-world flight (23,452 mi) in 94 hr. 1 mn. (*See* also AERONAUTICS; AEROPLANE; AIRSHIP, etc.)

(H. P. K.; X.)

TRANSPORT. This subject has been dealt with in separate articles as follows: ELECTRIC TRACTION; LOCOMOTIVE; MOTOR CAR; MOTOR TRANSPORT, COMMERCIAL; MOTOR VEHICLES, COMMERCIAL; RAILWAYS; RAILWAYS, TUBE; ROADS AND STREETS; TRAFFIC AND TRAFFIC REGULATION; TRAMWAY; TUNNEL.

Turning to transport at sea, a series of articles will be found under the headings BARGES AND CANAL CRAFT; INSURANCE: MISCELLANEOUS; SHIP; SHIPBUILDING; SHIPBUILDING: WORLD'S STATISTICS; SHIPPING, HISTORY OF; SHIPPING: MERCHANT SHIPS OF THE WORLD; SHIPPING: REGISTRATION, CLASSIFICATION AND STATE REGULATION; SHIPPING: TONNAGE TERMS; SHIPPING LINES AND GROUPS; SHIPPING ROUTES. As to waterways, a series of articles will be found under the headings CANALS AND CANALIZED RIVERS; LOCK; RIVER AND RIVER ENGINEERING; WEIR. Separate articles are devoted to the PANAMA CANAL and the SUEZ CANAL.

The group of subjects connected with ports and coast protection is treated under BREAKWATER; BUOY; COAST PROTECTION AND LAND RECLAMATION; DOCKS; HARBOURS; JETTY; LIGHTHOUSES; LIGHTSHIP; PIER; PORT OPERATION.

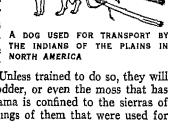
Articles on air transport will be found under AERONAUTICS; and AVIATION, CIVIL.

Below is given a brief general history of the subject.

PRIMITIVE TRANSPORT

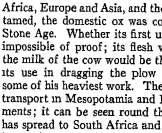
Woman was no doubt the first beast of burden, but her training was perhaps due less to her lord and master than to her children. Apes carry their young about, the latter assisting by clinging to the mother's fur with fingers and toes. Human mothers are furless, human babies less prehensile, and many are the contrivances for carrying babies or small children while leaving the hands free. The Eskimo hood, the American papoose frame, the Kafir skin bag, the Chinese yoke, the New Guinea net or the Andaman sling are all baby carriers, and similar devices may be used for carrying other loads. The daily labours of fetching water and firewood and of collecting roots, berries and other vegetable produce are usually women's work throughout the world; and while the man walks unencumbered save by his weapons, the woman carries all household gear when on the trail. For on the march the man is the hunter and fighter and must have his hands free.

Pack Animals.—The use of animals for transport—the dog, the ox, the horse, the ass, the reindeer, camel and elephant in the old world, the dog and the llama in the new—marked a great advance, especially as most of the old world animals were also milk-yielding The baskets, crates, carrying bags and other appliances could now be removed from the backs of women to those of pack animals, and not infrequently the harness is still the woman's concern, though the man has charge of the pack animal. The distribution of these transport animals depends upon their occurrence in a wild state, their subsequent diffusion and the distribution of their fodder, or their ability to adapt themselves to varying conditions. The reindeer cannot thrive beyond the limited range of the reindeer moss which is their chief food. Unless trained to do so, they will not willingly eat any artificial fodder, or even the moss that has been collected by hand. The llama is confined to the sierras of South America, and the long strings of them that were used for conveying merchandise down to the lower plains soon sickened in the enervating climate. The elephant, because of his appetite and delicacy, has a restricted range in southern Asia and has not been successfully domesticated in Africa; in the latter continent the tsetse fly hinders the efficiency of animal transport over the central area.



A DOG USED FOR TRANSPORT BY THE INDIANS OF THE PLAINS IN NORTH AMERICA

The dog was possibly one of the earliest animals to be used in transport, but because of its small size and limited strength, it was only trained when no better animal was available But throughout the arctic regions of the new and in much of the old world the dog is invaluable, its light weight enabling it to run over snow-covered ground, and its tractability making good teamwork possible.



ESKIMO SLEDGE, MADE OF DRIFTWOOD AND WHALE BONES WITH CARIBOU ANTLERS FOR STEERING

The ox was the most widely distributed of all the transport animals Various species existed in a wild state in North America, Africa, Europe and Asia, and though the American bison was never tamed, the domestic ox was common in Europe and Asia in the Stone Age. Whether its first use was for food or for transport is impossible of proof; its flesh was always appreciated, and while the milk of the cow would be the chief value to pastoral societies, its use in dragging the plow would help the agriculturalist in some of his heaviest work. The ox wagon was a familiar means of transport in Mesopotamia and Egypt, as is seen on ancient monuments; it can be seen round the Mediterranean even today, and has spread to South Africa and South America, the ox being used in the former continent for riding as well as draught. In Asia the yak is as essential for transport and valued for its milk in the Himalayas as the buffalo in southern India

The domestic horse, assumed to have been derived from the wild horse of the central Asiatic plains, appears to have been the earliest domesticated animal in Japan where it was ridden, not used for draught, and its westward spread covered the history of Europe, both political and social. Stray horses running wild over the plains and horses deliberately let loose in America soon produced wild herds both in the northern and southern continents, and profoundly influenced the mode of life of the American Indians. The horse is rarely used by the African native, except by those in close contact with the Arabs; drought and heat in the north and the tsetse fly to the south retarded its distribution and use. Human carriers (men, not women) are the usual means of transport over the greater part of the continent south of the equator as far as the cattle areas, where their place is taken by the ox

The reindeer provides not only transport, but milk, flesh and skins as well, and a herd of them constitutes wealth in Siberia and among the Lapps of northwestern Europe. Moreover, they support themselves on the reindeer moss (*Cladonia rangiferina*). The Lapp deer are much stronger and more heavily built than those of the semiwild Chukchi herds in eastern Siberia, which are not strong enough to carry a man and are not so highly valued for draught. Lapp law forbids a heavier load than 130 lb on the back and 190 lb on the sledge. Enormous distances are travelled by Tungus traders with their well-trained teams. In early winter, when in good condition after their summer pasturing, a good team will keep up a speed of 10 to 12 mi. an hour all day long, and a good bull will travel 150 mi. a day if the snow is hard and the temperature about 30 to 40° below zero. No attempt was ever made by the Amerinds to train the American reindeer.

The camel, whether the wild Bactrian camel or the domesticated Arabian (whose ancestry is unknown), with its thirst-defying stomach, its capacity for thriving on desert herbage and its flat feet spreading out over, instead of sinking into, the soft sand, has made life and wealth possible in the oases of the Sahara. It rivals the horse in the drier districts of Asia from the Holy Land to China, and it has rendered invaluable service in the exploration of the deserts of Australia. The camel fails—apart from the absence of suitable climate or fodder—in the tenderness of its pads over rough, stony, rocky or icy ground. It cannot be shod like a

horse, though its feet are often protected by artificial shoes or pieces of leather are stitched onto its tough soles. The camel provides not only transport, being surpassed in strength only by the elephant and surpassing all other animals in endurance, but it supplies milk, flesh, skins, wool and hair. A good riding camel will cover 150 mi. in a day, and the Bactrian or two-humped baggage camel may carry more than 1,000 lb.

The wild guanaco or mountain camel of South America has a wide range over the higher lands of the continent, but the llama and its relative the alpaca were domesticated and trained for transport only in the Peruvian-Bolivian area. The llama can carry only about 100 lb., and cannot be used for draught, but as they are very docile, a large herd of several hundreds was sent out with merchandise in charge of a few herdsmen, and in the absence of larger animals their value was very high. They still hold their own in high altitudes in competition with mules or donkeys.

The domestication of the African elephant is doubtful, but the Indian elephant was early trained for transport and for use in war. Its great strength and intelligence can be used to advantage, especially in pathless jungle and for transporting heavy weights for road and bridge building, but because of its enormous appetite, which can only be satisfied where vegetation is abundant, and the delicacy of its constitution compared with ox, horse or mule, its economic value and range are definitely and narrowly limited.

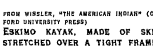
Draught.—Man can drag more than he can carry on his back, and where the surface of the country is suitable some contrivance is made for hauling. The American Indians, who developed a type of sledge, also dragged skins sewn into bags along the frozen ground. Though over the whole of arctic America packs are carried on the back (human and canine), as the ground hardens, sledges are made and far heavier loads can be transported.

The Eskimo sledge consists essentially of three pieces, the sides and crosspieces of wood lashed together with rawhide, and the runners or shoes. These are typically of whalebone or walrus ivory (now replaced by iron) pegged on. For winter travel a layer of mud or lichen mixed into a paste is smeared on, coated with ice. The western sledge is 3½ to 4 ft. long; the eastern type 12 to 24 ft. long according to the locality, with five to nine crossbars. This can carry a load of 1,000 lb. and keep up a steady pace of two miles an hour, drawn by a man, his wife and a couple of dogs. South of the frozen land the toboggan takes the place of the sledge, and in the bison area the special method of packing led to the development of the travois. Here the tent poles were fastened into bundles, one on either side of a dog—later a horse—with the ends of the poles trailing on the ground; the skin cover rolled into a bundle was tied on transversely across, and any household goods piled on the top. This suggested the fixed V-shaped framework known as the travois. Some such primitive construction preceded the wheeled cart of the old world, and its last surviving descendants are farm sleds for hauling timber, the sledge on runners used for carting furze in the north of England and boulders and farm products in northwestern U.S.S.R. or the slide car used for carting turf in Antrim. The wheel is not a primitive invention as applied to transport, and although wheeled chariots were familiar in early times in Assyria and Egypt, there was no wheeled vehicle in America before the discovery of the continent by Europeans.

TRANSPORT BY WATER

This usually requires less effort than transport by land, and is often more highly developed among primitive peoples. The earliest type of boat is the raft, made of grass, logs of wood, bundles of reeds or other light materials tied together, on which man can float. Such was the raft of the Tasmanians, made of eucalyptus bark tied in cigar-shaped bundles nine or ten feet long, thinning at either end. Similar floating rafts of varying materials were used by early Egyptians on the Nile, and by the Inca on Lake Titicaca. The Jarawa on the small island of South Andaman have no canoes, but lash bamboos together to form rafts for crossing creeks or inlets; the Semang of the Malay peninsula float down rivers by the same means, returning overland. In Africa, as in Mexico and Peru, large gourds are used for ferrying. On the Hadeija (running into Lake Chad) the Hausa ferrymen, balanced on a calabash, paddle themselves across with arms and legs, earning for themselves the name of *jemage* or bats; for transport guinea cornstalks (*Sorghum*) are laid across the calabashes to make a platform. Inflated skins take the place of gourds among the pastoral people of western Asia or north Africa, and inverted pots are used to support the rafts for ferrying across the Nile river. Another primitive type of boat found on the Tigris or Euphrates is the round *guffa*, made of basketwork, covered with skins coated with bitumen which was described by Herodotus (1. 194). The coracles of the ancient Briton, described by Pliny and still used in modern times in Wales and round the coasts of Ireland, the skin-covered canoes used by hunters in British Columbia, the bullskin boats in the western states of the U.S are varying developments of the same type.

The finest examples of skin boats are the Eskimo umiak and kayak. The umiak is often called the woman's boat, but, except in Greenland, it is more used by men than women, and is the boat commonly used for hunting large game. It may be from 10 to 20 ft. long, with wide flat bottom, broad spread and little distinction between stem and stern. The framework, lashed together with sealskin thongs, is covered with large sealskins strongly stitched together and put on green so that they shrink tight. The cover is lashed to the gunwale, and can be tightened as it stretches in getting wet. The kayak is seldom used for transport but is essentially hunting and fishing equipment. It is made in the same way as the umiak, but is entirely enclosed in skins save for a hole. It may be 25 ft. long, but is only just wide enough to contain the hunter, who in his waterproof coat slips into the central hole, ties the string of his coat round the rim and is absolutely impervious in his buoyant craft; he can travel at twice the pace of a two-man canoe, and ventures out in a rough sea. Skin boats are mostly fitted for temporary use; great care has to be taken in beaching them, while, if left in the water, the skins soon rot. Both kayak and umiak, still important, were less widely used than formerly in the 20th century.



FROM WISSLER, "THE AMERICAN INDIAN" (OXFORD UNIVERSITY PRESS)

ESKIMO KAYAK, MADE OF SKIN STRETCHED OVER A TIGHT FRAMEWORK WITH A HOLE FITTING THE HUNTER'S WAIST

Where suitable trees of good size are found a simple type of boat is made of a sheet of bark. The Lillooet canoes of British Columbia were formerly always of bark, poplar, cottonwood, spruce, cedar or birch. In the spring two rings were cut round the trunk and a line connecting them, and the bark was pried off in one piece. This was fixed to a wooden framework by sewing with root fibres, and all the crevices were caulked with moss and gum. The Australian bark canoes are of eucalyptus. A large sheet is peeled off, the ends are turned up and either tied or sewed and the joints caulked with resin.

The boat made out of a solid tree trunk has many advantages. In Melanesia (Kiwai Island) there is a tradition of the time when the only craft consisted of a solid log or tree trunk balanced by double outriggers supporting a platform fixed to sticks driven into the trunk. This type may everywhere have been the precursor of the hollowed log, but dugouts are so widely distributed in time and space that their origins are forgotten. Ancient dugout canoes, sometimes 50 to 60 ft. long, are found in British peat bogs, but it is not possible to date them with any precision. Metal tools were probably used in their construction, though stone adzes are preferred by the canoe makers of New Guinea.

The Andamanese hollowed out their canoes with shell adzes, without the aid of fire, but they chose softhearted wood such as Sterculia, and caulked the ends with beeswax (later by nailing up the end with a piece of tin). Some of the finest dugout canoes are made by the coast tribes of British Columbia. The only tools used in pretrading days were stone axes, hammers and chisels, and the wood was the native cedar. To fell the tree, two circular and parallel incisions are made in the trunk, nine or ten inches apart, and the wood is pried or pecked out piece by piece; when it is felled, the length for the canoe is cut off in the same way. It is

hollowed out with fire and adze and roughly shaped. Next, fires of smokeless embers are lit near by but not near enough to scorch, and the inside is filled with water brought to a boil with heated stones. This plims and softens the fibre of the wood and allows of the expanding and stretching of the sides, which are fixed in position to the desired width by thwarts pegged in place. Some of the canoes are from 30 to 50 ft. long, and will carry 60 to 100 people

The finest and most varied boats are found among the islands of Polynesia There are relics of primitive types, rafts of poles lashed together or bundles of bulrushes, and the Moriori of Chatham Island used to venture out to sea, 60 of them at a time, on a raft of flax flower stems (*Phormium tenax*) floating on sea kelp bladders But beautifully balanced dugout canoes with or without outriggers and carvel-built plank boats ingeniously lashed together with cord are universal, and in these the long voyages of hundreds of miles from island to island are undertaken The most imposing of the double canoes were those of the Society Islands, the lightest those from Hawaii and the strongest those of New Zealand. The plank-built canoes were usually made of breadfruit-tree wood (*Artocarpus incisa*) very carefully fitted together

The whole process of boatbuilding, from the felling of the trees to the launching of the boat is generally accompanied by feasts, charms, prayers and varied ceremonies to ensure good luck. Human victims as sacrifices are characteristic both of Oceania and of parts of Africa. Charms are often attached to boats, especially to assist in fishing or in war.

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HISTORY OF TRANSPORT

Early Inland and Ocean Transport.—Where rivers were available, as in China and Egypt, rafts and boats were used in the early stages of civilization and it was natural that canals extending or connecting river channels should be dug The Phoenicians, Greeks and Romans were able to navigate the ocean in vessels equipped with sails and with one to three banks of oars; and it was by means of these craft that they established and maintained their colonies The Roman armies and their equipment and supplies were transported to Carthage or Gaul in these boats. The early civilizations developed in river regions with special opportunities of production and transport, and about the Mediterranean, an inland sea providing a navigable highway. Rome built up and maintained a far-reaching empire by military power, by an efficient system of law and administration and by building roads Without its system of roads, it could not have governed its empire When the Roman power was overthrown and road building ceased in Britain, Gaul and Mediterranean lands, economic, social and political life became local. In course of time a feudal society developed that prevailed for centuries. The forces that brought about the change from the feudal to a national organization of society were many, but the improvements in facilities of transport by sea and land were potent factors.

The mariner's compass, though the properties of the lodestone were known in China and India long before they were in Europe, did not have much influence in the east because the orientals were not maritime people; but in Europe, from the 14th century on, mariners could sail by the compass whither they would, and by the end of the 15th century the sailing vessel had carried men to America and around Africa to India. The earth was known to be a sphere and the new continent of America had been discovered. The services rendered by the sailing vessel from the 15th to the 19th century in the discovery, settlement and development of new lands, are well known. It is, indeed, remarkable that these slow-going craft of only 80 to 300 tons' capacity could have so influenced the world's history. The largest of the three vessels in which Columbus made the voyage that resulted in his reaching the Americas, the "Santa Maria," was a decked ship of 100 tons; the "Pinta" and the "Niña" were caravels of 50 and 40 tons respectively. It took from Aug. 3 to Oct. 12, ten weeks, to make the passage via the Canary Islands to Watling's Island in the Bahamas. The sailing vessel provided a transport unit and facility appropriate to the commercial requirements of the 17th and 18th centuries. Trade, still in large part barter, was in small quantities and the ships were in most instances operated by the merchants in the conduct of their business Traders could advantageously send the small vessels of that day to shallow harbours as well as to deep ones The common carrier, as distinct from the merchant, operating vessels over fixed routes did not become general until the 19th century.

Road and Canal Building in the 17th and 18th Centuries.—France was the leader among European countries in developing a modernized inland transport system The work was begun in 1597 by Sully, who made a start with the task of creating a national system of roads surfaced with broken stone. The great road builder of France, however, was Colbert, who became comptroller of France in 1665. By enforcing the feudal system of compulsory labour of all able-bodied peasants he brought about the surfacing of 15,000 mi. of road. The roads thus built were not scientifically constructed and maintained In 1775, Tresaquet, by making provision for drainage of the roadway, began the construction of better roads and substituted a continuing force of paid workers in place of the intermittent labour under the *corvée* system Two Scotsmen, however, Thomas Telford (1757–1834) and John Loudon McAdam (1756–1836), were the first to build "macadam" roads according to the scientific methods followed thereafter, emphasizing the necessity of good drainage. Telford's practice was to lay a base of large stone on which smaller stones were placed, the surface being made of finely broken rock. McAdam began with crushed rock a few inches in diameter and omitted the foundation of large stone He showed that the angular surfaces of crushed rock, when pressed together by a heavy roller, would give to a layer a few inches in thickness strength sufficient to sustain the load that was ordinarily imposed on a highway. The McAdam road was thus lighter and less expensive to construct than the Telford road. The McAdam foundation continued to be used in road building, although there may be a binding of cement and the surface may be a layer of asphalt or of concrete. Great Britain formerly looked to the parishes and counties to construct and maintain public roads. From 1760 onward parliament chartered a large number of turnpike companies which built toll roads after the crude manner that prevailed until near the end of the 18th century, when Telford and McAdam began their work. In 1763 a stagecoach journey from London to Edinburgh required 14 days.

This situation in Britain was first ameliorated by the construction of canals, the first of which, promoted by the duke of Bridgewater to connect Worsley, and thus Liverpool, with Manchester, was opened in 1761. This canal reduced the cost of coal in Manchester 50%. The 3,000 mi. of canals constructed in the British Isles between 1760 and 1830, the rapid improvement of the highways from 1800 on and the development of railways after 1825 made it possible for England, in advance of other European countries, to market factory-made goods in large quantities at home and abroad.

England was not the first country to construct modern canals; Holland began first. France emphasized canal building for two centuries and by connecting her main rivers and improving their channels created a national system of inland waterways. Germany, like France, made large use of her natural waterways, but their improvement came mainly during the latter part of the 19th century. The waterways contributed to the economic development of many other countries, including the United States during the 19th century, but the role they played was a minor one in comparison with those of the railroad, ocean steamship, automobile, bus, truck and aircraft.

The Railway, Its Economic Significance.—The introduction of the locomotive and the railway inaugurated an economic

and social revolution. It gave man the service of a power capable of indefinite technical development to assist him in expanding his economic activities and his social contacts The railways, followed and supplemented in turn by the steamship, telegraph, telephone, electric railway, automobile, aeroplane and radio communication transformed the world. Changes came with accelerating rapidity until there seemed to be no limit to the degree of world unity made possible by developments in transport and communication.

Important milestones in developing the efficiency of railway transportation were the following. (1) The rolled steel rail which began to be laid about 1870 made possible the construction of a track capable of withstanding the strain of the heaviest and fastest trains; (2) trains could not be safely run at high speed until they were equipped with power brakes. George Westinghouse successfully applied the air brake to passenger trains in 1868 and to freight trains in 1887. The air brake reduced by 90% the time and distance required to stop a train by hand brakes; (3) the transport of fresh meat and fruit and later fresh vegetables was successfully accomplished during the 1870s with the refrigerator car; (4) the operation of freight trains on regular schedule and at increased speed placed production and merchandising upon a new basis. The merchant now did not have to carry a large quantity of goods nor did the manufacturer have to stock up with large amounts of materials and supplies. Business could be done with a smaller amount of inactive capital, productive activity and the employment of labour were more continuous; (5) as it is by the application of power that the work of transport is done, power efficiency determines the progress made by transport. Great technical achievements included development of the electric and the diesel locomotive (*see* below)

The Ocean Carrier and Its Development.—On the ocean, as well as on the land, rapid changes took place in the mechanism and services of transport and these changes affected industrial and commercial conditions on a wide scale. The wooden sailing vessel gradually gave way to the steel steamship during the first three-quarters of the 19th century. Robert Fulton's "Clermont" inaugurated steamboat navigation on inland waterways in 1807; the "Savannah" made an early transatlantic crossing with steam power in 1819; the screw propeller was invented in 1836; and the iron hull dated from about 1840 The Inman line adopted the propeller in 1850 and the Cunard line in 1862. The "Great Eastern," the giant of its time (1869), had not only a screw propeller, but paddle wheels and six masts for sails. Twin screws were first used on warships in 1880 and on a passenger vessel in 1888 Steel began to take the place of iron in hull construction about 1880.

The relatively slow technical development of the ocean vessel was largely the result of the limitations of the marine engine. The engines with low steam pressure and consequently long slow piston stroke could be used to drive paddle wheels by direct crankshaft action, whereas gearing and loss of power were involved in giving the propeller the requisite speed. While direct-acting engines were used to drive propellers as early as 1854, it was not until after 1870 that the present type, the inverted, direct-acting, compound steam engine came to be exclusively used; then the ocean vessel developed rapidly in speed, size and economy of service. The conspicuous, much advertised passenger liners attracted most public attention, but their influence was small in comparison with that of the slow freight steamers, some called tramps, which after 1870 could move cargo so cheaply as to make possible the shipment, for practically any distance, of bulk cargoes of grain and the essentials of industrial expansion.

The ocean vessel and ocean transport underwent revolutionary changes after the invention of the internal-combustion engine, the use of oil for fuel and the operation of freight vessels less as individual units and more in line services with scheduled sailings. The turbine, which had been invented in 1883–84, was introduced in warships and large high-speed ocean vessels about 1900; but while the turbine was superior to the reciprocating engine for some purposes, its use did not involve a fundamental change such as accompanied the introduction of the internal-combustion engine named after its inventor, Rudolf Diesel. The diesel engine did away with the boilers and furnaces, it occupied less space than steam equipment and thus added to available cargo capacity. It consumed much less fuel, gave a vessel a much greater sailing range and was more economical to operate. For these reasons it was largely adopted for vessels of moderate size and speeds One check upon the general dieselization of shipping was the higher cost of installation and the weight of the diesel engine and its auxiliaries, but these handicaps were steadily overcome by designers and builders

Electric and Diesel Railways.—Electric power was employed in three fields of transport, for city street railways, surface, elevated and underground; for interurban railways; and as a substitute for steam locomotives on railroads in large city terminals, tunnels and in mountain areas where current can be generated by water power

Before the motorbus appeared on the city streets, the electric railways were supplying all organized urban transport, and supplemented by suburban extensions they caused cities to spread out over ever-enlarging areas and did much to improve living conditions for the constantly increasing number of people living in cities. The importance of both the urban and interurban electric railway in the United States, however, was greatly reduced by the rapid development of motorbus service. Many interurban and suburban electric lines ceased to operate in the United States, and in most countries the suburban and local passenger traffic of steam railways, especially in the United States, was reduced by the extensive use of private automobiles and also by the competition of motorbuses.

At the beginning of the 20th century it was thought that steam railways would be electrified, there being no question as to the general superiority of electricity as a motive power, but electrification continued to be confined mainly to tunnels, to eliminate the smoke and gases, to a few large city terminals, also for the same reason, and to some mountain sections where electric locomotives are more efficient than steam and where current can usually be obtained from water power. The diesel engine, however, with its great power and efficiency (in a sense electrification via fuel oil) was widely adopted by railways after the mid-1930s to replace the steam locomotive on long hauls for both passenger and freight traffic. In the United States at mid-century only a small fraction of new locomotives were steam powered.

Highway Transport—the Automobile Age.—The movement for good public roads began in western Europe 100 years before it started in the United States, a newer country with a sparser population and less accumulated capital Moreover, the early and widespread development of railways in the United States provided facilities for other than short-distance and local transport that were fairly adequate until near the end of the 19th century. Then it became manifest that in the more thickly populated northeastern states improved county and state roads were necessary. New Jersey acted first, adopting a State highway law in 1890; Massachusetts, New York and some other states soon followed with similar acts. The movement, however, would probably have been much slower than it was, had it not been for the automobile, the use of which rapidly increased after 1900 and particularly from 1910 onward, until by mid-century there were more automobiles in the United States than there were families The demand of the private automobile owners throughout the United States for roads good throughout the year was strengthened during and after World War I by the operators of motorbuses and of motor trucks, whose use for local passenger and freight transport had increased with great rapidity. The states (aided from 1915 by the federal government) provided the country with a comprehensive system of state and interstate highways. The improved highway and the automobile in the United States brought mechanical transport to each man's door, and the same was true in varying degree in many other countries. (E. R. J.; X.)

TRANSPORT BY AIR

For the sequence of events in the development of passenger travel by air, *see* the article Aviation, Civil. Here emphasis is

placed upon cargo transport.

The first notable event in the evolution of the air cargo carrier was the Zeppelin airship launched in Germany in 1900. This mode of flight device was viewed, except in the United States, as the most likely to succeed in carrying heavy loads and operating over long distances. In Europe, and more especially in Germany, the Zeppelin type of lighter-than-air craft carried on a rather lively service among major cities. Although passenger business was paramount, valuable papers and small packages of relatively large unit value were also transported—essentially the beginning of air express. The Hamburg-America line, acting as agents for the German Zeppelin company, announced in 1932 the first regular transoceanic sailing schedule for the "Graf Zeppelin." The service was expanded in subsequent years to include both North Atlantic and South Atlantic crossings, until World War II forced its abandonment.

While interest in lighter-than-air vehicles grew apace in Europe, the United States turned its attention to the possibilities of heavier-than-air craft. World War I created a great demand among European nations for planes and stimulated U.S. manufacturers to focus much of their energies upon the development of this product. By the end of the war sufficient progress had been made to bring about the establishment of the first regular air-mail service. A line began operation May 15, 1918, between New York city and Washington, D.C., and gradually the service was extended until July 1, 1924, when the first transcontinental mail service was formally inaugurated. While this activity was in progress, the Universal Postal union was alert to international air-mail possibilities. As early as 1920 at the congress of the Universal Postal union at Madrid an international air-mail service was discussed and in 1924 such service was made the subject of official regulation

Europe did not lose sight of aeroplane possibilities, even with high interest in airships. By 1923 regular lines for both passengers and light freight were operated by the Netherlands, Denmark, Germany, England, France and Belgium. In subsequent years essentially all the nations of Europe subsidized lines, some of them, to be sure, quite restricted in scope.

Ocean steamship lines sought permission to operate air-cargo services. Although they were not given this privilege, some lines held financial interests in air lines and also entered into special contracts with air line companies for cargo services between stipulated ports.

By mid-20th century, every continent, in part or throughout, had a rather high density of air-route networks. The greatest area either relatively or wholly untouched was central and northern Asia and of course Antarctica. The aeroplane requiring only a landing field had moved the interior of South America, Africa and other regions to within a matter of hours from the United States, Europe and other highly advanced economic centres

The use of the plane for cargo transportation probably had its greatest development in the United States. In the early days of aviation in Europe there were some exceptional instances involving the carriage of heavy loads, such as a private car or two between England and the Netherlands, but there was no consistency in such operations During World War II the great possibilities of the plane for transporting heavy loads were first realized However, such use of the plane was not commercial. The post-World War II years marked the beginning of a rapid growth in scheduled freight and express services and in the use of planes exclusively for such purposes By mid-century, scheduled U.S. air-cargo carriers were flying more than 100,000,000 ton-mi of freight and 80,000,000 ton-mi of express annually. The Railway Express agency handled nearly all the cargo hauled by the air lines. This was a matter of convenience because the air lines had not developed a transportation service between the airports and the points of origin or destination of their cargo.

Adapting the plane for transportation of agricultural commodities aroused particular interest. In 1944 the bureau of agricultural economics of the United States department of agriculture published the results of its experiments in the transportation of lettuce from the Salinas valley in California to Detroit, Mich , and of fresh strawberries and tomatoes from various points in the south including Brownsville, Tex., and Miami, Fla , and from the Imperial valley, California. A wide variety of food thereafter was shipped from the west coast to New York city, Boston and other eastern markets.

Aerial transportation of commodities has presented many of the problems common to rail and motor truck transport plus the unique one of adjustment for low atmospheric pressures affecting a number of perishables, including live animals. Another element of concern has been abrupt changes in temperature in consequence of the short time interval in the course of landing, between the altitude of flight where temperatures may be quite low and that of the level of the airport where, especially in summer, temperatures may be extremely high.

Another aerial device tested as a carrier as early as 1939 was the helicopter, employed for short-haul duty, particularly the carriage of mail. It was also utilized for rescue work at sea and on land, involving the dropping of foodstuffs and other emergency supplies, as well as the transference of persons from hazardous locations to places of safety. Plans were under way for landing facilites on the roofs of railroad stations and other buildings Experiments were also conducted in the use of gliders as adjuncts of planes.

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TRANSPORT, MINISTRY OF: *see* GOVERNMENT DEPARTMENTS.

TRANSUBSTANTIATION, the term adopted by the Roman Catholic Church to express its teaching on the subject of the conversion of the Bread and Wine into the Body and Blood of Christ in the Eucharist. Its signfiration was authoritatively defined by the Council of Trent in the following words: "If any one shall say that, in the Holy Sacrament of the Eucharist there remains, together with the Body and Blood of Our Lord Jesus Christ, the substance of the Bread and Wine, and shall deny that wonderful and singular conversion of the whole substance of the Bread into (His) Body and of the Wine into (His) Blood, the species only of the Bread and Wine remaining—which conversion the Catholic Church most fittingly calls Transubstantiation—let him be anathema." (Sess. xiii. *can.* 2.) The word "transubstantiation" is not found earlier than the 12th century. But in the Eucharistic controversies of the 9th, 10th and 11th centuries the views which the term embodies were clearly expressed; as, for example, by Radbertus Paschasius (d. 865), who wrote that "the substance of the Bread and Wine is effectseously changed interiorly into the Flesh and Blood of Christ," and that after the consecration what is there is "nothing else but Christ the Bread of Heaven." The words "substantially converted" appear in the formula which Berengarius was compelled to sign in 1079. We may take it that the first use of the word is in a passage of Hildebert de Savardin (d. 1133), who brings it into an exhortation quite informally, as if it were in common use It is met with in a decretal of Innocent III The fourth Lateran council fully adopted it (1215). It is clear from the treatise of Radbertus Paschasius already quoted that the word "*substance*" was used for *reality* as distinguished from *outward* appearance, and that the word "species" meant outward appearance as opposed to reality. The terms, therefore, were not invented by St. Thomas Aquinas, and are not mere scholastic subtlety The definition of the Council of Trent was intended both to enforce the accepted Catholic position and to exclude the teaching of Luther, who, while not professing to be certain whether the substance of the Bread and Wine could or could not be said to remain, exclaimed against the intolerance of the Roman Catholic Church in defining the question.

BIBLIOGRAPHY.—For a full exposition of the Catholic teaching on transubstantiation the reader may consult Ludovico Billot, S.J., *De ecclesiae sacramentis* (Rome, 1896) *See* also the *Catholic Encyclopaedia*, article "Transubstantiation" The Abbé Pierre Batifol, in his *Etudes d'histoire et de théologie positive*, 2nd series (*Elaboration de la notion de conversion* and *Conversion et transubstantiation*), treats it from the point of view of development (Paris, 1905).

(J. C. H.; X)

TRANSURANIUM ELEMENTS. The term "transuranium elements" designates the chemical elements lying beyond uranium in the periodic table and hence including all the elements with atomic number higher than 92, the atomic number of uranium. All of the transuranium elements are radioactive, do not occur in appreciable amount in nature, and were discovered and investigated as a result of their syntheses by transmutation reactions starting with uranium (*q v.*) as the primary maternal. All those known are members of a group of chemically similar elements, the actinide transition series of elements, a group which is chemically similar to the rare-earth or lanthanide group of elements (*see* RARE EARTHS)

Plutonium (*q.v.*) assumed the position of dominating importance among the transuranium elements because of its very successful use as an explosive ingredient in the atomic weapon and the excellent prospects which it offers as the base material for the development of industrial uses of atomic power or energy. Plutonium is the only member of this synthetic group of elements for which methods had been developed by the 1950s for production in relatively large amounts, that is, kilogram amounts (*see* below). From a purely scientific point of view, however, the other transuranium elements are of nearly as great interest as plutonium.

A great deal of speculation had arisen by the early 1950s concerning the upper limit of atomic number for the existence of transuranium elements, with considerations that such a limit might arise from either atomic or nuclear (radioactivity or spontaneous fission) instability. If the former was not the limiting factor, it appeared likely, on the basis of extrapolation from the nuclear properties of the heaviest elements, that a few elements above atomic number 100 would have isotopes of sufficiently long life to make possible their physical investigation when the problem of their production in detectable amounts was solved Unfortunately,

predictions based on the systematics of radioactivity and the shape of the nuclear energy surface in the heavy region suggested that the half lives for even the longest lived (heavy mass) isotopes of the elements with atomic number over 100 would be so short as to make tracer chemical investigations difficult.

Speculation also arose about the chemical properties of the undiscovered, higher transuranium elements The elements through atomic number 103 should complete the rare-earthlike (actinide) transition group The hypothetical element with atomic number 104 should be chemically similar to hafnium (atomic number 72), that is, should be an ekahafnium The next 14 hypothetical elements with atomic numbers 105 to 118 inclusive should, consecutively, be chemical homologues to the 14 known elements with atomic numbers 73 (tantalum) to 86 (emanation or radon) inclusive.

The transuranium elements known in 1952 are described in the order of their increasing atomic numbers in the following discussion

Neptunium.—Neptunium (atomic number 93) was the first transuranium element to be discovered Using the neutrons from the University of California (Berkeley) 60-in cyclotron, E M. McMillan and P. H. Abelson in 1940 were able to show with the help of their chemical work that the irradiation of uranium leads to the production of the isotope Np^{239}. This isotope, which has a half life of 2 3 days, is the decay product of the 23-min. U^{239} formed by radiative neutron capture in U^{238} Their experiments on the tracer scale of investigation enabled them to show that neptunium is similar in chemical properties to uranium They named the element which they had discovered "neptunium," following uranium in the same order as the corresponding planets Uranus and Neptune Later the symbol Np was suggested for this element.

Another important isotope of neptunium, Np^{237}, was discovered by A. C. Wahl and G. T Seaborg early in 1942 by bombarding uranium with fast neutrons, using the Berkeley 60-in cyclotron. This isotope is the decay product of the previously known 7-day, beta-particle-emitting U^{237} which is formed as the result of an $(n,2n)$ reaction on U^{238}. The isotope Np^{237} is of particular importance because it is long-lived, emitting alpha particles with a half life of $2\ 20\times10^6$ years, and because it is available in weighable amounts. The first pure neptunium in the form of compounds of the isotope Np^{237} was isolated by L. B. Magnusson and T. J. LaChapelle at the Metallurgical laboratory of The University of Chicago (later the Argonne National laboratory) in Oct 1944 in experiments on the ultramicroscale with amounts ranging from 1 to 50 μg. This isotope is produced during the operation of the large uranium chain reacting units, a very fortunate circumstance, for otherwise it is probable that the element neptunium would not be available for study in the macroscopic state.

With this material it became possible to make an intensive study of the chemical properties of neptunium, leading to the establishment of its oxidation states and the properties of a large number of its compounds. This work showed that neptunium has the oxidation states VI, V, IV and III with a general shift in stability toward the lower oxidation states as compared with uranium.

The relatively low specific alpha activity of the isotope Np^{237} places the element neptunium in a class by itself in the transuranium group because it is relatively safe to handle from the health standpoint. The other transuranium elements are so highly alpha radioactive that special techniques and precautions are mandatory when they are handled in ordinary amounts However, the half life of Np^{237}, 2.20×10^6 years, corresponds to a specific alpha particle activity of about 1,500,000 alpha particles per minute per milligram, only about 1,000 times that of ordinary uranium. Material of this level of radioactivity can be handled without special equipment, provided reasonable care and precautions are observed. In addition to Np^{236} and Np^{237}, nine other isotopes of neptunium were known in 1952. These are listed in the accompanying table, which also includes all the known isotopes of the other transuranium elements

Plutonium.—Plutonium (atomic number 94) was discovered late in 1940 by G. T. Seaborg, E. M McMillan, J. W. Kennedy and A C. Wahl as a result of bombarding uranium with deuterons in the Berkeley 60-in. cyclotron This particular isotope was later shown to be Pu^{238} Early in 1941 the isotope of major interest, Pu^{239}, was discovered by J. W Kennedy, G. T. Seaborg, E. Segré, and A. C. Wahl, in uranium bombarded with neutrons produced in the same Berkeley cyclotron The nuclear reactions for the production of Pu^{239} are as follows.

$$U^{238}(n,\gamma)U^{239} \xrightarrow{\beta^-} Np^{239} \xrightarrow{\beta^-} Pu^{239}.$$

Element 94 was given the name "plutonium" (symbol Pu) by the discoverers after the planet Pluto to follow uranium and the previously discovered neptunium in the same order as the corresponding planets.

The chemistry of plutonium was first investigated by the tracer technique using the isotope Pu^{238}. These experiments showed that the chemical properties of this element are similar to those of neptunium and uranium, differing in that the lower oxidation states of plutonium are more stable.

The plutonium project of the Manhattan District was organized for the purpose of producing the isotope Pu^{239}, the explosive ingredient for the atomic weapon. The first pure plutonium in the form of compounds of the isotope Pu^{239} was isolated by B B Cunningham and L. B Werner at the Metallurgical laboratory of The University of Chicago on Aug. 18, 1942, in experiments on the ultramicroscale, using material prepared by means of bombardment with cyclotron neutrons, they made the first weighing of a plutonium compound on Sept. 10, 1942. This was the first synthetic element to be isolated in pure form. Chemical plants costing hundreds of millions of dollars were designed and constructed on the basis of early experiments involving only microgram quantities of plutonium.

The availability of the relatively large amounts of plutonium, as a result of the successful operation of the chain-reacting piles, made it possible to conduct complete investigations of its chemical properties using methods which can be considered to be those of ordinary chemistry except for the necessary health precautions. This work established that plutonium has the oxidation states VI, V, IV and III and that there is a shift in stability toward the III state as compared to neptunium and uranium. A large number of compounds of plutonium were prepared and their properties determined The chemistry of plutonium became understood as well as or better than that of most of the elements in the periodic system, even though its chemistry is very complex, as can be judged by the multiple oxidation states and their oxidation potentials (*see* PLUTONIUM).

Because of plutonium's relatively high specific alpha radioactivity, amounting to about 140,000,000 alpha distintegrations per minute per milligram, special equipment and precautions are necessary in the investigations of its properties. This high alpha radioactivity makes it expedient to continue to use rather small amounts—that is, milligram amounts—for a number of these investigations even though large amounts might be available Even if there were no other reasons, its high alpha radioactivity places plutonium outside the class of elements which might eventually find widespread distribution among chemists for investigation of its chemical properties.

The knowledge of the chemical properties of neptunium and plutonium which had become available as a result of the discovery and study of these elements made it possible to conduct very effective searches for these elements in various minerals. Early in 1942 G. T. Seaborg and M. L. Perlman in Berkeley undertook a search for these elements in pitchblende ore, the primary purpose at that time being to establish whether such a source of a fissionable transuranium isotope might serve as a practical substitute for (at that time) the undeveloped and questionable nuclear chain reaction for production purposes. The amount of plutonium in the pitchblende corresponded to about one part in 10^{12}, an amount which could not possibly have been found had the chemical properties been unknown, and this was too small to be of practical value. Subsequent work on numerous uranium ores confirmed the existence of such small concentrations of plutonium, which is continuously formed by the absorption in the uranium of neutrons from various natural sources. Other transuranium elements, other

than Np^{237} which is present in uranium ores in slightly smaller concentration than Pu^{239}, are present in nature at concentrations too small to measure The known isotopes of plutonium are summarized in the accompanying table.

Americium.—Americium, the element with atomic number 95, was the fourth transuranium element to be discovered, its first identification taking place late in 1944 and early in 1945. The first isotope of this element was identified in the experiments of G T Seaborg, R A. James and L O. Morgan at the Metallurgical laboratory. They showed that the bombardment of Pu^{239} with neutrons leads to the formation of Pu^{241} as the result of the successive capture of two neutrons The Am^{241} is the daughter of 14-year beta-particle-emitting Pu^{241}. The reactions therefore are as follows:

$$Pu^{239} + n \longrightarrow Pu^{240} + n \longrightarrow Pu^{241},$$

$$Pu^{241} \xrightarrow[14\ \text{years}]{\beta^-} Am^{241}$$

The isotope Am^{241} emits alpha particles with a half life of 475 years. This element was named "americium," symbol Am (after the Americas), by analogy to the naming of the chemically homologous rare-earth element europium (named after Europe)

The availability of this isotope of americium made it possible to study the chemical properties of this element, using the tracer technique in the first experiments It became possible also to isolate americium in the form of pure compounds and to study its chemical properties in macroscopic concentrations B B Cunningham, working at the Metallurgical laboratory, succeeded in the fall of 1945 in isolating this element and studying its chemical properties using a weighable amount on the ultramicrochemical scale. This, then, was the third synthetic element to be isolated in pure form. Following its initial isolation a great deal of later work was done in the study of its properties using milligram amounts The work with pure americium in aqueous solution confirmed the tracer work by showing that the III oxidation state is very stable in solution and is the predominant and most important state. Americium can be oxidized with strong oxidizing agents to the IV, V, and VI states

Americium in the form of Am^{241} with its 475-year half life, has a higher specific alpha activity than even Pu^{239} Its specific alpha activity amounts to about 7,000,000,000 alpha disintegrations per minute per milligram. Thus even if this isotope should become available in ordinary amounts, it would always be necessary to conduct its investigation with special precautions and using the special techniques for handling highly alpha active material Future chemical investigations might use longer-lived isotopes such as Am^{243} to lessen this difficulty. A number of additional known isotopes are listed in the table

Curium.—Curium (atomic number 96) was the third transuranium element to be discovered The first isotope of this element was Cm^{242}, identified in the summer of 1944 by G T. Seaborg, R A James and A. Ghiorso at the Metallurgical laboratory as the result of its production in the Berkeley 60-in cyclotron by the following reaction.

$$Pu^{239}(\alpha,n)Cm^{242}$$

The isotope Cm^{242} is an alpha particle emitter with a half life of about 162 days This element was given the name "curium," symbol Cm (after Pierre and Marie Curie, pioneer investigators in radioactivity), by analogy to the naming of gadolinium, the chemically homologous rare-earth element (named after Johan Gadolin, pioneer rare-earth chemist)

The availability of this isotope of curium made it possible to study the chemical properties of this element by use of the tracer technique. Extensive investigations led to the conclusion that curium probably exists exclusively in the III oxidation state in aqueous solution. It is carried quantitatively by the rare-earth fluorides in precipitation reactions and can be separated from them only with difficulty.

The isotope Cm^{242} is formed in weighable amounts as the result of the strong neutron irradiation of Am^{241}. The Am^{241} absorbs neutrons to form the short-lived (16-hour half life) beta emitter, Am^{242}, which in turn decays to the Cm^{242} These nuclear reactions may be summarized as follows:

$$Am^{241} + n \longrightarrow Am^{242} + \gamma,$$

$$Am^{242} \xrightarrow[16\ \text{hours}]{\beta^-} Cm^{242}.$$

I. Perlman and L. B Werner succeeded in the fall of 1947 at the University of California (Berkeley) in isolating curium (as Cm^{242}) in the form of a pure compound by work on the ultramicrochemical scale. The isotope Cm^{242} with its 162-day half life has a specific alpha activity corresponding to about 10^{13} alpha disintegrations per minute per milligram. Among the difficulties in working with this isotope are the rapid decomposition of the water in the solution, the formation of hydrogen peroxide in the solution, heating of the solution and other effects. It was possible, however, to study the chemical properties of curium by work on the ultramicrochemical scale, and this work confirmed the fact that the element exists exclusively in the III oxidation state in aqueous solution. Future chemical studies of curium would make use of longer-lived isotopes such as Cm^{244} in order to lessen this difficulty The known curium isotopes are given in the accompanying table

Berkelium.—Berkelium (atomic number 97) was the fifth transuranium element to be discovered This was accomplished in Dec. 1949 at the University of California (Berkeley) by S. G Thompson, A Ghiorso and G T. Seaborg as a result of the bombardment of americium (Am^{241}) with helium ions in the 60-in cyclotron. Like the other transuranium elements, all of its isotopes are radioactive; the first one discovered, that with the mass number 243, has a half life of about 4 6 hours This element is the eighth member of the actinide transition series and was given its name after the city of Berkeley, Calif., in a manner similar to that used in naming its chemical homologue terbium (rare earth with atomic number 65) whose name was derived from the town of Ytterby, Swed , where the rare-earth minerals were first found In 1952 this element had not been isolated in weighable amounts and therefore its chemical properties were studied solely with invisible amounts through the use of its radioactive properties for detection purposes It has valence states of III and IV and rare-earthlike properties in aqueous solution. The known isotopes of berkelium are summarized in the accompanying table.

Californium.—Californium (atomic number 98) was discovered in Feb 1950 by S. G Thompson, K Street, Jr , A. Ghiorso and G T. Seaborg at the University of California (Berkeley) as a result of the bombardment of curium (Cm^{242}) with helium ions in the 60-in cyclotron This element is the ninth member of the actinide transition series, chemically homologous to the rare earth dysprosium, and was named after the university and state where the work was done Since californium, like berkelium, had not been isolated in weighable amounts by 1952, its chemical properties were studied with invisible amounts through the use of its radioactive properties for detection purposes. It has a valence state of III with rare-earthlike properties in aqueous solution The first isotope which was discovered (mass number 244) has a half life of about 45 minutes. The known isotopes of californium are summarized in the accompanying table

See G T Seaborg, J J. Katz and W. M. Manning (eds), *The Transuranium Elements: Research Papers*, parts 1 and 11, vol 14B (1949), and G. T. Seaborg and J J. Katz, *The Actinide Elements*, vol 14A (1953) in the "National Nuclear Energy Series," Plutonium Project Record (G. T. Sc)

Summary of Isotopes of Transuranium Elements

Isotope	Half life	Radiations*
Neptunium		
Np_{231}	≈50 min	α
Np_{232}	≈12 min	EC
Np_{233}	35 min	EC, α
Np_{234}	4.40 days	EC, α
Np_{235}	420 days	EC, α
Np_{236}	22 hr	EC, β^-
Np_{237}	2 20 X10^6 yr	α
Np_{238}	2 10 days	β^-
Np_{239}	2 33 days	β^-
Np_{240}	7 5 min	β^-
Np_{241}	60 min	β^-
Plutonium		
Pu_{232}	36 min	EC, α
Pu_{234}	9 0 hr	EC, α
Pu_{236}	26 min	EC, α
Pu_{236}	2.7 yr	α
Pu_{237}	≈40 days	EC
Pu_{238}	90 yr	α
Pu_{239}	24,400 yr	α
Pu_{240}	6,600 yr	α
Pu_{241}	14 yr	β^-, α
Pu_{242}	5 X10^5 yr	α
Pu_{244}	5 0 hr	β^-
Americium		
Am_{237}	≈1 3 hr	EC, α
Am_{238}	2 1 hr.	EC
Am_{239}	12 hr.	EC, α
Am_{240}	50 hr	EC
Am_{241}	475 yr.	α
Am_{242}	≈100 yr.	β^-, α
Am_{242m}	16 0 hr.	β^-, EC, IT
Am_{243}	≈5000 yr.	α
Am_{244}	≈25 min	β^-
Curium		
Cm_{238}	≈2 5 hr	α
Cm_{239}	≈10 hr	EC
Cm_{240}	26 8 days	α
Cm_{241}	35 days	EC, α
Cm_{242}	162.5 days	α
Cm_{243}	≈100 yr.	α
Cm_{244}	≈10 yr.	α
Berkelium		
Bk_{243}	4 6 hr	EC, α
Bk_{244}	≈4 5 hr	EC
Bk_{245}	4-95 days	EC, α
Californium		
Cf_{244}	45 min.	α, EC?
Cf_{244}	35 ? hr.	α

*α, alpha particle, EC, electron capture; IT, isomeric transition; β^-, beta particle

TRANSVAAL, an inland province of the Union of South Africa between the Vaal and Limpopo rivers. It lies, roughly, between 22½° and 27½° S. and 25° and 32° E., and is bounded on the south by the Orange Free State and Natal, on the west by the Cape Province and the Bechuanaland protectorate, on the north by Rhodesia and on the east by Portuguese East Africa and Swaziland.

Save on the southwest the frontiers, for the main part, are well-defined natural features. From the southwest to the northeast corners the colony is 570 mi.; east to west its greatest extent is 397 mi. The total area is 110,450 sq.mi., a little less than the area of Great Britain and Ireland.

PHYSICAL FEATURES

About five-sixths of the country lies west of the Drakenberg (*q.v.*). The boundary of the Transvaal over against Portuguese East Africa runs along the Lebombo Range, between which and the Drakenberg is a belt of low country. The Lebombo hills approach within 35 mi. of the sea at Delagoa bay. The part of the plateau, east of Johannesburg, is from 5,000 to 6,400 ft. high; the western and somewhat larger half is generally below 5,000 ft. and sinks to about 4,000 ft. on the Bechuanaland border. This plateau land is called the high veld, and covers about 34,000 sq.mi. The northern edge of the plateau follows an irregular line from somewhat north of Mafeking on the west to the Mauchberg on the east. This edge is marked by ranges of hills such as the Witwatersrand, Witwatersberg and Magaliesberg; the Witwatersrand, which extends eastward to Johannesburg, forms the watershed between the rivers flowing to the Atlantic and Indian oceans. Farther north, beyond the intervening slopes and low bush, are two elevated regions covering together more than 4,000 sq mi. They are the Waterberg, and, more to the east, separated from the Waterberg by the valley of the Magalakwane tributary of the Limpopo, the Zoutpansberg. An eastern offshoot of the Zoutpansberg is known as the Murchison range The low land between the high veld and the Waterberg and Zoutpansberg is traversed by the Olifants river, an east flowing tributary of the Limpopo.

The true high veld, extending east to west 120 mi., and north to south 100 mi, consists of rolling grass-covered downs, absolutely treeless, save where, as at Johannesburg, plantations have been made by man, the crest of the rolls being known as *buits* and the hollows as *laagtes* The surface is occasionally broken by *kopjes*—either table-shaped or pointed—rising sometimes 100 ft. above the general level. Small springs of fresh water are frequent and there are several shallow lakes or pans—flat bottomed depressions with no outlet. The largest of these pans, Lake Chrissie, about 5 mi. long by 1 mi. broad, is the southeastern part of the high veld. The water in the pans is usually brackish. The middle veld is marked by long low stony ridges, known as rands, and these rands and the *kopjes* are often covered with scrub.

The banken veld, formed by the denudation of the plateau, is much broken up and is rich in romantic scenery. It covers about 27,000 sq.mi., and has an average breadth of 40 mi. In places, as between Mafeking and Johannesburg, the descent is in terrace-like steps, each step marked by a line of hills; in other places there is a gradual slope and elsewhere the descent is abrupt, with outlying hills and deep well-wooded valleys. The rocks at the base of the slopes are granite, the upper escarpments are of sedimentary rocks. Thence issue many streams which in their course to the ocean have cut their way across the ranges of hills which mark the steps in the plateau, forming the narrow passes or *poorts* characteristic of South African scenery.

As in the middle veld, rands and *kopjes* occur in the low or bush veld, but the general characteristic of this part of the country, which covers more than 50,000 sq mi, is its uniformity. The low veld east of the Drakenberg begins at about 3,000 ft above the sea and slopes to 1,000 ft or less until it meets the ridge of the Lebombo hills. The lowest point is at Komati Poort, a gorge through the Lebombo hills only 476 ft. above the sea. West and north of the Drakenberg the general level of the low veld is not much below that of the lowest altitudes of the middle veld, though the climatic conditions greatly differ. North of the Zoutpansberg the ground falls rapidly, however, to the Limpopo flats which are little more than 1,200 ft. above the sea. Near the northwest foot of the Zoutpansberg is the large saltpan from which the mountains get their name The low veld is everywhere covered with scrub, and water is scarce, the rivers being often dry in winter.

River Systems.—There are four separate river basins in the Transvaal. Of these the Komati (*q.v.*) and its affluents, and the Pongola and its affluents rise in the high veld and flowing eastward to the Indian Ocean drain but a comparatively small area of the province, of which the Pongola forms for some distance the southeastern frontier. The rest of the country is divided between the drainage areas of the Vaal and Limpopo. The absence of alluvial deposits of any size is a characteristic of the Transvaal rivers. For the climate of the Transvaal *see* SOUTH AFRICA, UNION OF

Vegetation.—Forest patches are confined to deep *kloofs*, to the valleys of the larger rivers and to the seaward slopes of the Drakenberg and other ranges, where they receive mists and rains from the moisture laden winds Many trees have been introduced and considerable plantations made, as for instance on the slopes between Johannesburg and Pretoria Among the most successful of the imported trees are citrus trees, the Australian wattle and the eucalyptus Grassland is the prevalent association in the province. (*See* SOUTH AFRICA, UNION OF)

Fauna.—When first entered by white men the Transvaal abounded in big game, the lion, leopard, elephant, giraffe, zebra and rhinoceros being very numerous, while the hippopotamus and crocodile were found in all the rivers. The indiscriminate destruction of these animals has greatly reduced their numbers Shooting is now restricted by legislation In the Pretoria Game reserve and in the Kruger National park shooting and hunting are absolutely prohibited. The latter was formed by the amalgamation of the Shingwedzi and Sabie reserves It covers more than 20,000 sq mi in the low country, and promises to be one of the finest nature reserves in the world

Insects abound, the greatest pest being the tsetse fly, common in the low veld. Six species of tick, including the blue tick common throughout South Africa, are found, especially in the low veld, where they are the means of the transmission of disease to cattle Mosquitoes, locusts and ants are also common.

Population.—The population in 1946 was 4,283,038 including 1,063,121 whites. A large proportion of these live on the Witwatersrand, on the coal field or in Pretoria. The natives in 1946 numbered 3,122,173. Apart from the large numbers employed in the gold and coal mines, the natives are found chiefly in the northern part of the province Basuto are numerous in the Zoutpansberg and Lydenburg districts. Bechuana are largely confined to the west and southwest Amazulu are found principally in the Wakkerstroom and Standerton districts, and Amaswazi in the Barberton, Ermelo and Wakkerstroom districts. Shangaan and other east coast tribes form an appreciable element in Barberton, Lydenburg and Zoutpansberg. Asiatics totalled 37,758 in 1946. They are largely engaged in trade, and are settled on the Witwatersrand, in Pretoria and Barberton. The number of mixed and others was 59,986 in 1946, including a few Hottentots and Koranna, who live chiefly in the southwest of the province. (*See* SOUTH AFRICA, UNION OF.)

Towns.—Pretoria is the administrative capital of the Transvaal, and of the Union of South Africa. The city of Johannesburg is the largest urban agglomeration in the Union. Germiston and Boksburg are virtually suburbs of Johannesburg. Among the other towns are Potchefstroom, Klerksdorp, Middelburg, Barberton, etc. (*See* separate articles.)

Mineral Resources.—The Transvaal, the principal gold producing country in the world, is noted for the abundance and variety of its mineral resources. The minerals chiefly mined besides gold are diamonds and coal, but the country possesses also platinum, silver, iron, copper, lead, cobalt, sulphur, saltpetre and many other mineral deposits.

Gold.—The principal gold-bearing reefs are found along the Witwatersrand ("The Rand"). Probably connected with the

Rand reefs are the gold-bearing rocks in the Klerksdorp, Potchefstroom and Venterskroon districts. Other auriferous reefs are found all along the eastern escarpment of the Drakenberg and are worked in the De Kaap (Barberton) district, on the Swaziland frontier, in the Lydenburg district, in the Murchison Range and in other places in the Zoutpansberg Gold fields also exist in the Waterberg and on the western frontier in the Marico district (the Malmani fields). Production of gold in 1941 amounted to 14,037,741 oz., with a value of £120,845,428; in 1942, to 14,120,617 oz., valued at £118,613,182. (*See also* SOUTH AFRICA, UNION OF *Economic Conditions*)

Diamonds.—The chief diamond fields are in the Pretoria district. The ground was discovered to be diamondiferous in 1897, but it was not until 1903, when mining began on the Premier mine, situated 20 mi northeast of Pretoria, that the wealth of the fields was proved. In June 1903 mining began and the diamonds found in the first five months realized over £90,000. On Jan. 27, 1905, the largest diamond in the world, weighing 3,025¾ carats, more than 1½ lb. avoirdupois, was found in the mine and named the Cullinan The Premier mine is of the same character as the diamond mines at Kimberley (*see* DIAMOND), and is considerably larger The area of the "pipe" containing blue ground is estimated at 350,000 sq yd. Besides the Pretoria fields there are diamondiferous areas (alluvial diggings) in the Bloemhof district on the Vaal river northeast of Kimberley, and in other regions. In 1940 the output of diamonds in the Transvaal had fallen to £229,439, as against £4,487,921 in 1926

Platinum.—In 1924, in the Lydenburg district, a bed of norite, an igneous rock in the Bushveld Igneous Complex, was found to contain platinum, the quantity varying from 2 to 5 pennyweight per ton. The outcrop of this bed has been traced for about 60 miles. In 1925 platinum bearing rocks were recognized near Potgietersrust. The Bushveld norite has also been traced in the Rustenberg area for about 100 mi. The production of platinum in 1940 was £397,081.

Coal and Other Minerals.—There are extensive beds of good coal, including thick seams of steam coal near the Rand and other gold fields. Coal appears to have been first discovered in the neighbourhood of Bronkhorst Spruit between the Wilge and Olifants rivers, where it was so near the surface that farmers dug it up for their own use.

In 1887 coal was found at Boksburg in the East Rand, and a mine was at once started. The principal collieries are those at Boksburg and at Brakpan, also on the East Rand, with a coal area of 2,400 acres; at Vereeniging and Klerksdorp, near the Vaal, at Watervaal, 12 mi. north of Pretoria, and in the Middelburg district, which in 1945 supplied most of the coal used by the gold mines. Like that of Natal the Transvaal coal burns with a clear flame and leaves little ash The mines are free from gas and fire damp and none is more than 500 ft. deep. The output in 1940 was 14,646,902 short tons.

Iron and copper are widely distributed. The Yzerberg near Marabastad in the Zoutpansberg consists of exceedingly rich iron ore, which has been smelted by the natives for many centuries. Silver is found in many districts, and mines near Pretoria have yielded in one year ore worth £30,000. Salt is obtainable from the many pans on the plateaus, notably in the Zout (salt) pansberg, and was formerly manufactured in considerable quantities.

Agriculture.—Next to mining, agriculture is the most important industry. The chief occupation of the majority of the white farmers is stock raising. The high veld is admirably adapted for the raising of stock, its grasses being of excellent quality and the climate good. Even better pasture is found in the low veld, but there stock suffers in summer from many endemic diseases, and in the more northerly regions is subject to the attack of the tsetse fly. The banken veld is also unsuited in summer for horses and sheep, though cattle thrive Much of the stock is moved from the lower to the higher regions according to the season. Among the high veld farmers breeding of merino sheep is popular. In 1939 there were 3,373,846 cattle; 4,041,446 sheep and 916,838 goats in the province, excluding those in villages and towns.

The amount of land under cultivation is very small in comparison with the area of the province. The small proportion of land tilled is due to many causes, among which paucity of population is not the least Moreover while large areas on the high veld are suitable for the raising of crops of a very varied character, in other districts, including a great part of the low veld, arable farming is impossible or unprofitable. Many regions suffer permanently from deficient rainfall, in others, owing to the absence of irrigation works, the water supply is lost, while the burning of the grass at the end of summer, a practice adopted by many farmers, tends to impoverish the soil and render it arid The country suffers also from periods of excessive heat and general drought, while locusts used to sweep over the land, devouring every green thing. In some seasons the locusts, both red and brown, come in enormous swarms covering an area of 5 mi. broad and from 40 to 60 mi. long. The chief method employed for their destruction is spraying the swarms with arsenic The districts with the greatest area under cultivation are Heidelberg, Witwatersrand, Pretoria, Standerton and Krugersdorp. The chief crops grown for grain are maize (mealie), kafir corn and wheat (*See* SOUTH AFRICA, UNION OF) Maize is the staple food of the natives. Oats, barley and millet are largely grown for forage. Oats are cut shortly before reaching maturity, when they are known as oat-hay The chief vegetables grown are potatoes, pumpkins, carrots, onions and tomatoes. Fruit farming is a growing industry on the slopes of the plateaus and in the warmer valleys, where citrus and other subtropical fruits thrive, as, for example, about Rustenberg, Waterberg, etc. In 1925 there were nearly 2,000,000 orange trees in the province, mostly navel oranges. Grapefruit trees numbered about 27,000, peach trees 33,000, and apple trees nearly 200,000. Apples, and, to some extent peaches thrive better in the higher districts. These figures refer to trees, the fruit of which is mostly grown for export.

Cotton growing has made little progress The number of acres under this crop in 1919–20 was 6,932: in 1936–37 the number of acres was 6,087. Cotton grows well in the western part of the Transvaal, north of the Magaliesberg Range, and in the low veld of the north and east, where frost is absent for six or seven months Tobacco is grown in the Magaliesberg area, and about Potchefstroom, the cultivation of more than 36,179 ac in 1938–39 yielding 14,970,518 lb. of tobacco.

There was a marked increase in manufacturing before and during World War II. In the Transvaal province, the number of manufacturing establishments increased from 3,159 in 1933–34 to 3,835 in 1938–39, with a twofold increase in the net value of the total output. Large-scale production of iron and steel commenced early in 1934, and is carried on at Vereeniging and Pretoria.

Provincial Government.—At the head of the executive is a provincial administrator, appointed by the governor-general-in-council. He holds office for five years, and is assisted by an executive committee of four members elected by the provincial council consisting of 50 members, elected for the same constituencies and by the same electorate as are the members of the house of assembly. The provincial council, which has strictly local powers, sits for a statutory period of three years.

Provincial revenues in 1941 were £6,795,426, including a Union government subsidy of £2,235,061. Expenditure was £6,391,477 of which £3,769,221 was for education.

Education.—After 1910 education, other than elementary, is under the control of the provincial council At the head of the permanent staff is the director of education. The province is divided into 31 school districts, in each of which is a school board, consisting partly of elected and partly of nominated members: its functions are advisory. Both primary and secondary education are free Attendance is compulsory for European children between the ages of 7 and 15. The age limit has been raised to 16 in 27 of the school districts. Religious teaching is confined to the undenominational instruction in Bible history. In 1941 there were more than 859 state schools for Europeans, with 156,671 pupils, and 984 for non-Europeans, with 161,541 pupils. Many schools are also directed by missionary bodies. (*See also* SOUTH AFRICA, UNION OF.) (F. R. C.; R. U. S.; P. W. I.)

HISTORY

At the beginning of the 19th century the country now known as the Transvaal was inhabited, apparently somewhat sparsely, by Bavenda and other Bantu Negroes, and in the southwest by wandering Bushmen and Hottentots. About 1817 the country was invaded by the chieftain Mosilikatze and his impis, who were fleeing from the vengeance of Chaka, king of the Zulus. The inhabitants were unable to withstand the attacks of the disciplined Zulu warriors—or Matabele, as they were henceforth called—by whom large areas of central and western Transvaal were swept bare. The remnants of the Bavenda retreated north to the Waterberg and Zoutpansberg, while Mosilikatze made his chief kraal at Mosega, not far from the site of the town of Zeerust, and near the Bechuana border. At that time the region between the Vaal and Limpopo was scarcely known to Europeans. In 1829, however, Mosilikatze was visited at Mosega by the celebrated missionary to the Bechuana, Robert Moffat, and between that date and 1836 a few British traders and explorers visited the country and made known its principal features. Such was the situation when Boer emigrants first crossed the Vaal

FOUNDATION OF THE REPUBLIC

As shown elsewhere (*see* SOUTH AFRICA, UNION OF and CAPE PROVINCE) the *voortrekkers* had an intense desire to be rid of British control, and to be allowed to set up independent communities and govern the natives in such fashion as they saw fit. The first party to cross the Vaal consisted of 98 persons under the leadership of Louis Trichard and Jan van Rensburg. They left Cape Colony in 1835 and trekked to the Zoutpansberg. Here Rensburg's party separated from the others, but were soon afterwards murdered by natives. Trichard's party determined to examine the country between the Zoutpansberg and Delagoa bay. Fever carried off several of their number, and it was not until 1838 that the survivors reached the coast. Eventually they proceeded by boat to Natal. Meantime, in 1836, another party of farmers under Andries Hendrik Potgieter had established their headquarters on the banks of the Vet river. Potgieter and some companions followed the trail of Trichard's party as far as the Zoutpansberg, where they were shown gold workings by the natives and saw rings of gold made by native workmen. They also ascertained that a trade between the natives and the Portuguese at Delagoa bay already existed. On returning to the Vet, Potgieter learned that a hunting party of Boers which had crossed the Vaal had been attacked by the Matabele, who had also killed Boer women and children. This act led to reprisals, and on Jan. 17, 1837, a Boer commando surprised Mosilikatze's encampment at Mosega, inflicting heavy loss on the Matabele without themselves losing a man—for the Boers had, and the Matabele had not, firearms. In November of the same year Mosilikatze suffered further heavy losses at the hands of the Boers, and early in 1838 he fled north beyond the Limpopo, never to return. Potgieter, after the flight of the Matabele, issued a proclamation in which he declared the country which Mosilikatze had abandoned forfeited to the emigrant farmers. After the Matabele peril had been removed, many farmers trekked across the Vaal and occupied parts of the district left derelict. Into these depopulated areas there was also a considerable immigration of Basuto, Bechuana and other Bantu tribes.

The first permanent white settlement north of the Vaal was made in Nov. 1838 by Potgieter and some followers who settled on the banks of the Mooi river and founded the town of Potchefstroom. The next settlement appears to have been in the Magaliesberg, where Rustenburg was founded At that time the emigrant farmers had set up the republic of Natal; in 1840 Potgieter's party entered into a loose alliance with the Natal Boers and with those at Winburg, north of the Orange In this alliance Natal had the leadership; but in 1843 the British annexed Natal and in the following years many burghers left that country, recrossed the Drakenberg, and set up an independent government in the Transvaal. Dissensions among the immigrants broke out almost at once and in 1845 Potgieter, with a considerable number of Potchefstroom burghers and some from Winburg migrated northeast towards Delagoa bay, where Potgieter made a treaty with the Portuguese. A spot on the inner slopes of the Drakenberg was chosen as headquarters and there was built the village of Andries Ohrigstad It proved fever-ridden and was abandoned, a new village being laid out on higher ground and named Lydenburg by the farmers in memory of their sufferings at Ohrigstad. Other emigrants settled in the Potchefstroom district and in 1848 Andries Pretorius (*q v*) became their leader. Pretorius, in the middle of that year, had fought unavailingly against the establishment of British sovereignty by Sir Henry Smith (*q v*) between the Orange and the Vaal. The Transvaal thus became the refuge of the most irreconcilable to British rule of the Boer farmers—who were, however, much more pastoralists than agriculturalists.

Sand River Convention.—Pretorius persuaded the more responsible farmers to agree to one *volksraad* for the whole country, but Potgieter, by nature a dictator, would not agree and he and his friends removed from Lydenburg farther north to the Zoutpansberg. However the British Government abandoned its claim to regard all the emigrant farmers beyond the Vaal as British subjects. Commissioners sent to the Orange Sovereignty opened negotiations with Pretorius and on Jan. 17, 1852, a convention was signed at a farm by the Sand river, in the Orange Sovereignty, acknowledging the independence of the Transvaal without regard to the divisions among the Boers The first article of the Sand River Convention was as follows:—

> The assistant commissioners guarantee in the fullest manner, on the part of the British Government, to the emigrant farmers beyond the Vaal river, the right to manage their own affairs, and to govern themselves according to their own laws, without any interference on the part of the British Government, and that no encroachment shall be made by the said Government on the territory beyond to the north of the Vaal river, with the further assurance that the warmest wish of the British Government is to promote peace, free trade, and friendly intercourse with the emigrant farmers now inhabiting, or who hereafter may inhabit, that country; it being understood that this system of non-interference is binding upon both parties.

At this time there were settled north of the Vaal about 5,000 families of European extraction. They had obtained independence, but as has been shown they were far from being a united people When Pretorius conducted the negotiations which led to the signing of the Sand River Convention, though he had the support of the Rustenburg and Lydenburg districts, he did so without consulting the *volksraad*, and Potgieter's party accused him of usurping power and aiming at domination over the whole country. However, the *volksraad*, at a meeting held at Rustenburg on March 16, 1852, ratified the convention, Potgieter and Pretorius having been publicly reconciled on the morning of the same day Both leaders were near the end of their careers; Potgieter died in March and Pretorius in July 1853.

The Constitution.—Upon the death of Andries Pretorius his son Marthinius was (Aug. 1853) elected commandant-general of the Potchefstroom and Rustenburg districts; he had been in office little more than six months when the Orange Sovereignty was abandoned by the British and the Orange Free State as an independent republic took its place. Marthinius Pretorius was a man of large ideas and he worked for the union of the Boer States First he had to start with his own country. In 1855 the town of Pretoria was founded and the Pretoria district created; in 1856 the burghers of Potchefstroom, Rustenburg and Pretoria united to form "the South African Republic." The title was chosen, a national flag (the *Vierkleur*) adopted and the constitution (*grondwet*) elaborated at a special session of delegates held in December at Potchefstroom. It was decided that Pretoria should be the capital of the State. The legislative power was given to a *volksraad*, elected by the burghers (that is the franchise was confined to white men); the administration was entrusted to a president aided by an executive council which included a popularly elected commandant-general. Members both of the *volksraad* and council were to be of European blood and members of the Dutch Reformed Church. A high court of justice separate from the *volksraad* was instituted. The constitution further expressly declared that no equality of coloured people with the white inhabitants would be tolerated either in Church or State. Paul Kruger, then a

man of 30 and leader of the Rustenburg burghers, took a leading part in framing the constitution.

The Civil "War."—At the time both Lydenburg and Zoutpansberg repudiated the authority of the South African Republic of which, as a matter of course, Pretorius was elected president (Jan 1857). The same year Pretorius, with Kruger's aid, tried unsuccessfully, by means of an armed raid, to compel the Free State to join the S.A.R. Pretorius nevertheless retained many supporters in that State Not long afterwards the efforts of the British high commissioner, Sir George Grey, for a federation of all the South African states came to nothing Pretorius now secured the incorporation of Lydenburg and Zoutpansberg in the S.A.R. A vacancy occurring in the presidency of the Free State, Pretorius was elected. He went to Bloemfontein with the fixed object of uniting the two Boer republics He found, however, discontent in the Free State, a depleted treasury and much trouble with the Basutos. Moreover the British authorities frowned on proposals for the union of the O.F.S. and the S.A.R. Old rivalries broke out in the Transvaal, and the country presented the spectacle of two rival presidents, or acting presidents, and two rival Governments. This in turn led to a sort of civil war, though without actual fighting. There was a "bombardment" of Potchefstroom —with one gun—by Paul Kruger and on that occasion three lives were lost and a few burghers wounded In this conflict Kruger supported the side which he held to be the legal government and called his force the army of the State (*staatsleger*). Pretorius intervened more than once; at last in April 1863 he resigned his presidency of the Free State, but in the Transvaal a new election resulted (Oct. 1863) in the return of W. J. C. van Rensburg as president (Rensburg had been one of the acting-presidents since April 1862; his rival being Stephanus Schoeman, the Zoutpansberg commandant-general, a son-in-law of Potgieter). The Pretorius party declared van Rensburg improperly elected and brought their *volksleger* (people's army) into the field under Com. J. Viljoen Kruger called out his *staatsleger* and seeing that he was being outmanoeuvred determined to fight in earnest. "He shot to kill and ended the civil war" (Walker's *History of South Africa*). The parties now in fact came to terms; a new election was held and this time Pretorius was returned at the head of the poll, while Kruger became commandant-general. On May 10, 1864, Pretorius took up the presidency again. In February John Brand had become president of the Free State and he succeeded in making it a model commonwealth. Pretorius lacked the ability and solidity which distinguished Brand and he had even more intractable human material with which to deal.

Church Controversies: the Doppers.—Political dissension had been accompanied by ecclesiastical strife Practically all the burghers were members of the Dutch Reformed Church, but the Cape synod of that Church had disapproved the *trek* and the emigrants had been left almost without ministers. They were, however, deeply religious in a narrow Calvinistic fashion, and in all their settlements built a church even though without a minister. Their literature was almost confined to the Bible; many of them looked upon themselves as the chosen people on a new pilgrimage, so that church affairs filled an important part in their lives. After much controversy it was decided in 1853 that there should be no incorporation of the Transvaal churches with the Cape Synod; for one thing the Transvaalers objected to the legal equality of blacks with whites permitted in the colonial churches.

In 1858–59 another cause of dissension arose. There was already in some strength among the burghers the sect of Doppers, who contended that while hymns were good spiritual aids in private devotion, they should not be sung in church, not being (like the psalms) part of holy scripture. In 1858 the Rev. D. Postma, of the Separatist Reformed Church of Zwolle, Holland, became minister at Rustenburg and at once gained the support of all the Doppers. At a general assembly at Pretoria in Jan. 1859 Postma refused to use hymns, and Kruger and other laymen gave notice that they had left the *Hervormde Kerk* (the Dutch Reformed Church) and proposed to form a new church. Efforts at compromise failed and later in the year the Separatist (Dopper) Church was formed. Its official title is *Christlijh Afgeschiedene Gereformeerde Kerk*. During the civil war Kruger got the constitution altered so that a member of any Reformed Church might hold full political rights.

From the first, whatever their internal dissension, the Transvaal Boers had vast territorial ambitions; at an early stage they even put forward a claim to all the land north of the Vaal from ocean to ocean, and they repeatedly and persistently tried to get an outlet to the sea. One of their earliest claims, made a few weeks after the signing of the Sand River Convention, was to the land of the Bechuana, and Andries Pretorius asked the British to close the "lower road," that is the route to the far interior opened up originally by the missionaries, Moffat and Livingstone This request was followed (Aug. 1852) by a raid on the Bakwena Bechuana—who were said to be harbouring a chief who had looted Boer cattle. In this "punitive expedition" Livingstone's house at Kolobeng was *looted*, and some 200 to 300 women and children carried off by the Boers. The struggle for Bechuanaland thus begun lasted for nearly 40 years, ending in the discomfiture of the Boers (*see* BECHUANALAND).

The Slavery Charge.—The action of the commandos against the Bakwena brought against the Boers the charge of slavery, and the apprentice law passed by the *volksraad* in 1856, it was alleged, practically legalized slavery. It must be remembered that when the Boers first emigrated to the Transvaal, slavery had been but recently abolished in Cape Colony; Potgieter and others of the *voortrekkers* may have been slave-owners, but slavery as such was not recognized in the Transvaal. The organized native tribes with whom they had dealings were usually required to produce a "labour tax" in kind; that is, the chief had to furnish labourers to perform specific work. There was no great hardship in this. But many farmers on the borders of the old Cape Colony had had a habit of kidnapping Bushmen children and others and "apprenticing" them together with other apprentices obtained in a more legitimate fashion. This reprehensible habit persisted among the Boers in the Transvaal—among whom were many bad characters who had no claim to be farmers and who were not all of Dutch blood. The apprentice system was in existence in other parts of South Africa, and almost inevitably led to abuses. The Apprentice Law of 1856 in the Transvaal was an effort to mend matters. It provided safeguards against misuse of power; that it had to be repeated three or four times showed how its provisions were disregarded. The apprentices were usually small children, exchanged for goods by their parents "picked up starving" on the veld, "orphans" (a plentiful supply), young persons obtained from tribes fighting one another; children, in short, obtained in any fashion; in 1864 Marthinius Pretorius is reported as asking the landdrost of Zoutpansberg to buy him half-a-dozen little Kafirs at a time when the Swazis were raiding. The worst feature of the system was that there was a regular traffic in apprentices. This practice, forbidden by the law, made of apprentices goods and chattels. Thus the charge of practising virtual slavery was justified. Towards the natives in general the Transvaalers adopted an attitude of modified indifference; they had their locations and could manage their own tribal affairs as long as they provided the farmers with the needed labour; missionaries among them were tolerated; but the Boers made no attempt to produce a civilized class of African. But they adopted very stern measures against misdoers. Thus in 1854 to avenge the murder of a party of Boers (including women and children) M. Pretorius led a commando against the chief Makapan, many of whose people, who had taken refuge in caverns, were smoked or starved to death and many others shot while attempting to escape. This chastisement kept the tribes quiet for years.

When in 1864 M. Pretorius again became president the Transvaal was suffering from the depression which at that time affected the whole of South Africa, and it had trouble with the Zulus, with the Bechuana, and with the powerful tribes in the Zoutpansberg. Schoemansdal (named after Com-gen. Schoeman) in the Zoutpansberg, was then the most important settlement of the district. In 1867 Schoemansdal and a considerable portion of the district were abandoned on the advice of commandant-gen-

eral Kruger, and Schoemansdal was burnt to ashes by natives. It was not until 1869 that peace was patched up, and the settlement arrived at left the mountain tribes in practical independence.

Meanwhile the public credit and finances of the Transvaal had gone from bad to worse. The paper notes, issued since 1865, had been constituted by law legal tender for all debts, but in 1868 their power of purchase was only 30% compared with that of gold, and by 1870 it had fallen as low as 25%. Civil servants, who were paid in this depreciated scrip, suffered considerable distress. The revenue for 1869 was stated as £31,511; the expenditure at £30,836.

Territorial Disputes.—While the situation was very sombre there came the discovery of diamonds in Griqualand and of gold at Tati, and again the claims of the Transvaal to territorial expansion were put forward. Following the discoveries at Tati, Pretorius, in April 1868, issued a proclamation extending the Transvaal frontiers on the west and north so as to embrace the gold field and all Bechuanaland. The same proclamation extended Transvaal territory on the east so as to include part of Delagoa bay. The eastern extension claimed by Pretorius was the direct sequel to endeavours made shortly before by a Scotsman from Natal (Alex. McCorkindale) to develop trade along the Maputa river. But it was also part of the old desire of the Transvaal Boers to obtain a seaport, a desire which had led them as early as 1860 to treat with the Zulus for the possession of St. Lucia bay. That effort had, however, failed And now the proclamation of Pretorius was followed by protests on the part of the British high commissioner, Sir Philip Wodehouse, as well as on the part of the consul-general for Portugal in South Africa. The boundary on the east was settled by a treaty with Portugal in 1869, the Boers abandoning their claim to Delagoa bay; that on the west was dealt with, partially, in 1871.

Disputes on the Bechuana border had been constant; they became again prominent by the discovery of alluvial diamonds in the strip of land between the Vaal and Harts rivers, to the sovereignty of which there were rival claims A little later the famous dry diggings on the De Beer and other farms were discovered. They were south of the Vaal and to them the Orange Free State laid claim. But there was a rival claimant in the Griqua chief, Nicholas Waterboer, and since 1862 the Griqua claims had been urged by his agent David Arnot, a clever Cape Colony attorney, who in the end bluffed all his opponents The various claims including those of the Barolong Bechuana to land north of the Vaal where, as at Bloembof, Transvaal authority was in fact exercised, were submitted to the arbitration of R. W. Keate, lieutenant-governor of Natal. His award was made in Oct. 1871, and was admittedly just on the evidence produced. It gave Waterboer all he claimed—though he had no title whatever to the diamond fields—and the Barolong, an area which the Transvaal actually held. Now Waterboer, before the arbitration court met, had offered his territory to Great Britain and it was known to all the parties that the offer would be accepted. Accordingly a few days after the publication of the Keate award, Sir Henry Barkly, the high commissioner, took over as British territory Waterboer's land (*see* GRIQUALAND EAST AND GRIQUALAND WEST). This included the triangular piece of land above the confluence of the Vaal and Harts rivers, in which diamonds had first been found. As to the land awarded to the Barolong, no steps were taken to enforce the Keate award; the Transvaal Boers remained in possession of Bloemhof and all the farms they held, and disputes with the Bechuana continued.

President Burgers.—The award caused a strong feeling of resentment among the Transvaal burghers and led to the resignation of President Pretorius and most of his executive. The burghers now cast about to find a man who should have the necessary ability, as they said, to negotiate on equal terms with the British authorities should any future dispute arise. They asked President Brand of the Free State if he would come over and rule them. Brand declined, telling the Transvaalers—greatly perturbed though he was by the loss of the Kimberley diamond fields—that their true interests lay in friendship with, not in hostility to, Great Britain and the British. Having failed with Brand, the Boers invited the Rev. Thomas François Burgers, a member of a well-known Cape Colony family and a minister of the Dutch Reformed Church known to be of "liberal" views in theological matters, to allow himself to be nominated. Burgers accepted the offer, and in 1872 was elected president. About this time gold reefs were discovered in the Zoutpansberg district near Marabastad, and a few gold seekers from Europe and Cape Colony began to prospect the northern portions of the Transvaal. The miners and prospectors did not, however, exceed a few hundred for several years.

Burgers was able, active, enlightened and impulsive; a visionary rather than a man of affairs or sound judgment. He foresaw a great future for the country, but he neglected practical steps to ensure ordered progress; he took up, with all its entanglements, the policy of intrigues with native chiefs beyond the border, and was unable to control the tribes within the border. He held firmly to the belief in having an outlet to the sea free from British control, and in 1875 proceeded to Europe with the project of raising a loan for the construction of a railway to Delagoa bay, though no survey for a railway had been made. He was empowered by the *volksraad* to raise £300,000, but with great difficulty he obtained in Holland the sum of £90,000 only, and that at a high rate of interest. With this inadequate sum some railway plant was obtained, which subsequently lay derelict for ten years at Delagoa bay While in Europe, Burgers visited France and Germany, and found in the latter country an awakening interest in South Africa; it was the period of the first stirrings of a colonial policy in Germany. On his return to the Transvaal in 1876 Burgers found that the condition of affairs in the State was worse than ever. The acting-president had in his absence been granted leave by the *volksraad* to carry out various measures opposed to the public welfare; native lands had been indiscriminately allotted to adventurers, and a war with Sikukuni (Secocoeni), a native chief on the eastern borders of the country, was imminent. A *commando* was called out, which the president himself led. The expedition was an ignominious failure, and many burghers did not hesitate to assign their non-success to the fact that Burgers' views on religious questions were not sound Indeed a party of Boers—some 300—had trekked across the Kalahari into Angola largely because they disliked the rule of a heretical *predikant*. Burgers then proceeded to levy taxes, which were never paid; and to enrol troops, which never marched. The Transvaal was in a bad way; financially it was well-nigh bankrupt.

FIRST ANNEXATION BY GREAT BRITAIN

It was in conditions such as these that the British secretary of state for the colonies, the 4th earl of Carnarvon, launched his scheme for the confederation of the various South African states and colonies The story is told elsewhere (*see* SOUTH AFRICA, UNION OF) In the Transvaal the agent selected to carry out Lord Carnarvon's policy was Sir Theophilus Shepstone (*q.v.*), the chief of the native affairs department in Natal, a man with a profound knowledge of the mind of the Negroes of South East Africa, and also with a considerable knowledge of Boer mentality. He was in London in 1876 and was then given a dormant commission dated Oct. 5, 1876, instructing him to visit the Transvaal and empowering him, if it was desired by the inhabitants and in his judgment necessary, to annex the country to the British crown Sir Theophilus went to Pretoria in Jan. 1877, with an escort of 25 mounted police, and entered into conferences with the president and executive as to the state of the country. Federation plans were being considered in Cape Colony and Natal and in the Free State; there was also a party in the Transvaal in favour of union. One of the chief difficulties was the different conception of native policy held in the various colonies and states; and the treatment of the natives in the Transvaal caused grave concern to its neighbours. The impetus for federation, however, came from without, and the *volksraad*, after having Carnarvon's proposals put before it, rejected them.

When the *volksraad* realized that Shepstone was about to take a decisive step it hurriedly passed a number of reforms, but this

kind of insincere death-bed repentance was useless. On April 12, 1877, Shepstone issued a proclamation annexing the South African Republic to the British Crown. There were protests, some purely formal, others expressing indignation truly felt, but there was no active opposition and a considerable number of the town dwellers welcomed annexation.

Shepstone had given assurances that it was the wish of the British Government that the Transvaal "shall enjoy the fullest legislative privileges compatible with the circumstances of the country and the intelligence of its people." But he did little to substitute anything better for the Government he had found in office, a Government he had characterized as "a thorough sham." Nevertheless he had done something by the abolition of obnoxious taxes while public credit was restored (in the last days of Burgers the Transvaal £1 notes were worth only 1s.). Moreover the continuance of the apprentice system—not of the traffic in apprentices—with Shepstone's approval and aid, did not, at least, alienate Boer opinion. The true hindrance to acceptance by the Boers of British rule was the failure to redeem the pledge to grant the Transvaal "the fullest legislative privileges." Shepstone at the outset had wanted to summon the *volksraad* (May 1877), but here he met with opposition from the high commissioner, Sir Bartle Frere, who had himself ideas as to what the new constitution should be and wished to consult leading burghers on the matter.

The Agitation for Retrocession.—That the British annexation at first caused no grave discontent may be inferred by the retention of office by all the members of Burgers' executive council except Piet Joubert, "the irreconcilable." The rest, including Paul Kruger and Dr. E. J. P. Jorissen (a Hollander brought out by Burgers) kept their posts and drew their salaries as British officials. In accordance with a last resolution of the *volksraad*, Kruger, who was accompanied half-heartedly by Jorissen, was given leave to go to London, where he was told by Carnarvon that the act of annexation was irrevocable, but was promised concession in the matter of local government, including the use of Dutch. Kruger and Jorissen in turn promised to endeavour to "promote a feeling of satisfaction"; showed some anxiety to continue in government employment and after a visit to the Continent returned home. This was in Jan. 1878, and they found that in the Transvaal the phase of acquiescence in annexation was rapidly passing, for reasons already indicated. Another deputation to London was decided upon, Kruger on this occasion being accompanied by Piet Joubert Before Kruger left Pretoria Shepstone dismissed him from office, holding that it was not the place of an official to be endeavouring to overthrow the Government in whose service he was. This deputation spent some months in England (July–Oct. 1878) but failed to get satisfaction Carnarvon's federation scheme was moribund and he himself had been succeeded at the Colonial Office by Sir Michael Hicks Beach. Sir Michael told the deputation indeed (despatch of Sept. 16, 1878) that the cabinet intended to grant the Transvaal "to the utmost practical extent its individuality and powers of self-government," but not independence. On their way back to the Transvaal Kruger and Joubert met the high commissioner in Natal. Frere endorsed Hicks Beach's promise of self-government for the Transvaal, and the Boer leaders (both competent men on the question) gave Frere sound advice in regard to the war with the Zulus then impending. That war began in Jan. 1879 and soon there came the disaster of Isandhlwana. Discontent with British rule in the Transvaal was by this time marked; advocates of extreme Dutch Affikanderdom went so far as to consider it meritorious of the Transvaal burghers to refrain from helping the Zulus against the British.

Shepstone was now replaced by Col. Owen Lanyon, administrator of Griqualand West, an able, active man, but not *persona grata* to the Boers. Then in April 1879 Frere himself visited the Transvaal; and found assembled to meet him on the road to Pretoria an armed commando of recalcitrant Boers who had established a *laager* and looked threatening. Frere induced them to disperse; he set Lanyon to work to effect real reforms. And again he repeated the assurances that the Transvaal would be granted home rule. Just at this time however Frere received news that he had been censured for his Zulu policy by the home Government (the Disraeli cabinet), and he returned to Capetown. As high commissioner for South-East Africa he was succeeded by Sir Garnet Wolseley. The Zulu War ended, Wolseley in Sept. 1879 came to Pretoria and told the malcontent Boers (by this time the majority of the burghers) in grandiose words that the sun would forget to shine and the Vaal flow backwards sooner than the British flag would cease to fly over the Transvaal. Wolseley gave the country relief in one direction; he reduced to submission (Dec. 1879) Sikukuni (Secocoeni), a chief who had long giver the Transvaal trouble. Instead of granting a liberal constitution he mocked the Boers' hopes by setting up (March 1880) a nominated legislative council. In May 1880 Wolseley returned home.

Meanwhile events in Great Britain had taken a turn which gave encouragement to the Boers. Gladstone became prime minister and on being directly appealed to by Kruger and Joubert, he replied that the liberty which they sought to manage their own affairs, and which it was the desire of the British Government they should possess, might be "most easily and promptly conceded to the Transvaal as a member of a South African Confederation." That was in June 1880.

The Majuba Campaign.—In November matters were brought to a head by the wagons of a farmer named Bezuidenhout being seized in respect of the nonpayment of taxes, and promptly retaken from the sheriff by a party of Boers. Lanyon began to recognize that the position was becoming grave, and telegraphed to Sir George Colley, the high commissioner of South-East Africa, for military aid. This, however, was not immediately available, and on Dec. 13 the Boers in public meeting at Paardekraal resolved once more to proclaim the South African Republic, and in the meantime to appoint a triumvirate, consisting of Kruger, Pretorius and Joubert, as a provisional government. Formal proclamation of the republic was made on Dec. 16 (Dingaan's day) at Heidelberg. Hostilities forthwith began. The first shots fired were outside Potchefstroom, which was then occupied by a small British garrison. On Dec. 20, about 240 men under Col. Anstruther, chiefly belonging to the 94th regiment, while marching from Lydenburg to Pretoria, were surprised at Bronkhorst Spruit, and cut up by the Boer forces. Pretoria, Rustenberg, Lydenburg and other smaller towns had been placed in a position of defense under the directions of Col. Bellairs. Sir George Colley, with 1,400 men, marched towards the Transvaal frontier, but before reaching it he found, on Jan. 24, 1881, that the Boers had already invaded Natal and occupied Laing's Nek. He pitched his camp at Ingogo Having been defeated at Laing's Nek, and suffered considerable loss in an engagement near Ingogo, Colley took a force to the top of Majuba, a mountain overlooking the Boer camp and the Nek. He went up during the night, and in the morning was attacked and overwhelmed by the Boers (Feb. 27). Of the 554 men who constituted the British force on Majuba, 92 (including Sir George Colley) were killed and 134 wounded.

For a considerable time before hostilities began efforts had been made in South Africa to adjust the differences between the Transvaalers and the British, notably by President Brand of the O F.S. Early in December Brand sent an urgent warning to Capetown, which reached London only three weeks later and was disregarded. At the opening of parliament on Jan. 6, 1881, the queen's speech spoke of the duty of vindicating her majesty's authority; on Jan. 26 the first intimation was made—to Capetown, not to Colley—that the British government was prepared to negotiate. It was not until the day of the reverse at Ingogo (Feb 8) that Colley was told of the negotiations. Kruger only received the day after Majuba a despatch from Colley of Feb 21, stating that on the Boers ceasing armed opposition, the British Government would be prepared to appoint a commission with large powers. Kruger's reply, construed as a virtual acceptance of the British offer, did not reach Sir Evelyn Wood (Colley's successor) until March 7; the previous day a truce had been arranged. These negotiations were kept entirely from the knowledge of the British people, who only knew that Sir Frederick Roberts and 10,000 men had been ordered out to South

Africa. When they learned that negotiations for peace were proceeding without an attempt to "avenge" Majuba there was great indignation. Gladstone insisted that that incident should not be allowed to interrupt negotiations The fact remains that it was only after the British arms had suffered reverses that the British cabinet opened negotiations. Alike by the Boers and by the "loyalists" in South Africa the peace shortly afterwards concluded was regarded as a British surrender The bitterness felt by the British over their "betrayal" was intense; so intense that it turned to hatred in many cases Nor would it be easy to exaggerate the feeling of disgust felt by the Natalians over Gladstone's action Nevertheless in view of the "loitering unwisdom" shown by the British almost from the day of annexation the retrocession of the Transvaal was the proper end of the episode

A convention signed at Pretoria on Aug. 3, 1881, regulated the new relations between the Transvaal and the British Government. The Boers were granted internal self-government, but British suzerainty was explicitly maintained; a British Resident was appointed to Pretoria; the country was to be called the Transvaal State, the frontiers (for the first time) were defined. In drawing up the convention Wood had as colleagues Sir Hercules Robinson (the new high commissioner) and Chief Justice de Villiers, of the Cape bench, an Afrikander who, like President Brand, had done much to keep in check Dutch feeling in South Africa generally The government of the Transvaal was handed over to the Boer triumvirate on Aug 8; it was continued in their name until May 1883 when Kruger was elected president—an office he held until the Transvaal again lost its independence.

FROM RETROCESSION TO THE SOUTH AFRICAN WAR

The Transvaal in 1881 was in a much better condition than in 1877; in material matters the retrocession conditions much favoured the Boers. And a new commercial era was dawning. But the burghers were dissatisfied with the limitations of the Pretoria Convention; nor did they keep its terms. Especially they encroached once again on Bechuanaland, where they set up the so-styled republics of Stellaland and Goshen. Kruger, in reply to remonstrances, described this as an "irresponsible" movement for expansion, came again to London (Nov. 1883) and with the 15th earl of Derby, then secretary of State for the colonies, concluded another agreement known as the London Convention It was signed on Feb. 27, 1884, being the third anniversary of the fight at Majuba. The London Convention neither denied nor affirmed British suzerainty—Lord Derby maintained that he had preserved the substance if not the word—but limits were still imposed on complete independence. The State was permitted again to call itself the South African Republic; but it bound itself not to extend its borders, which were once again strictly defined; to allow freedom of trade, travel and residence to "all persons" other than natives, not to impose any taxes, local or general, upon foreigners other than those imposed on citizens of the republic (this to apply to the persons, property, commerce and industry of such foreigners) and to conclude no treaty or engagement with any other State or nation (the Orange Free State excepted) nor with any native tribe east or west of the republic until such treaty had been approved by the British Government.

Territorial Expansion.—Notwithstanding the precise fixing of the boundaries of the republic by the London Convention, Kruger endeavoured to maintain the Boer hold on Goshen and Stellaland, but the British Government on this point proved firm, and an expedition set out in 1884 under Sir Charles Warren, broke up the freebooters' two states, and occupied the country without a shot being fired (*see* BECHUANALAND). This at last put an end to Boer attempts at encroachment westwards, and a little later treaties with Lobengula and the grant to Cecil Rhodes and his co-directors of a charter for the British South Africa Company put a check on designs the Boers held to expand northwards (*see* RHODESIA).

On the eastern border the policy of expansion was also followed by the Boers, and in this instance with more success. Following the downfall of the Zulu power after the British conquest in 1879, several parties of Boers began intriguing with the petty chiefs, and in May 1884, in the presence of 10,000 Zulus, they proclaimed Dinzulu, the son of Cetywayo, to be king of Zululand (*see* ZULULAND). As a "reward" for their services to the Zulus, the Boers, under Gen. Lukas Meyer, then took over from them a tract of country in which they established a "New Republic." In 1886 the "New Republic," with limits considerably narrowed, was recognized by Great Britain, and the territory became incorporated with the Transvaal in 1888. A similar policy eventually brought Swaziland almost entirely under their dominion (*see* SWAZILAND). At the same time Kruger revived the project of obtaining a seaport for the State, one of the objects of Boer ambitions after 1860 (*see* above). Kruger endeavoured to acquire Kosi bay, to the north of Zululand and only 50 mi. east of the Swazi frontier. In this endeavour he was foiled, for the British annexed Tongoland and with it Kosi bay, but that was not until 1895.

Gold Discoveries: Influx of Uitlanders.—In 1884, the year of the London Convention, the Sheba gold mine in the de Kaap valley—where gold had been found as far back as 1875—had attracted a population of about 1,000. For the first time gold digging in the Transvaal ceased to be a precarious method of earning an existence Barberton was founded, there was a rush to the fields from Europe as well as South Africa. Soon, however, came collapse; by the end of 1887 the Barberton fields were mostly deserted. In the meantime, gold had been discovered on the Witwatersrand. The gold fields there were proclaimed and Johannesburg founded at the end of 1886. In a very few years it was seen that here was the richest gold field in the world; and a republic composed mainly of cattle and sheep farmers of very limited outlook and education was speedily faced with a difficult problem. Thousands of whites poured into the Transvaal so that in a few years the *uitlanders* came to outnumber the native white population The newcomers included a large proportion of South Africans, both Dutch and English speaking, from the Cape, Natal and the Free State; equally with Europeans and Americans they were regarded as *uitlanders*. This new population was concentrated in one region—the Rand.

President Kruger and the *raad* had two points to consider: (1) economic; (2) political The Boers gained by the development of mining, both individually and as a State Land went up enormously in value; so attractive were the prices realized that a third or more of the area of the country was sold to *uitlanders*. But with speculation and wealth came also corruption and peculation; vices to which many members of the Boer executive succumbed. But the Boer was shrewd and at once grasped the need of railway transport from the mines to the sea. From their first crossing of the Vaal the Boers had sought an outlet at Delagoa bay—its great attraction being that it was not under British control. Alternatively, or additionally, they had sought a seaport of their own—hence the effort to secure Kosi bay. In 1884 Kruger granted a concession to Hollander and German capitalists of all rights to build railways in the Transvaal; this led to the formation of the Netherlands South African Railway Company. The grant of monopolies, as an easy way of raising revenue, had become a feature of Transvaal methods from the time of the retrocession in 1881. In 1882 a monopoly was granted for the manufacture of spirituous liquor. By 1889 the list of things under monopoly grants, besides railways and spirits, included dynamite, iron, sugar, wool, bricks, jam and paper. The dynamite monopoly, a necessity for the mines, pressed particularly heavily on the gold industry.

The political policy of the Boers was animated by a lively distrust of everything British. With many of his people Kruger came also to distrust the Cape Dutch, whose interests suffered with those of other *uitlanders*, from the policy of rigid exclusion of the newcomers from political power in the Transvaal. In 1882 a law had been passed raising the period of residence necessary to obtain full franchise rights from two to five years—a reasonable requirement; but the Boers soon foresaw that before long under that law many *uitlanders* would qualify for the franchise. Other measures, then, must be tried to maintain Boer supremacy. In 1887 Kruger endeavoured to induce the Orange

Free State to enter into an offensive and defensive alliance with the Transvaal against the "common enemy." President Brand, who did not see an enemy in Great Britain, refused, but in 1889 Kruger got his treaty with the new president of the O.F.S.—F. W. Reitz. Next came, in 1890, a raising of the franchise qualification, followed in 1894 by other laws, the effect being that no foreigner under 40 could obtain the franchise, and then only if he had lived 14 years in the Transvaal. Kruger's object was the preservation of the independence of the country; that is the maintenance in full power of the Boer burghers; his distrust of the British had led him to open relations with Germany, which country, with her colonial fever then at the full, responded at once, but with a natural regard to German rather than Boer interests.

The mining industry on the Rand had grown very rapidly. At first there was the usual rush and struggle on the gold fields, but in four or five years, while there was the inevitable gathering of undesirables and of those who never intended to settle, there was too a settled community—mainly British—decent and hard working, and capable of voicing its grievances. The feeling entertained towards the president was shown in an unfortunate incident when he visited Johannesburg in 1890. The Transvaal flag flying over the Landdrost's house was pulled down by the mob. Kruger was greatly incensed, and for years he quoted it as a reason against granting *uitlander* claims.

First Reform Movement.—Representations made to the Government at Pretoria in the year 1890 were unavailing, and by 1892 the *uitlanders* felt that to obtain redress both for their political and economic grievances they must resort to combined action. What became known as the first reform movement was then started. The Transvaal National Union was formed by mercantile and professional men and artisans. The chairman was J. Tudhope, an ex-minister of Cape Colony, and its most prominent members Charles Leonard and his brother James Leonard, ex-attorney-general of Cape Colony. Both the Leonards, as well as many of their followers, were South Africans by birth. They, in common with the great bulk of the *uitlanders*, recognized that the State had every right to have its independence respected. But they asserted that a narrow and retrogressive policy, such as Kruger was following, was the very thing to endanger that independence. The legitimacy of *uitlander* aspirations were recognized by a few Boer officials at Pretoria. But Kruger, in reply to seven delegates from the National Union, in Sept. 1892, told Charles Leonard to "go back and tell your people that I shall never give them anything. I shall never change my policy. And now let the storm burst."

In 1894 British subjects in the Transvaal were commandeered to suppress a native rising. This brought a sharp and effective remonstrance from the high commissioner, Sir Henry Loch, who came up to the Transvaal, his visit to the Rand being made the occasion of a "jingo" demonstration highly offensive to the Boers and insulting to the president. Then at a banquet in Jan. 1895 in honour of the German emperor's birthday Kruger referred in glowing terms to the friendship of Germany for the Transvaal; in May 1895 the Boer road to the sea was finally blocked by the proclamation of a British protectorate over Tongaland (which included Kosi bay). The Transvaal Government had failed to fulfil the conditions under which it might have secured Kosi bay; the definite loss of the port made the Boers angry. The really remarkable thing was that Great Britain should for so long have left open to Boer or German adventurers so tempting a harbourage.

Railway politics played their part in the drama. The goal of the railways was the Rand and it was Kruger's policy to favour Delagoa bay. Nevertheless until the railways were complete the Natalians with their *ox-transport* service got most of the trade. But there was much delay in building the Portuguese section of the Delagoa line and through-rail connection between the Rand and the Cape ports came first (Sept. 1892). However, less than two years later—in May 1894—the Netherlands Railway Company (of which the Transvaal Government took 85% of the profits) had at last connected the Rand with Delagoa bay. Efforts made by the Cape Government to keep a fair share of the traffic failed, and to encourage trade to Delagoa bay prohibitive rates were imposed on the 30 mi. of the line to Cape ports within the Transvaal. The Cape retaliated by unloading goods at certain drifts (fords) over the Vaal and sending them on thence by wagon to Johannesburg. This was in Sept. 1895; in October, Kruger closed the drifts. The Cape Government appealed to the British Government, and under an almost direct threat of war the Transvaal gave way and the drifts were reopened in Nov. 1895. Kruger had broken the London Convention in closing the drifts and knew he was in the wrong. While this dispute was still unsettled the railway from Durban reached the Rand. Natal, it had been agreed, was to get a third of the Rand traffic.

At this time—1895—the *uitlanders*, according to a well informed member of that community, owned half the land and nine-tenths of the property of the country, a statement which partly explains Kruger's determination to prevent the "stifling" of Boer nationality which he held would follow the grant of the franchise to the *uitlander*. But there were many burghers who held enlightened views and who saw that the admission of *uitlanders* to the franchise—many taking up citizenship would have been South Africans—would in reality preserve the republic. These men had chosen Piet Joubert as reform candidate for the presidency in the election which occurred in 1893. All the liberal elements in the Transvaal supported Joubert; the official figures (not, it is believed, the true figures) gave Kruger a majority of 700 out of some 15,000 burghers voting. Kruger ignored protests and retained office. Henceforth he kept power, aided by the Hollander advisers he had gathered round him, of whom Dr. W. J. Leyds, State secretary, was the most prominent. By 1895 the great majority of the *uitlanders*, who had neither the wealth of the mine owners nor any civic rights, were growing desperate. Many felt that, as Kruger expected, "the storm would burst."

(F. R. C.)

The Jameson Raid.—At this juncture (Oct. 1895) came overtures to the leading *uitlanders* from Cecil Rhodes, then prime minister of Cape Colony, and from Dr. Jameson, leading to the Jameson Raid. To one or two men this scheme, subsequently known as the Jameson Plan, had been revealed in the previous June, but to the majority even of the small group of leaders it was not known till Oct. or Nov. 1895. The proposition came in a tempting hour. Between them it was arranged that Jameson should gather a force of 800 men on the Transvaal border; that the *uitlanders* should continue their agitations; and that, should no satisfactory concession be obtained from Kruger, a combined movement of armed forces should be made against the Government. The arsenal at Pretoria was to be seized; the *uitlanders* in Johannesburg were to rise and hold the town. Jameson was to make a rapid march to Johannesburg. Meanwhile, in order to give Kruger a final chance of making concessions with a good grace, and for the purpose of stating the *uitlander* case to the world, Charles Leonard, as chairman of the National Union, issued a manifesto, which concluded as follows:—

> What do we want? We want: (1) the establishment of this republic as a true republic; (2) a *grondwet* or constitution which shall be framed by competent persons selected by representatives of the whole people and framed on lines laid down by them—a constitution which shall be safeguarded against hasty alteration; (3) an equitable franchise law and fair representation; (4) equality of the Dutch and English languages; (5) responsibility of the legislature to the heads of the great departments; (6) removal of religious disabilities; (7) independence of the courts of justice, with adequate and secured remuneration of the judges; (8) liberal and comprehensive education; (9) efficient civil service, with adequate provision for pay and pension; (10) free trade in South African products. That is what we want.

The Jameson conspiracy fared no worse and no better than the great majority of conspiracies in history. Jameson did not obtain more than 500 men. Johannesburg had the greatest difficulty in smuggling in and distributing the rifles with which the insurgents were to be armed. The scheme to seize the Pretoria fort had to be abandoned, as at the time fixed Pretoria was thronged with Boers. Finally, Jameson, becoming impatient of delay, in spite of receiving direct messages from the leaders at

Johannesburg telling him on no account to move, marched into the Transvaal.

The policy of delay in the execution of the plot which the *uitlander* leaders found themselves compelled to adopt was determined by a variety of causes. Apart from the difficulty of obtaining arms, a serious question arose at the eleventh hour which filled some of the *uitlanders* with mistrust. The reform leaders in the Transvaal, down to and including the Johannesburg rising, had always recognized as a cardinal principle the maintenance of the independence of the State. From Capetown it was hinted that the movement in which Jameson was to co-operate should, in Rhodes's view, be carried out under the British flag. A meeting of *uitlander* leaders was hastily summoned on Dec. 25. Two messengers were that night despatched to interview Rhodes, who then gave the assurance that the flag question might be left to a plebiscite of the inhabitants of the Transvaal (see *Blue-book*, 1897, 165, p. 21). It was determined nevertheless to postpone action; however, on Dec. 29, Jameson started, and the news of his having done so reached Johannesburg from outside sources. A number of leading citizens were at once formed into a reform committee. In the absence of Charles Leonard, who had been sent as one of the delegates to Capetown to interview Rhodes, Lionel Phillips, a partner in Messrs. Eckstein and Company, the largest mining firm on the Rand, was elected chairman. Under the supervision of the reform committee, such arms as had been smuggled in were distributed, and Col. Frank Rhodes was given charge of the armed men. A large body of police was enrolled, and order was maintained throughout the town On Jan. 2, 1896, Jameson, who found himself at Doornkop in a position surrounded by Boers, surrendered. Jameson and his men were conveyed to Pretoria as prisoners, and subsequently handed over to the high commissioner (Sir Hercules Robinson, who had succeeded Sir Henry Loch in June 1895).

Years later, speaking at Durban (Aug. 9, 1910), Jameson declared that the raid was not racial in the sense usually understood, but an effort towards federation. Had the raid succeeded it was proposed to make Gen. Lukas Meyer (d. 1902) president. He subsequently explained, however, that they had had no communication with Meyer on the subject.

The Kaiser's Telegram.—Significant of the attitude of Germany—whose "flirtation" with the Transvaal has been noted—was an open telegram sent by the emperor William II. the day after the surrender of Jameson, congratulating Kruger that "without appealing to the help of friendly Powers" he had repelled the raiders. The British Government rejoined by commissioning a flying squadron and by calling attention to the London Convention. In Johannesburg meanwhile the Kruger government regained control. The members of the reform committee (except a few who fled the country) were arrested on a charge of high treason and imprisoned in Pretoria In April, at the trial, the four leaders—Lionel Phillips, Frank Rhodes, J H. Hammond and George Farrar, who in conjunction with Charles Leonard had made the arrangements with Jameson—were sentenced to death, the sentence being after some months' imprisonment commuted to a fine of £25,000 each. The rest of the committee were each sentenced to two years' imprisonment, £2,000 fine or another year's imprisonment and three years' banishment This sentence, after a month's incarceration, was also commuted. The fine was exacted, and the prisoners, with the exception of Woolls Sampson and W. D. (Karri) Davies, were liberated on undertaking to abstain from politics for three years in lieu of banishment. Sampson and Davies, refusing to appeal to the executive for a reconsideration of their sentence, were retained in prison for over a year.

After the Raid.—Hercules Robinson reached Pretoria on Jan. 4. He had no sooner learned of the raid in Capetown than he issued a proclamation through Sir Jacobus de Wet, the British resident at Pretoria, warning all British subjects in Johannesburg or elsewhere from aiding and abetting Jameson. This was freely distributed among the public of Johannesburg. While in Pretoria the high commissioner in the first instance addressed himself to inducing Johannesburg to lay down its arms. He telegraphed to the reform committee that Kruger had insisted "that Johannesburg must lay down arms unconditionally as a precedent to any discussions and consideration of grievances." On the following day, Jan. 7, Sir Hercules telegraphed again through the British agent, who was then at Johannesburg, saying that "if the *uitlanders* do not comply with my request they will forfeit all claims to sympathy from Her Majesty's Government and from British subjects throughout the world, as the lives of Jameson and the prisoners are now practically in their hands." The 2,000 odd rifles which had been distributed among the *uitlanders* were then given up. After the Johannesburg disarmament Kruger had 64 members of the reform committee arrested, announcing at the same time that his motto would be "Forget and forgive." In 1897 Hercules Robinson was succeeded in the high commissionership by Alfred (Lord) Milner.

In the period which intervened between the Jameson raid and the outbreak of the war in Oct. 1899 President Kruger's administration deteriorated. The Aliens Expulsion and Immigration Laws, as well as the new Press Law, were passed in the latter part of 1896. In 1897 a decision of Chief Justice Kotze was overruled by an act of the *volksraad*. This led to a strong protest from the judges of the high court, and eventually to the dismissal of the chief justice, who had held that office for over 20 years, and had shown himself an able and upright judge. An industrial commission appointed during this year by President Kruger fared no better than the high court had done. It made several sensible proposals which would have helped both the mining industry and the administration, but to very little purpose. All remonstrances, all warnings from the Dutch-speaking people of the Cape were unheeded.

Second Reform Movement.—In March 1899 the *uitlanders*, hopeless of ever obtaining redress from President Kruger, weary of sending petitions to the *raad* only to be jeered at, determined to invoke intervention if nothing else could avail, and forwarded a petition to Queen Victoria. This petition, the outcome of the second *uitlander* movement for reform, was signed by 21,000 British subjects, and stated the *uitlander* position.

In response to this appeal, Chamberlain, in a despatch dated May 10, proposed a conference at Pretoria. Six days before Sir Alfred Milner had telegraphed to London a summary of the situation, comparing the position of the *uitlanders* to that of helots and declaring the case for intervention to be overwhelming. Neither of these despatches was made public at the time. But on the day Chamberlain wrote his despatch the friends of the Transvaal Government in Cape Colony and the Orange Free State invited Milner to meet Kruger at Bloemfontein, hoping to be able to exert pressure on both parties and to arrange a settlement as favourable as possible to the Transvaal. The conference opened on May 31 and closed on June 5. It no sooner opened than it was evident that Kruger had come to obtain, not to grant, concessions. He offered, it is true, a seven years' franchise law in place of the five years' franchise which Sir Alfred Milner asked for. But this seven years' franchise was only to be given on certain conditions, one of which was that all future disputes between the Transvaal and the Imperial Government should be referred to a court of arbitration, the president of which should be a foreigner. Milner urged the home Government to insist upon a minimum of reform, and primarily on the five years' franchise (this had the full support of the *uitlanders* and of the majority of whites throughout South Africa); and Chamberlain, backed by the cabinet, adopted the policy of the high commissioner.

(X)

The Eve of War.—Each side had committed itself to a position from which a peaceful issue was unlikely. The most stupid explanation of the impasse is that which attributes the forcing of the hands of the British Government to Rand "magnates" who desired to seize the gold fields. It is more true to say the quarrel was racial; it is certain that Kruger and his advisers fully understood that the grant of political rights to the *uitlanders* meant the doom of their rule; and they vastly underrated the military power of Great Britain.

After the Bloemfontein Conference the tactics of the Boer executive were simply directed towards putting off a crisis till the

beginning of October, when the grass would be growing on the veld, and meanwhile towards doing all they could in their despatches to put the blame on Great Britain At last they drafted, on Sept. 27, an ultimatum to the British Government. For military rather than diplomatic reasons it was not until Oct. 9 that the ultimatum was presented to Conyngham Greene, the British agent at Pretoria. The scheduled demands were:—

"(*a*) That all points of mutual difference shall be regulated by the friendly course of arbitration, or by whatever amicable way may be agreed upon by the Government with Her Majesty's Government. (*b*) That the troops on the borders of this republic shall be instantly withdrawn. (*c*) That all reinforcements of troops which have arrived in South Africa since June 1, 1899, shall be removed from South Africa within a reasonable time, to be agreed upon with this Government, and with a mutual assurance and guarantee on the part of this Government that no attack upon or hostilities against any portion of the possessions of the British Government shall be made by the republic during further negotiations within a period of time to be subsequently agreed upon between the Governments, and this Government will, on compliance therewith, be prepared to withdraw the armed burghers of this republic from the borders. (*d*) That Her Majesty's troops now on the high seas shall not be landed in any part of South Africa." To these demands the Transvaal Government required an answer within 48 hours.

There could be only one reply, and on Wednesday, Oct. 11, 1899, at five o'clock P.M., a state of war existed between the British Government and the two Boer republics, for the Free State threw in its lot with the Transvaal

FROM ANNEXATION TO UNION: AND AFTER

The course of the war is described in detail in the article SOUTH AFRICAN WAR. On July 4, 1900, a month after the occupation of Pretoria, a commission was issued to Lord Roberts authorizing him to annex the Transvaal The proclamation of annexation was dated Sept. 1. Lord Roberts held the post of administrator of the colony until his departure for England in the December following, when he was succeeded by Milner, the high commissioner. It was not, however, until March 1901 that Milner, who resigned his governorship of Cape Colony, arrived at Pretoria to inaugurate a civil administration. Hostilities were still proceeding, but in the areas under control Lord Milner (who was raised to the peerage in May) speedily set the machinery of government in motion.

Reconstruction.—Some of the gold mines were permitted to restart crushing in May 1901. In November following the main body of the *uitlanders* were allowed to return to the Rand and in June 1902 a tax of 10% on the profits of gold mining was imposed. The administration was equally alive to the needs of the country districts and a land board was established in Dec. 1901. Another department taken in hand was that of education; and here remarkable success was achieved.

After the signature of the articles of peace the work of reconstruction was accelerated. The end of the military government was signalled by the assumption, June 21, 1902, by Lord Milner of the title of governor of the Transvaal and by the creation of an executive council. With the proceeds of a loan of £35,000,000, guaranteed by the British Government, the debt of the South African Republic was paid off, the Transvaal and the Orange River Colony railways were bought by the State, and new railways and other public works were undertaken. The £3,000,000 granted by the articles of peace, and other considerable sums, besides £7,000,000 from the loan, were expended on repatriation and compensation.

The efforts made by the administration to restore the Boers to the land, to develop the material resources of the country, and to remove all barriers to the intellectual and moral development of the people, were soon, however, hampered by severe commercial depression.

Chinese Labour.—The commercial depression was due to many causes; of these the most apparent was the shortage of labour at the Rand mines. When work restarted after the war, the mine owners offered the native workmen little more than half the wages paid in 1898; but this effort at economy was abandoned, and the old rates of pay were restored in Jan. 1903. Nevertheless, the labour available continued to be very much below the needs of the mines. The consequent small gold output meant a serious decrease of revenue, which was not compensated for by the heavy tax levied on the output of the Premier diamond mine, where operations began in 1903. Finally, to enable them to work their mines to their full capacity, the Rand houses asked for leave to import Chinese labourers. Milner, anxious above everything else to obtain sufficient revenue to carry on his work of reconstruction, gave his consent to the experiment. The home Government concurred, and during 1904–06 over 50,000 Chinese were brought to the Rand on three years' indentures. In the Transvaal all parties agreed that no new racial or economic complications should be permitted; and these were guarded against by the restriction of the coolies to unskilled labour in the gold mines and by their compulsory repatriation. By the introduction of the Chinese the gold output from the mines was greatly increased, with the result that the Transvaal suffered less than any other part of South Africa from the restriction of commerce, which lasted for several years.

The discussions in the legislative council on the Chinese coolie question had been accompanied by a demand on the part of the Boers that such an important step should not be taken "without the constitutional approval of the white people of the Transvaal"; and after the importation of the coolies had begun, the agitation for the grant of representative institutions grew in volume. The British Government was also of opinion that the time was near for the setting up of such institutions, and the pending grant of a constitution to the Transvaal was announced in parliament in July 1904. Meantime the existing (nominated) legislative council was dealing with another and a vital phase of the Asiatic question. There were in the Transvaal some 10,000 British Indians, whose right to "enter, travel or reside" in the country was secured by the London Convention of 1884. Under republican rule these Indians—who were mainly small shopkeepers, but included some professional men of high standing—had suffered many restrictions, and their cause had been espoused by the British Government. Nevertheless, under British rule their situation was in no way improved, and a determination was shown by the European inhabitants of the Transvaal, both British and Boer, further to restrict their privileges and at the same time to stop the immigration of other Indians. Alfred Lyttelton (who had succeeded Chamberlain as secretary of State for the colonies) endeavoured to meet the wishes of the Transvaal by sanctioning legislation which would greatly restrict the immigration of Indians, but he would allow no tampering with the rights of Indians already in the colony.

Self-government.—A constitution for the Transvaal on representative lines was promulgated by letters patent on March 31, 1905; but there was already an agitation for the immediate grant of full self-government, and on the accession to office of the Campbell-Bannerman administration in Dec. 1905 it was decided to accede to it. New letters patent were issued (Dec. 12, 1906), and the first general election (Feb. 1907) resulted in the return of a majority belonging to *Het Volk*, a Boer organization formed for political purposes. Lord Selborne, who had during 1905 succeeded Lord Milner as high commissioner and governor of the Transvaal, entrusted Gen. Botha with the formation of a ministry Botha chose as colleagues Gen. J. C. Smuts and other men of progressive, in some respects democratic, views, and thus showed his determination not to be dominated by the "back veld" Boers. He was strengthened in his attitude by the firm action of the Progressive (*i.e.*, the ex-*Uitlander*) Party, which secured 21 seats (out of a total of 69) in the legislative chamber, entirely in the Rand and Pretoria districts, and was led by Sir George Farrar and Sir Percy Fitzpatrick. The Government announced that there would be no wholesale repatriation of Chinese. The men left gradually as the licences expired, and by Feb. 1910 all the Chinese coolies had returned home. At the same time successful efforts were made by the ministry to increase the supply of native labour

for the mines. On the education question an agreement satisfactory to both the British and Dutch-speaking communities was reached.

One of the first problems which confronted the Botha ministry was the attitude to be adopted towards the other British colonies in South Africa Milner, by various measures, had endeavoured to pave the way for federation, and Chamberlain when he visited South Africa in 1903 had also put forward federation as the desired goal.

On economic as well as political grounds, the leaders of both parties in the Transvaal were prepared to consider favourably the proposals put forward by Dr. Jameson at the close of 1906 for a closer union of all the self-governing colonies, and the first direct step to that end was taken at an inter-colonial conference held in May 1908 The history of this movement, which resulted in the establishment of the Union of South Africa on May 31, 1910, is given under SOUTH AFRICA, UNION OF Apart from this movement the most notable events in the Transvaal at this period were the development of agriculture, the gradual revival of trade, and the continued difficulty with regard to British Indians.

On this last point the Botha ministry sought to enforce registration of Indians, and, for failing to register, M. K. Gandhi and other leaders were imprisoned in 1908 and large numbers of Indians were deported. However, the establishment of the Union of South Africa removed from the competence of the Transvaal provincial council all legislation specially or differentially affecting Asiatics (F. R. C.)

The Union.—When the Union was established, Gen. Botha became prime minister and two of his colleagues, Smuts and Hull, also joined the Union ministry. A fourth minister—Johann F. B. Rissik—was appointed first administrator of the Transvaal province, a post he held until 1917, when he was succeeded by A. G. Robertson. J. H Hofmeyr served from 1924 to 1929. He was followed by M. J. Smit, who served until 1934. Simon Bekker was administrator until his death in 1938, when the office was filled by Gen J. J. Pienaar.

Some Boers of the Transvaal took part in the rebellion of 1914, but the influence of Gens Botha and Smuts kept most burghers loyal to the British connection. Feelings continued to be strongly marked in the provincial council, as was shown by agitations against officials because of their nationality or their politics. Thus, after the general election in June 1924, when the Nationalist and Labour parties gained the victory, there was an agitation to remove the administrator, J. H. Hofmeyr, because he belonged to the South African party, an agitation which Gen. Hertzog refused to heed. In the flag controversy of 1926–27 the Dutch burghers followed Tielman Roos, then minister of justice and leader of the Transvaal Nationalists, who supported the compromise by which both the *vierkleur* and the union jack formed part of the flag By the end of the 1920s both political and economic questions had, however, largely ceased to be kept within provincial lines.

The respective claims of Durban and Lourenço Marques (Delagoa bay) to the trade of the Rand had been settled in 1909 by the Mozambique convention, signed by the Transvaal and Portuguese authorities. This convention also permitted the recruitment of Portuguese natives for work in the Transvaal mines. The convention lapsed in 1923, though a *modus vivendi* was reached in respect to native labour. In the negotiations for a new solution the question of the control of Lourenço Marques gave much trouble. On Sept. 11, 1928, a new convention was concluded at Pretoria between the union government and the Portuguese. The revised convention, 1934, gave 47½% of sea-borne imports to Transvaal to Lourenço Marques.

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(P. W. I.)

TRANSVERSE RIB or **CROSS RIB,** in architecture. (*See* VAULT)

TRANSYLVANIA, a former principality (*Grossfürstentum*) occupying, until 1918, the extreme eastern portion of the kingdom of Hungary, but then added to Rumania, after which the Rumanian name Ardeal became the official one Under Rumania its area was 22,312 sq mi and its population 3,217,749 Rumania yielded the northern part to Hungary in 1940.

Transylvania has the form of an irregular circle, and is a high plateau of a mean altitude of 1,000–1,600 ft above sea level, surrounded on all sides by the Transylvanian mountains (*q.v.*), the southeastern continuation of the Carpathian system. On the west side there are easy passes, but on the east and south frontiers the mountains give it the aspect of a huge natural fortress.

The Latin name appears first after the 12th century, and signifies "beyond the woods," *i.e.*, from Hungary; the Hungarian and Rumanian names both mean "forest land" The German name is usually derived from the seven principal fortified towns or "burgs," founded by the German colonists, though some authorities prefer to connect it with the Cibin mountains on the south frontier.

Until 1848 political rights belonged only to the Hungarian and the closely-related Szekler and the Saxon inhabitants, the Rumanian majority having no recognition. These privileged elements formed rather more than 40% of the population, the Hungarians being Roman Catholics or Unitarians and the Germans Protestants. A gypsy element has long been important The chief town is Cluj (Kolozsvár).

(For further geographical details *see* RUMANIA and TRANSYLVANIAN MOUNTAINS.) (H. J F.; X.)

HISTORY

After A.D. 103 Transylvania formed part of the Roman province of Dacia (*q.v.*), and long supported a large Roman or Romanized population. After Aurelian withdrew his legions (A.D. 271) its history remains a blank for many centuries. It was occupied or overrun by various Germanic (Goths, Gepidae), Ural-Altaic (Huns, Avars, perhaps Bulgars, Petchenegs), and probably also Slavonic tribes. The debated question whether a Roman population survived these storms is discussed elsewhere (*see* VLACHS). The very few early documents on Transylvania mention Vlachs first in 1222, and then as shepherds; but they appear soon after as settled peasants; Vlach "nobles" are specifically mentioned in the 13th and 14th centuries, after which they apparently became Magyarized, and at this period the Vlach population in Transylvania, the Banat and Maramures, was certainly considerable and increasing.

Hungarian Conquest.—In 1003 King Stephen of Hungary incorporated Transylvania in his domains under a voivode, also granting fiefs to certain nobles. The early Hungarian administration was probably somewhat shadowy; but it was consolidated at an early date by settlements of the Szeklers (*q.v.*) in the southeast, probably as a frontier guard, and of the "Saxons" (Germans from Luxembourg and the Rhine) for the same purpose in the 12th and 13th centuries. Both Saxons and Székklers were free, self-governing communities under the king. The Saxons especially, who founded numerous cities, were a great civilizing influence. The chief of their many privileges was the charter granted them in 1224 by Andrew II As organized in the 14th century, they formed the communities of the "Sieben Stühle" round Hermannstadt (Sibiu), the "Zwei Stühle" (Mediás), the Burzenland (Kronstadt, Rum. Brassó), and the Nösnerland (Bistritz, Rum. Bistrita).

In spite of various invasions, the chief being the Mongol of 1241, the early prosperity of Transylvania was considerable and its communal life active. Its diet met at least as early as 1229;

and when the power of Hungary began to decline, and Turkish invasions harassed the frontiers, the dominant classes took steps to defend their own position. A rising of the Magyar and Vlach peasants in 1437 caused the Saxons, Széklers, and nobles to meet at Kápolna on Sept. 14 of that year and conclude a "Brotherly Union," by which they swore fealty to the king of Hungary, promised to support each other against the peasants and the Turks, and agreed to settle disputes between themselves by arbitration. This union was renewed in 1438 and 1459, and in 1506 a supreme court of justice was established for all three communities, then referred to as "nations." This third union formed henceforward the basis of the Transylvanian local constitution, relations with the serfs being regulated by the "codex tripartitum" introduced in Hungary in 1515, after the peasant rising of the previous year.

Transylvania a Principality.—After the defeat of the Hungarian forces by the Turks at Mohács (1526), John Zápolya, voivode of Transylvania, who had arrived too late for the battle, was left the strongest power in Hungary and elected king by the anti-Habsburg party (Nov. 10, 1526). He was recognized as king of Transylvania and part of Hungary by Ferdinand I. of Austria (1538); and on his death in 1540 the Estates, instead of joining Austria, as had been stipulated, elected Zápolya's son, cut themselves loose from Hungary, and became tributary to the sultan. Under the dynasties of Zápolya and Báthory the princes of Transylvania were able to preserve practical independence by playing off the sultan against the emperor, and to play an important part in international affairs, especially under Stephen Báthory (1576–86), who was also king of Poland.

The chief internal event of the 16th century was the triumph, after a severe struggle, of the Reformation. The Saxons were converted to the Lutheran Church, the majority of the Magyars to the Calvinist, and another party, including most of the Széklers, to the Unitarian. A certain party, usually identified with the Habsburg cause, remained Catholic. The diet, by a series of resolutions (1557, 1568, 1571, Compilation of 1669), declared the Calvinist, Catholic, Lutheran, and Unitarian religions to be alone "received" and entitled to free exercise and equal rights for all time. By this means it bound another shackle on the Rumanian peasantry, who were Greek Orthodox and controlled by a patriarch in Walachia. The backbone of the national movement was formed by the various Protestant creeds, and the efforts of the Catholic Báthorys, assisted by the Jesuits, to carry through the Counter-Reformation were a main cause of the confused wars which filled the last years of the century, in the course of which a fourth party in the person of Michael, voivode of Walachia (1593–1601), unexpectedly intervened and for a year (1600) actually united Moldavia, Walachia, and Transylvania in a national Rumanian state, for which, however, he did homage to the emperor. He was murdered in 1601 by order of General Basta, and in 1604 the emperor Rudolph secured Transylvania; but the persecutions indulged in by the imperial troops under General Basta, and the proselytizing fury of the Jesuits, provoked a speedy rebellion. On April 5, 1605, the diet elected as prince Stephen Bocskay (*q.v.*), who by the Peace of Vienna (June 23, 1606) forced the emperor to recognize him as prince of an enlarged Transylvania and secured the confirmation of all traditional liberties; while by the Truce of Zsitvatörök (Nov. 1606) he negotiated a 20 years' truce between the emperor and the sultan. Unfortunately, Bocskay died on Dec. 29, 1606. Gabriel Báthory (1608–13) was the most tyrannical ruler Transylvania ever had; but the reign of Gabriel Bethlen (1613–29) restored the principality's former glories and is generally regarded as its golden age.

Under Bethlen and George Rákóczy I (1630–48) Transylvania was again a power of international importance and the chief bulwark of Protestantism in Eastern Europe. The emperor, distracted by the Thirty Years' War, was obliged to treat with the princes of Transylvania as equals, while the Turkish empire, for the time, was unable to interfere with its nominal vassal. Only when George Rákóczy II (1648–60) was defeated in an unlucky campaign against Poland did the reviving Porte again intervene, depose Rákóczy, and, after six princes had died violent deaths within three years, appoint a Székler, Michael Apafi (1661), who ruled as a mere vassal of the Turks; and Transylvania sank again into extreme misery.

When the Turks were defeated before Vienna (1683), and their power again declined, the Estates opened secret negotiations with the emperor Leopold I., whose suzerainty they recognized under the Treaties of Vienna (1686) and Blasendorf (Blaj) (1687). Apafi died in 1690, being succeeded by his son, Apafi II. On Dec. 4, 1691, the emperor Leopold, after long negotiations, issued the diploma which regulated relations between him and his subjects.

Period of Habsburg Rule.—By this most important document the emperor swore to uphold the constitution of Transylvania, which was again considered *de jure* a part of Hungary, confirmed the privileges and liberties of the three "nations" and four "received religions," and agreed that the diet should meet annually; but also imposed a tribute on Transylvania, stationed a garrison in it, and put it under a "gubernium," directed after 1694 from the *Siebenbürgische Hofkanzlei* in Vienna. In 1697 Apafi was induced to abdicate. The Porte recognized the situation under the Peace of Karlovitz (1699). In Transylvania itself the resistance to the imperial troops and the Jesuits ceased only after the Peace of Szatmár (1711). In 1721 the Transylvanian diet accepted the Pragmatic Sanction.

During the succeeding century the pressure of Catholic and bureaucratic rule gradually broke down the old individuality of Transylvania, which was promoted, in compensation, to the title of a Grand Principality in 1765. The privileges of the Széklers had already almost vanished in the 16th century and many of them had sunk into serfdom. In the 18th the Saxons were in danger of following suit, but were saved by their great minister, Brukenthal. Some of the Rumanians, on the other hand, emerged for the first time from serfdom when Maria Theresa extended the system of the Military Frontier (*q.v.*) to three Walach districts in Transylvania in 1766. They had already acquired a measure of religious liberty under the union of 1698–99, which allowed any Orthodox priest in Hungary immunities equal to those of the Catholics conditional on his accepting certain dogmas. The creation of the Uniat Church was probably not meant as an attempt to play off the oppressed against the dominant classes; but the Rumanians, who were largely reinforced during the 18th century by refugees from the Phanariot regime in Walachia and Moldavia, were at last able to develop a national consciousness. The visits of Joseph II to Transylvania (1773, 1783) gave rise to rumour that the serfs were to be liberated and armed against their masters. In 1785 the Rumanian peasants, led by Nicolas Horea, rose and had massacred many Magyar nobles before the revolt was suppressed. On Joseph's death, after recanting his reforms in Hungary, the Rumanians submitted to his successor, Leopold II., the *supplex libellus Valachorum*, in which they prayed to be set on an equality with the other nationalities and inaugurated the "Vlach controversy" in modern politics by appealing to their "ancient rights" as the autochthonous inhabitants of Transylvania. The document was passed by Leopold to the Transylvanian diet of 1790–91, which, itself busily engaged in reaffirming its position after the disturbing Josefinean interlude, rejected it decisively and restored the old constitution. Actually, however, under Francis I. and Ferdinand II. there was little liberty for any party. Meanwhile, the wave of the Magyar national revival swept through Transylvania, bringing with it a strong demand among the Magyars for full union with Hungary and creating a corresponding antagonism among the non-Magyars.

On the outbreak of the revolution of 1848 the Magyars petitioned for union with Hungary, promising the Rumanians the abolition of serfdom and other reforms in return for their support. The Rumanians, however, rejected the alliance, and at the "Field of Liberty" of Blaj (Blasendorf) declared themselves a free nation, forming an integral part of Transylvania, and swore fealty to the Habsburgs (*May* 15). A political program, based on "the principles of fraternity and liberty," was drawn up, but rejected by the diet at Klausenburg (Cluj), which proclaimed the union with Hungary, the Saxon representatives accepting this decision by a majority, and declared the new Hungarian laws to be sufficient guarantee that all necessary reforms would be granted—

a conclusion also reached by a commission of the Hungarian parliament. In the subsequent fighting between the Hungarian and the Austro-Russian troops, much of which took place in Transylvania, both Saxons and Rumanians took up arms against the Magyars, and a very bitter racial war resulted. The Austrian constitution of 1851, which abolished both the Military Frontier and the Saxon privileges, treated all nationalities with equal severity, and the reaction affected all equally heavily. The diploma of Oct. 20, 1860, restored the old constitution and the Hofkanzlei, but these were abolished when Transylvania became an integral portion of Hungary under the Austro-Hungarian Compromise of 1867. In the following year it was reorganized in "comitats" with the rest of Hungary

From 1868–1918 Transylvania was dominated by the Magyar racial policy. The basic Nationalities Law of 1868 was in theory extremely liberal, but in practice remained almost a dead letter The Saxons, in view of their numerical inferiority, confined themselves to building up a close organization for the defence of their social and religious individuality. In spite of this they lost ground, especially after their ancient national status was abolished in March 1876. The Rumanian national movement was more active. In past centuries it had been essentially social rather than national. The idea of uniting all Rumanians in one body politic had, indeed, been mooted; but so long as the Danubian provinces remained under Turkish suzerainty the suggestion most commonly put forward, even by Rumanian rulers, *e.g.*, Michael the Brave and Matthias Bassarab, had been for a Rumanian state under Habsburg rule. Austria, however, lost her last chance of acquiring Moldavia and Walachia through her unskilful diplomacy during the Crimean War; by the Compromise with Hungary she sealed the alienation of her Rumanian subjects. The immediate social struggle was ended by the abolition of serfdom in 1853–54; the agitation for a land reform dated chiefly from the 20th century. The national struggle proper occupied the chief attention of the new Rumanian intelligentsia and middle classes. A Rumanian irredenta, though invited by the creation of an independent Rumanian kingdom, never assumed the proportions of the Serb, owing to the discouragement given it by King Charles of Rumania, who was allied with Austria-Hungary; but in the last years before World War I it was increasingly furthered by nearly all educated elements in Rumania; and the severity of the measures taken in Transylvania during the war by the Hungarian government and military, especially after the Rumanian advance into Transylvania in 1916, showed that practically all Rumanians desired the dissolution of Austria-Hungary.

Union with Rumania.—In Oct. 1918 the Rumanians of Transylvania announced their decision to direct their own destinies. On Oct. 27 a National Council was established at Arad, and on Dec. 1 a Convention assembled at Alba Julia and proclaimed the union of Transylvania with the kingdom of Rumania, at the same time promising to respect the rights and liberties of the other nationalities. The Saxons adhered to this resolution on Jan. 21, 1919; the representatives of the Magyars not till 1921, and then under protest. The union was thus carried through without calling on the secret treaty of Aug. 17, 1916, under which the Allies had promised Transylvania to Rumania. The frontier was determined by the Treaty of Trianon (June 4, 1920). The effect was to leave a western fringe with a very considerable Magyar population; it represented the results of a difficult endeavour to reconcile very conflicting ethnical and other claims. The Rumanian Minorities Treaty guaranteed the rights of the non-Rumanian populations; but, for all that, the transference of the administration from Magyar to Rumanian hands was accompanied by considerable friction. In part this was due to the discontent prevalent in Hungary on account of the new frontier, in part to certain undeniable weaknesses in the new regime, aggravated by the confusion of the postwar period. In particular, complaints were brought forward by the Magyar landowners, and supported by the Hungarian government, regarding the application of the land reform.

Cession of Northern Transylvania to Hungary.—By the award of Vienna, Aug. 30, 1940, Germany and Italy forced Rumania to cede most of Transylvania to Hungary The part awarded was the northern territory with a population of 2,392,603 and an area of 16,642 sq.mi., including Cluj. Throughout World War II the area continued to be a source of friction between the two nominal axis partners, and on several occasions open warfare was narrowly averted by Germany

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TRANSYLVANIAN MOUNTAINS. This is an inclusive name for the mountainous region which abuts against the south-eastern end of the Carpathian range south of the Jablonica pass. In the east they form a continuation of this range but across the rest of the tract the mountains are arranged in scattered groups, in broken connection with one another, the land between forming the Transylvanian basin Formed in Tertiary times, they are part of the eastern arm of the Alpine fold-system which passes in a wide arc through the Carpathians, turns abruptly westward at Pietrite Fetei into the Transylvanian Alps, again turns almost as abruptly southward at Reteizat through the Szretinye mountains and across the Danube at Iron Gates to turn eastward into the Balkan mountains

The eastern mountains, the Moldavian Carpathians, are divided parallel to their trend by the upper valleys of the Mureşul and the Oltu, separating the outer (eastern) ranges which consist of highly folded *Flysch* (Cretaceous, Eocene and Oligocene) lying upon an (inner) crystalline massif of plutonic rocks, gneisses and schists with Carboniferous, Permian and Triassic rocks The western of these two ranges, the Harghtei complex of Tertiary volcanic rocks (andesites, andesitic tuffs, etc.), forms the eastern boundary of the Transylvanian basin and through it break the rivers Oltu and Mureşul The Transylvanian basin seldom rises above 1,600 ft. in altitude and is covered by Miocene deposits. The southern boundary is formed by the Transylvanian Alps which consist almost entirely of a crystalline massif of gneiss, schist and granite with a very narrow and broken fringe of *Flysch* on its southern (outer) edge. This forms the most continuous range in the region and contains the highest peak (Negoiul, 8,320 ft.).

The mountains of the south-west and west, which do not form a continuous range but are isolated by wide valleys, have a more complex structure than the Transylvanian Alps, for around crystalline massifs, which beneath the covering rocks are probably continuous with that of the latter chain, are Triassic, Rhaetic, Jurassic and Cretaceous beds and to a less extent Carboniferous and Permian. Here are three main masses, the Szretinye mountains, the Transylvanian Ore-mountains and the Bihor mountains Here, as well as in the Nagybánya district in the north, are Tertiary volcanic rocks of andesitic composition associated with which are important gold and silver lodes. Some of the mines (*e.g.*, Roşia-Montană [Verespatak]) have been worked since Roman times and the district still contains the most valuable gold deposits in Europe. These volcanic rocks are probably associated with north to south faulting which occurs in this region. The northern boundary is less well defined and comprises a low range in the west with the higher range, the Ródna Hegység, farther east.

There are evidences of past glaciation among the highest peaks which nowhere reach 9,000 ft., so that none of them are permanently snow-capped. Precipitation in the Transylvanian basin averages 24 in. and great extremes of temperature are experienced This basin cannot be called a plateau for it does not possess extensive plains but is cut up by a network of valleys formed by mountain streams that drain into it from the peripheral ranges. The three main streams are the Great Sameşul, which draining the northern half of the basin, flows north-west to join the Theiss; the Mureşul, which crossing from east to west enters the Hungarian plain along the southern scarp of the Transylvanian Ore-mountains and also joins the Theiss; and the Alt

which breaks through the Transylvanian Alps by the Tumul-Ros pass to join the Danube. Other passes in this range, all of which are followed by railways, are the Bodza, Tömös, Vulcan and Teregova, whilst those in the Moldavian Alps are the Prislopul, Rodna, Borgo, Tölgyes, Békás, Gyimes and Oitoz passes, several of which are used by railways. (*See* RUMANIA.)

TRAP, a mechanical device for snaring or catching anything, and especially wild animals. The term trap is also used to designate a wooden instrument, shaped something like a shoe, used in playing trap-ball; a machine used for throwing clay pigeons or balls into the air; a bent or partitioned chamber, as in a drain pipe (*see* PLUMBING), in which the liquid forms a seal to prevent the passage of sewer gas, etc.; and the term has been used colloquially to designate a light horse carriage.

Trap is derived from O.E *treppe* or *trædppe*, properly a step, as that on which an animal places its foot and is caught, *cf.* Ger *Treppe*, a flight of stairs. Traps for animals are of great antiquity and no savage people has ever been discovered, whatever its culture, that did not possess some variety of snare.

In the most primitive form of wild animal trap no mechanism need be present, *e.g.*, a cavity into which the animal walks, as the pitfall of the Arabs and Africans or the snow-hole of the Eskimos Dr. O. T. Mason has divided traps into three classes: *enclosing* traps, which imprison the victim without injury; *arresting* traps, which seize the victim without killing it, unless it be caught by the neck or round the lungs; and *killing* traps, which crush, pierce or cut to death.

Enclosing traps include the pen, cage, pit and door-traps. Pen-traps are represented by the fences built in Africa into which antelopes and other animals are driven; and by fish-seines and pound-nets. Among cage-traps may be mentioned bird-cones filled with corn and smeared with bird-lime, which adhere to the bird's head, blinding it and rendering its capture easy; the fish-trap and lobster-pot; and the coop-traps, of which the turkey-trap is an example. This consists of a roofed ditch ending in a cul-de-sac into which the bird is led by a row of grains of corn. Over the further end a kind of coop is built; the bird, instead of endeavouring to retrace its steps, always seeks to escape upward and remains cooped. Pitfalls include not only those dug in the earth, at the bottom of which knives and spears are often fixed, but also several kinds of traps for small animals. One of these consists of a box near the top of which a platform is hung, in such a way that, when the animal leaps upon it to secure the bait it is precipitated into the bottom of the box, while the platform automatically swings back into place.

The door-traps range in size from the immense cage with sliding door in which such beasts as tigers are caught, to the common box-trap for mice or squirrels, the door of which falls when the spindle upon which the bait is fixed is moved. Four classes of arresting traps are: the mesh, the set-hook, the noose and the clutch. The mesh-traps include the mesh and thong toils used of old for the capture of the lion and other large game, and the gill-net in the meshes of which fish are caught by the gills. To the set-hook division are reckoned the set-lines of the angler, several kinds of trawls and the toggle or gorge attached to a line, which the animal, bird or fish swallows only to be held prisoner. The noose-trap class is a very extensive one. The simplest examples are the common slip-noose snares of twine, wire or horsehair, set for birds or small mammals either on their feeding grounds or runways, the victim being caught by the neck, body or foot as it tries to push through the noose. When the noose is used with bait it is generally attached to a stout sapling, which is bent over and kept from springing back by some device of the "figure-4" kind. This is constructed of three pieces of wood, one the horizontal spindle on which the bait is placed, one the upright driven into the ground, and the third the connecting cross-piece, fitted to the others so loosely that only the strain of the elastic sapling keeps the trap together. When the victim tries to secure the bait he dislodges the cross-piece and is caught by the noose, which is spread on the ground under the bait or is so arranged as to encircle the neck.

Besides the figure-4, several other very effective trigger devices are in use. There are two widely different types of clutch-traps: bird-lime and other tenacious substances, and jaw and clap-traps. The simplest form of the first is adhesive fly-paper. Some examples of the clap-trap are the clap-net, consisting of two nets laid flat on the ground and attached to cords in such a manner that they fly up and close when the draw-cord is pulled by a concealed trapper; and the various other spring-traps used by bird-catchers. The jaw-traps are the most important class of device for the capture of fur-bearing animals. Steel-traps consist of two jaws, with or without teeth, which are worked by powerful single or double springs and are "sprung" when the victim steps upon the "pan," which is placed between the jaws and attached to a lever. They are made in many sizes, from the smallest, designed for rats, to the "Great Bear Tamer," weighing over 40 lb., with jaws of 16in. in which lions, tigers and grizzly bears are trapped. The steel-trap is set and concealed in such a manner that the animal must step on its pan in passing over it to secure the bait. During recent years many types of traps, designed to reduce suffering and to displace the ordinary steel-trap, have been put out, but are not yet in general use.

With the clutch-traps must also be reckoned the oldest form of steel-trap, now to be seen only in museums, the man-trap, which was used first about the middle of the 18th century when the systematic preservation of game rendered protection against poachers a necessity. Such a trap, from Gloucestershire, is over 6ft. long, has 19in. serrated jaws and weighs 88 pounds. Another form of man-trap, the spring-gun, belongs to the next category, the killing traps, which are divided into traps of weight, point and edge. The most important of the weight class is the dead-fall, of which the typical form consists of a pen over whose narrow entrance one or more logs are laid across a lighter log, which is balanced upon a spindle necessarily struck by the entering animal, causing the logs to fall upon its back. In some cases the bait is attached to the spindle itself. The dead-fall was always the favourite trap of the American Indians, and is in use among many aboriginal tribes in Africa and South America. A slab of stone is often used as a weight. The common mouse-trap which kills either by a blow or strangulation is a variety of dead-fall. Of point-traps may be mentioned those of the impaling and the missile classes. An example of the former is the stake or spear placed by Arab and African tribes at the bottom of pitfalls for big game. Another impaling trap common in Africa is the harpoon down-fall, generally used for the hippopotamus. It consists of a heavily weighted harpoon suspended in such a way that the animal, passing beneath, breaks a cord and precipitates the harpoon upon itself. Another example of impalement is the hawk-trap, consisting of a circle of stout sharp wires, in the centre of which a live fowl is placed. A bird of prey attempting to secure the fowl is impaled upon the wires. Of missile-traps the most universal are the ancient spring-bow and its modern representative the spring-gun. This is fixed upon stakes, or against a tree, with a line attached to the trigger and stretched immediately in front of the muzzle. An animal pressing against the string pulls the trigger and discharges the piece into its own body. An arrangement of sticks holding the bait in front of the muzzle is sometimes substituted for the string. Of edge-traps a curious example is the wolf-knife of Western America, which consists of a very sharp blade embedded in frozen fat. One of the wolves, licking the fat, cuts its tongue and a flow of blood ensues, with the result that not only the wolf itself but its companions become infuriated by the smell and taste, and the wounded beast, and often many of the others, are killed and devoured. The Alaskan knife-trap for large game consists of a heavy blade attached to a lever, which, when released by the animal biting at the bait, moves over and strikes the victim.

See *Shifts and Expedients of Camp Life*, by W. B. Lord (1871); *Camp Life and the Tricks of Trapping*, by W. H. Gibson (1902); O. T. Mason, "Traps of the American Indians," *Annual Report*, Smithsonian Institution, for 1901; *The Story of the Trapper*, by A. C. Laut (1903).

TRAPANI (anc. *Drepanum*), a city and episcopal see of Sicily, capital of the province of the same name, on the west coast, 3 mi. W. of the Monte San Giuliano, which rises above it, 121 mi. W. by S. of Palermo by rail, and 47 mi. direct. Pop. (1936) town 52,661, commune 63,540. The ancient Drepanum

(δρέπανον, a sickle, from the shape of the low spit of land on which it stands) was originally the port of Eryx. It is represented by Virgil in the *Aeneid* as the scene of the death of Anchises. It was an important Carthaginian naval station in the First Punic War (260 B.C.), part of the inhabitants of Eryx being transferred thither. Near Drepanum the Roman fleet was defeated in 250 B.C., while the struggle to obtain possession of it ended in the decisive Roman victory off the Aegates Islands in 241, which led to the conclusion of peace. (*See* PUNIC WARS.) Under the Norman kings, at the time of the first crusade, it became a place of importance; it was a residence of the Aragonese kings. In the 16th and 17th centuries it was strongly fortified.

There are some fine Gothic and baroque palaces, and a few churches with interesting details. Trapani has a harbour of some importance. There are also large salt pans near by. Trapani was heavily bombed by the Allies in World War II.

TRAPPISTS, Cistercian monks of the reform instituted by Armand J. le B. de Rancé (*q.v.*), abbot of La Trappe, 1664. La Trappe was a Cistercian abbey near Soligny, in the diocese of Sées, in Normandy, founded 1140. It suffered grievously from the English wars and from commendatory abbots. Armand Jean de Rancé became commendatory abbot at the age of ten, 1636; and on his conversion from a worldly life he began to interest himself in his abbey and conceived the project of restoring the monastic life therein, 1662. With this object he visited La Trappe, but the monks were recalcitrant and threatened his life; through the intervention of Louis XIV. he was able to pension them off; they were replaced by a community of Cistercians of the strict observance, and the monastic buildings, which had fallen into ruin, were repaired at de Rancé's expense. He himself then entered the novitiate in one of the reformed Cistercian abbeys, and came to La Trappe as regular abbot, 1664. He persuaded his community to adopt a manner of life beyond Cistercian practice, and far beyond St. Benedict's rule. The Trappist régime is probably the most penitential that has ever had any permanence in the Western Church. Yet it attracted vocations in such numbers that de Rancé had 300 monks under him. Through age and ill health he resigned his abbacy in 1695, and died five years later.

During the 18th century La Trappe continued faithful to de Rancé's ideas, but the observance spread only into two monasteries in Italy. It was the dispersal of the community at the French Revolution that turned the Trappists into a congregation in the Cistercian order and finally into a separate order. Dom Augustine de Lestrange, the novice-master at the time of the suppression in 1790, kept twenty of the monks together and obtained permission for them to settle at Val-Sainte in Fribourg, Switzerland. Here they made their life still stricter than that of La Trappe, and postulants flocked to them in such numbers that in two years' time colonies went forth to establish Trappist monasteries in England, Belgium, Piedmont, Spain and Canada; and in 1794 Dom Augustine was named by the Holy See Father Abbot of all these foundations, thus formed into a congregation. In 1817 they returned to La Trappe, many new foundations were made, and by Dom Augustine's death in 1827 there were in all some seven hundred Trappist monks. In the course of the century three or four congregations arose—a Belgian, an Italian, and two in France—each with a vicar subject to the general of the Cistercians. In 1892 these congregations were united into a single Order of Reformed Cistercians, or of Strict Observance, with an abbot-general resident in Rome and independent of the general of the Cistercians of the Common Observance. In 1898 the Trappists recovered possession of Citeaux, the mother-house of the Cistercians, secularized since the Revolution, and it was declared to be the mother house of the Reformed Cistercians.

The Trappists are a thriving and vigorous order, represented in all the countries of western Europe; also in the United States and in Canada. Besides they have a house in China, one each in Japan, Asia Minor, Palestine, Bosnia and Dalmatia, and four in various parts of Africa. In heathen countries the Trappists now give themselves up to missionary work.

The first Trappist nunnery was the abbey of Les Clairet, near Chartres, which de Rancé persuaded to adopt his reforms. Dom Augustine de Lestrange established another in 1796, and now there are fifteen with 350 choir nuns and 500 lay sisters. One is in England at Stapehill, near Wimborne, founded in 1802.

BIBLIOGRAPHY.—*See the Lives* of de Rancé. A minute account of the observance is in de Rancé's *Réglemens de la Trappe* (1701). The beginning of the reform is told by Helyot, *Histoire des ordres religieux* (1718), vol. vi. ch. 1; the developments under Dom Augustine de Lestrange are described in the supplementary matter in Migne's *Dictionnaire des ordres religieux* (1858). The whole subject is well treated by Max Heimbucher, *Orden u. Kongregationen* (1907), vol. i. § 48; in the *Catholic Encyclopaedia*; in Wetzer und Welte, *Kirchenlexicon* (and ed.), and Herzog, *Realencyklopädie* (3rd ed.). A realistic and sympathetic picture of Trappist life is the redeeming feature of J. Huysman's *En route*. (E. C. B.)

TRAP-SHOOTING, shooting at live or clay birds released from traps. In Great Britain shooting at live birds prevails, but is widely condemned. In the United States the sport is almost wholly confined to shooting artificial birds. Trap-shooting began in America in 1825.

Cincinnati, O., is the recognized home of organized trap-shooting in the United States, a club having been established there in 1831. Glass balls were the first inanimate targets, with an improvement later in the form of feathers inside the globes which gave an impression of game when struck. Spring-board traps catapulted the targets into the air. Keen shots began club organization over the country and regular competitions ensued. New model traps were invented and with them trap-shooting passed from the glass ball stage to the mechanism which tossed off the first saucer-shaped clay disc or "brittle pigeon." The Ligowski trap and bird, the latter equipped with a sort of flipper which the machine engaged and slung to various tangents, were pioneers. These earlier traps were set in rows behind earth ramparts. Poor trap delivery, small rotation imparted to targets, slower powders and tough composition of the "birds" caused the lower scores of those days. But with the advent of smokeless powders, chilled shot, better targets and traps and above all better choke-boring of guns, scores mounted and with them nation-wide interest in



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A "WESTERN" AUTOMATIC TRAP SET FOR THROWING DOUBLE TARGETS

trap-shooting. Remote rural districts turned out gun clubs and, as a result, the Inter-State Trapshooting Association became the governing body of the sport in the United States.

Subsequently came the American Trapshooting Association with which were connected, more or less as financial backers, the gun and ammunition interests of the country. The American Trapshooting Association was in turn passed over to the Amateur Trapshooting Association in 1923. With the formation of the latter association, control and direction of trap-shooting in the United

States (with Canadian affiliation) passed directly into the hands of the amateurs as distinguished from gun and ammunition firms having a commercial interest in the sport. Amateur control has resulted in the foundation at Vandalia, O., of a permanent trap-shooting home and club grounds which is probably the most elaborate layout of its kind in the world. Here, usually in late August, is decided, after a week of steady firing, the Grand American Handicap programme, culminating in the main event of that name, the "Grand American."

Trap-shooting in the United States has shown a gratifying increase since passing into the hands of the Amateur Trap-shooting Association. A conservative estimate of the number of targets fired at in a season's trap-shooting in the United States and Canada, approximates 75,000,000, at least a million of which are thrown during one week's programme of the Grand American. The longest run record in singles was made by Joe Hiestand, 1,179 registered targets, started in Yorklyn, Del., in August 1938, and ended at Carmel, Ind. on Labor Day. If practice and shoot-off targets were included, the run would have been 1,404. The highest score in singles in one year's shooting was made by E. F. Woodward in 1932 and 1933, score 995 x 1,000 The highest score in doubles was made by Homer Clark, Sr., at Paris, Ky., and by Col. J B. Grier at Shawnee, Pa., score 100 x 100.

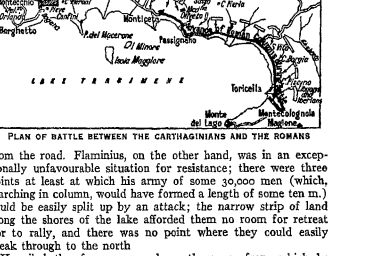
Highest score in all events ever achieved at the Grand American was made by Joe Hiestand in 1936 and 1938, and by R. A. King in 1937, score 881 x 900.

Notable among women trap-shooters who have won national recognition are Mrs. Frank Butler (the late Annie Oakley), Mrs Adolph Topperwein and Mrs. Lela Hall. Mrs. Hall won the women's championship for five years.

TRASIMENUS, LAKE, a lake of Umbria, Italy, 12m. W. from Perugia, 843ft above sea-level, 50m. in circumference, and 8m. to 14m. across (Lat. *Trasumemus Lacus;* Ital. *Lago Trasimeno*). Having no natural outlet, it was formerly subject to sudden rises, which occasioned inundations, and these in turn malaria. An artificial outlet was completed in 1898 from the south-east corner of the lake to the Caina, a small tributary of the Tiber. The locality was the scene of the second great defeat suffered by the Romans during the Second Punic War.

In the early spring of 217 B.C. Hannibal left the winter quarters (probably near Modena or Bologna) to which he had withdrawn after the victory of the Trebia (*q.v.*) and crossed the Apennines, continuing his march by a shorter route than the usual one, a route which obliged him to march through an inundated and marshy district for four days and three nights. Which pass it was that he took has been much discussed, but it is most likely that he followed the modern route from Bologna to Bagni della Porretta, and thence went by the Collina pass to Pistoia From here he passed through the (at that time) marshy district between Pistoia and Florence, and after resting his troops advanced towards Cortona and Lake Trasimenus, his object in taking this route being, as Polybius tells us, to move onto the rear of the consul Flaminius, who was at Arretium (Arezzo) and, by this strategic surprise, gain an opportunity to fight with the advantage. Fulfilling Hannibal's calculation, Flaminius, on hearing that Hannibal was plundering the countryside, hastily started in pursuit; while the other consul Servilius, who was at Ariminum, marched along the Via Flaminia, their object doubtless being to attack him from two sides before he could reach Foligno. But Flaminius advanced rapidly and without taking the most elementary precautions of scouting He probably reached the lake in a single day's march from Arezzo, in any case late in the evening, and encamped by it, probably to the east of Monte Gualandro and west of Tuoro, and started early on the following morning along the north side of the lake, which was covered with a thick mist.

Hannibal, as he marched along the shores of the lake, had not failed to notice the exceptionally good opportunities of surprise which the terrain afforded. From the hill of Montigeto, a little to the west of Passignano, to Torricella, where the road to Perugia and Foligno leaves the lake and climbs some 300ft. in half a mile to the pass of Montecolognola over the hills which surround it, is a distance of some six or seven miles. For the greater part of this the road runs along a narrow level strip of ground completely commanded by the hills which rise from the lake, while the ascent to the pass is shut in by hills in front and on each side, with the lake behind; so that it corresponds extremely well with the description of Polybius. Even without the mist, which was of course an added advantage, Hannibal would have been able to conceal the greater part of his troops behind hills or in dead ground at a comparatively short distance away



PLAN OF BATTLE BETWEEN THE CARTHAGINIANS AND THE ROMANS

from the road. Flaminius, on the other hand, was in an exceptionally unfavourable situation for resistance; there were three points at least at which his army of some 30,000 men (which, marching in column, would have formed a length of some ten m.) could be easily split up by an attack; the narrow strip of land along the shores of the lake afforded them no room for retreat nor to rally, and there was no point where they could easily break through to the north

Hannibal therefore encamped on the pass, from which he could command a view of the defile as far back as Passignano, and kept his heavy Spanish and African troops under his own command to hold the pass, while the light troops were placed on the left, behind Montecolognola itself, and the Gauls and cavalry formed the right wing, which extended along the hills above the lake as far as Montigeto, the cavalry being placed at the beginning of the defile, and concealed behind the hill of Montigeto, so as to be able to close the defile as soon as the last units of Flaminius' army had entered it. So the Romans marched on to their doom; and when the head of their column came into contact with the troops in the centre at the pass of Montecolognola, concealment was neither possible, nor indeed necessary, and Hannibal gave the signal for a general attack. The greater part of the army was already in the trap and was attacked on all sides from the higher ground, so that, we are told, the centurions and tribunes could not even understand the situation, still less do anything to help it, and the Romans were mostly slain in their marching formation, without having any opportunity of defending themselves, or realizing what was to be done. Many of them were driven into the lake and met their death there.

The head of the column, however, which was naturally more prepared to offer effective resistance, to a number of some 6,000 men, rallied and advanced against the pass. They succeeded in piercing through the light troops on Hannibal's left in a southerly direction, and only when they had done so found that there were no other troops opposed to them. From the high ground they had reached, they were able, now that the mist had cleared, to see the full extent of the disaster, but as they were unable to offer any assistance they marched off to an unnamed Etruscan village, where they surrendered to Maharbal on the following day, in the vain hope of being set free if they laid down their arms; but with the rest of the prisoners (another 10,000 or so) they were all thrown into chains. The number of killed was about 15,000; while the Carthaginian losses were only about 1,500.

It is the only instance in history of a general lying in ambush with the whole of a large army and accounting for practically the whole of the troops opposed to him, and it was, thanks to the favourable nature of the ground, the carelessness of Flaminius and

the fortunate circumstance of the morning mist, a brilliant success. Kromayer's account of the battle, which we have followed, fits in with the account of Polybius and with the actual terrain better than any of the rival theories which have been advanced. Of these, the only one deserving of consideration is that which asserts that the battle took place a good deal farther to the west, in the valley of Montigeto, near the village of Tuoro. But here there is no long defile where an army on the march could be attacked—only a quite short one at Borghetto, close to the shore of the lake and too narrow for the passage of an army.

Immediately after this terrible defeat the Romans suffered a minor discomfiture. Servilius, who was hastening to his colleague's assistance, had sent his cavalry, some 4,000 men, under C. Centenius, ahead of his main body. Hannibal sent Maharbal with the light troops and part of his cavalry against him, and an engagement followed in which, according to Polybius, the Romans lost half their forces, while the rest sought shelter on a hill, but were surrounded and taken prisoners the next day. (*See* CALLICULA.)

See J. Kromayer, *Antike Schlachtfelder*, iii. 1, 148 *sqq.* (1912). (T. A.)

TRASS, the local name of a volcanic tuff occurring in the Eifel, where it is worked for hydraulic mortar. It is a grey or cream-coloured fragmental rock, largely composed of pumiceous dust, and may be regarded as a trachytic tuff. It much resembles the Italian puzzolana and is applied to like purposes. Mixed with lime and sand, or with Portland cement, it is extensively employed for hydraulic work, especially in Holland; whilst the compact varieties have been used as a building material and as a fire-stone in ovens. Trass was formerly worked extensively in the Brohl valley and is now obtained from the valley of the Nette.

TRAUN, OTTO FERDINAND, COUNT VON ABENSPERG UND (1677–1748), Austrian field marshal, was born at Oldenburg on Aug. 27, 1677, of a noble family. In 1693 he left the University of Halle to serve with the Prussian forces in the Low Countries. After seeing much service in the War of the Grand Alliance, he entered the imperial army.

In the War of the Spanish Succession, Traun served with distinction in Italy and on the Rhine till 1709, when he became lieutenant-colonel and aide-de-camp to Field Marshal Count Guido Starhemberg (1654–1737) in Spain. A year later, he was made colonel, and in 1712 chief of a regiment of foot. At Francavilla in Sicily (June 20, 1719) he received a severe wound. He was promoted General-Feldwachtmeister in 1723. In 1727 he became governor of Messina, and in 1733 lieutenant field marshal.

In 1734 he won a European reputation by his defence first of the pass of S. Germano and then of the half-ruined fortress of Capua. He was promoted Feldzeugmeister and employed in a semi-political command in Hungary, then as commander-in-chief in north Italy and interim governor-general of the Milanese. In 1741 he was made a field-marshal. In the War of the Austrian Succession (*q.v.*) he commanded in Italy till 1743, when, on the death of Field Marshal Count Khevenhüller (*q.v.*), he was made the principal military adviser of Prince Charles (*q.v.*) of Lorraine, commanding the Austrians in Bohemia and on the Danube, whose successful operating he inspired. Traun's last active service was the command of an army sent to Frankfurt to influence the election of a successor to Charles VII. He died at Sibiu (Hermannstadt), Feb. 18, 1748.

See *Biographien k. k. Heerführer, herausgegeben v. d. Direktion des k. und k. Kriegsarchiv;* Thürheim, *F. M. Otto Ferdinand, Graf v. Abensperg und Traun.*

TRAUTENAU: *see* TRUTNOV.

TRAVANCORE, a state of southern India. Area, 7,662 sq.mi. In 1941 the population was 6,070,018. The state stands seventeenth among the native states of India in area and third in population. Travancore extends more than 150 mi. along the west coast as far as Cape Comorin, the southernmost point of the peninsula. The Western Ghats, rising to an elevation of 8,000 ft. and clothed with forests, throw out spurs toward the coast, along which there is a belt of flat country of about 10 mi. in width. It is covered with coco-nut and areca palms, which to a great extent constitute the wealth of the country. The whole surface is undulating, and presents a series of hills and valleys traversed from east to west by many rivers, the floods of which, arrested by the peculiar action of the Arabian sea, spread themselves out into lagoons or backwaters, connected here and there by artificial canals, and form an inland line of smooth-water communication for nearly the whole length of the coast. The chief river is the Periyar, 142 m. in length. Other important rivers are the Pambai and its tributary the Achenkoil, the Kallada, and the Western Tambraparni, on which there is a reservoir irrigating about 70,000 acres. Mica, monazite and lignite occur. Elephants, bison, etc., are still found in the Cardamom hills. Travancore has an abundant rainfall. The principal ports are Alleppi, Quilon and Paravur; but there is no real harbour. The Cochin-Shoranur and the Tinnevelly-Quilon railways pass through the state. The Periyar irrigation project conducts water through the Ghats in a tunnel to irrigate the Madras district of Madura, for which compensation of Rs. 40,000 is annually paid to Travancore. Rice is the staple crop. Other products are pepper, tapioca, coco-nuts, cardamoms, coffee, tea and rubber in the hills. Trade is large, the chief exports being copra, coir and other coco-nut products, pepper, tea, rubber, fish, etc. Cotton is woven and matting made. The capital is Trivandrum. The tribute is £53,333, and there is a military force of about 1,500. The maharaja of Travancore claims descent from Cheraman Perumal, the last Hindu monarch of united Malabar, whose date is variously given from A.D. 378 to 825. Though he is a Kshatriya, the succession follows the local custom of inheritance through females; consequently his *sanad* of adoption authorizes him to adopt sisters' sons. For some generations the rulers have been men of education and character, and the state is conspicuous for good administration and prosperity. There is a popular assembly, with women on an equal footing with men as voters and members, and a legislative council, remodelled in 1921. Primary education is free. The state came into direct relations with the British government in 1923. Native Christians, chiefly of the Syrian rite, form nearly one-fourth of the population.

TRAVELLER'S TREE, a remarkable tree, native of Madagascar and Réunion, with a straight stem reaching 30 ft. in height and bearing at the top a number of large long-stalked leaves which spread vertically like a fan. The leaf has a large sheath at the base in which water collects in such quantity as to yield a copious supply—hence the popular name. The plant is known botanically as *Ravenala madagascariensis*.

TRAVERSE CITY, the county-seat of Grand Traverse county, Michigan, U.S.A., on Grand Traverse bay (Lake Michigan), 150 mi. N. of Grand Rapids, at the mouth of the Boardman river, which widens there into a lake. It is on federal highways 31 and 131, and is served by the Pennsylvania and the Chesapeake and Ohio railways, motorbus lines and lake steamers. The population was 16,679 in 1950 and 14,455 in 1940. The city has various manufacturing industries. It is the seat of the Traverse City State Hospital for the Insane (1885). It was settled in 1847, incorporated as a village in 1881, and chartered as a city in 1895. Con Foster museum, located there, has a large collection of pioneer and Indian relics.

TRAVERSER. A long very shallow structure running on a number of wheels, and used to transfer locomotives, carriages, and wagons from one line of rails to another. The vehicle is hauled on to the rails which are fixed to the platform of the traverser, and the latter is then moved on its several sets of rails, by hand, steam, or electric power, until the vehicle comes into line with the desired position. There are two types, *surface* traversers for carriages and wagons, and *pit* traversers for locomotives, carriages and wagons. The surface type has the traverser tracks and the vehicle tracks at the same level, enabling through ways to be provided at any position across the traverser track. The pit design has the traverser rails sunk at a lower level, and is used chiefly in or between shops manufacturing or repairing rolling-stock. The vehicle rails are level with those from which the stock is taken and replaced, so that running on and off is simple. The surface machine must have a certain depth of con-

struction, hence the rails upon which it receives the carriage must be at some distance above the ground rails, and to enable the stock to mount the traverser, ramps (inclined rails) have to be provided at the ends.

The Stokes surface traverser is built up of steel plates and girders in such a manner that the distance between the respective heights of the rails can be as little as four inches. This is important on account of the large amount of bogie stock now used, the six or eight inches difference in ordinary surface traversers being too great to enable these to mount without seriously straining or damaging the bogie and its parts. Another style, the Bowtell, has the traverser vehicle rails ramped for a short distance from the ends. Thus when the back wheels of the bogie begin to mount the ordinary ramps not on the traverser, the front wheels are mounting those on the traverser. By this means a vehicle may mount a traverser which has deep construction, without injury, the angle of tilt being no greater than that which occurs when mounting the Stokes shallow type above mentioned.

TRAVERTINE, a calcareous deposit formed by springs. (*See* SINTER.)

TRAVIÈS DE VILLERS, CHARLES JOSEPH (1804–1859), French painter and caricaturist, was born at Winterthur, Switzerland, on Feb. 21, 1804. He studied first in Strassburg and later at the École des Beaux Arts in Paris. He began as a portrait painter but later devoted himself almost entirely to caricature, finding that his greater talent was in that direction. He was a founder of *Charivari* and later of *La Caricature* and a prolific contributor to both journals. His numerous humorous sketches appearing in the latter magazine were later gathered into such volumes as *La galerie des épicuriens, Les contrastes, Tableaux de Paris, La vie littéraire* and *Comme on dine à Paris*. These burlesque studies of Parisian life, remarkable for the observational powers shown and full of wit, were immensely popular. The series was continued in *Les Français peints par eux-mêmes, Les rues de Paris, Le miroir grotesque* and, doubtless the most notable of all, *Mayeux*. From 1848 to 1855 he assisted in the illustration of Balzac's novels. His large painting "Jésus et la Samaritaine" (1853) was acquired by the State. He died in Paris on Aug. 13, 1859.

His brother EDWARD TRAVIÈS, also a painter, was known for his still life and his excellent animal studies.

TRAVNIK, known till the 18th century as Lašva, a town in Bosnia, Yugoslavia. Pop. (1931) 6,803. It is built round a steep mass of rock, with the tempestuous Lašva at its base, and crowned by an old Turkish citadel. Travnik is very picturesque, with its minarets and narrow lanes, bordered by quaint old wooden houses, and its busy bazaar. There are some good public buildings, a tobacco factory, a State stud farm and horticultural school, and an establishment for woodwork. Sheep rearing is the principal occupation on the surrounding heights, and some horse breeding is also carried on. Many Roman remains are found in the district. During the 15th century the town was the stronghold of the Bogomils, and from 1686, after the downfall of the Turks in Hungary, to 1850, it superseded Banjaluka as the capital of Bosnia. German troops occupied it in World War II.

TRAY, a flat receptacle with a raised edge used for a variety of purposes, chiefly domestic. The tray takes many forms—oblong, circular, oval, square—and is made in a vast number of materials, from papier mâché to the precious metals. The tea-tray is the most familiar form; next to it comes the small round tray, usually of silver or electroplate, chiefly used for handing letters or a glass of wine. When thus employed it is usually called a "waiter." The English tea-trays of the latter part of the 18th century were usually oval in shape and sometimes had handles; mahogany and rosewood were the favourite materials. Sheraton and Shearer, among other cabinet-makers of the great English period, are credited with trays of this type. These were succeeded in the early and mid-Victorian period by trays of japanned iron, which possessed no charm but had the virtue of durability. Sheffield plate snuffer-trays of satisfying simplicity were made in large numbers, and are now much sought after.

TRAY-LANDSCAPE. For discussion of various aspects see the articles: BON-SEKI; BON-KEI; HAKO-NIWA.

TRAZ, ROBERT DE (1884–), French author, was born in Paris on June 14, 1884. He studied law in his native city and afterwards lived in England and Italy, establishing himself finally in Geneva, Switzerland, where in 1920 he founded *La Revue de Genève*. He first won notice as a novelist by his *Au temps de la jeunesse* (1908). He has since published a series of novels and short stories which have received liberal critical praise, among them *Vivre* (1910); *Les désirs du coeur; L'homme dans le rang; Complices* (1924); *L'écorche* (1927), and *La puritaine et l'amour* (1928). They indicate a writer possessed of a pleasant narrative form, unusual observational powers, and a fine sensitiveness. He has travelled widely and his essays collected in *Dépaysments* (1923) and *Le dépaysments de l'Orient* (1926) are of more than ordinary interest.

TRAZ-OS-MONTES, an ancient frontier province in the extreme N E. of Portugal, bounded on the N. and E. by Spain, S. by the river Douro which separates it from Beira, and W. by the Gerez, Cabreira and Marão mountains, which separate it from Entre-Minho-e-Douro. Pop. (1940) 502,347; area, 4,163 sq.mi. For administrative purposes Traz-os-Montes was divided in 1833 into the districts of Bragança (*q.v.*) and Villa Real.

TREACLE, the thick viscid syrup obtained in the early processes of refining sugar, the uncrystallizable fluid obtained in the process of procuring refined crystallized sugar being known as "golden syrup" and the drainings from the crude sugar as "molasses" (*see* SUGAR). The word was properly and first used for a medical compound of varying ingredients which was supposed to be a sovereign remedy against snake bites or poison generally. A well-known specific was Venice treacle, *Theriaca Andromachi*, a compound of a large number of drugs reduced to an electuary, a medicinal compound prepared with honey, which dissolves in the mouth. The old French *triacle*, of which "treacle," earlier "triacle," is an adaptation, is a corruption of *thériaque*, Latin *theriaca*, Greek θηριακή (*sc.* φάρμακα), literally drugs used as an antidote against the bite of poisonous or wild animals (θήριον, dim. of θήρ, wild beast). The word "triacle" came to be used of any remedy or antidote. The composition of electuaries with honey or syrup naturally transferred the name to the most familiar syrup, that obtained from the drainings of sugar.

TREADMILL, a penal appliance introduced by Sir William Cubitt in 1818 and intended by him as a means of employing criminals usefully. It was a large hollow cylinder of wood on an iron frame, round the circumference of which were a series of steps about 7½in. apart. The criminal, steadying himself by hand-rails on either side, trod on these, his weight causing the mill to revolve and compelling him to take each step in turn.

By the British Prison Act, 1865, a male prisoner over 16, sentenced to hard labour, had to spend three months at least of his sentence in labour of the first class. This consisted primarily of the treadmill, or, as an alternative, the crank. The latter consisted of a small hand-wheel, like the paddle-wheel of a steamer revolving in a box. Both treadmill and crank were in time made to subserve useful purposes, but both have gradually been abolished; in 1895 there were 39 treadmills and 29 cranks in use in English prisons, and these had dwindled down to 13 and five respectively in 1901. They are now disused.

The fundamental idea of Cubitt's invention, *i.e.*, procuring rotary motion for industrial purposes by the weight of men or animals, is very old. "Tread-wheels," of this type, usually consist of hollow cylinders, round the inner surface of which a horse, dog or man walks, foothold being kept by slabs of wood nailed across at short intervals.

TREASON, a general term for the crime of attacking the safety of a sovereign State or its head. The law which punishes treason is a necessary consequence of the idea of a State, and is essential to the existence of the State. Most, if not all, nations have accordingly, at an early period of their history, made provision by legislation or otherwise for its punishment.

The law of England as to treason corresponds to a considerable extent with Roman law; in fact, treason is treated by Blackstone

as the equivalent of the *crimen laesae maiestatis*. The history of the crime in the two systems agrees in this that in both the law was settled by legislation at a comparatively early period, and subsequently developed by judicial construction. In both, too, there were exceptional features distinguishing this crime from other offences. Treason was the subject of legislation in many of the pre-Conquest codes The laws of Alfred and Aethelred punished with death any one plotting against the life of the king The *Leges Henrici Primi* put anyone slaying the king's messenger in the king's mercy. The crime was shortly defined by Glanvill, and at a greater length by Britton, and by Bracton, who follows Roman law closely.

The offence of high treason was not precisely defined by the common law (1 Hale, 76), and until the passing of the Treason Act 1351 depended much on the opinions of the king and his judges. That statute appears to be the answer to a petition of the Commons in 1348 (1 Hale, 87), praying for a definition of the offence of accroaching royal power, a charge on which several persons—notably Gaveston and the Despensers—had suffered. The offences made high treason by the statute which still remain are these. (1) to compass or imagine the death of the king, the queen or their eldest son and heir; (2) to violate the king's companion, or his eldest daughter unmarried, or the wife of his eldest son and heir; (3) to levy war against the king in his realm, or be adherent to the king's enemies in his realm, giving them aid and comfort in the realm or elsewhere; (4) to slay the chancellor, treasurer, or the king's justices of the one bench or the other, justices in eyre, or justices of assize, and all other justices assigned to hear and determine, being in their places doing their offices In all cases of treason not specified in the statute the justices before whom the case came are to tarry without going to judgment until the cause has been showed and declared before the king and his parliament whether it ought to be judged treason or felony. The statute, so far as it defines the offence of high treason, is still law.

The statute also treated as high treason forgery of the great or privy seal, counterfeiting the king's coin and importing counterfeits thereof, and this was the law until 1832 These offences are now felonies under the Coinage Offences Act 1861 and the Forgery Act 1913. It also defined petty treason (now merged in wilful murder by s. 8 of the Offences against the Person Act 1861) as the slaying of a master by his servant, a husband by his wife, or a prelate by a man secular or religious owing him allegiance. Between 1351 and 1553 many new offences were made treason, but most of the Acts creating these new treasons were repealed at the earliest opportunity by parliament. The reign most prolific in statutory additions to the law of treason was that of Henry VIII. The Acts of this period were repealed in 1553 and the Act of 1351 was then made the standard of the offence.

Besides the Acts of 1351 and 1553 the following statutes are still in force with respect to the substantive law of treason. By a statute of 1495 persons serving the king *de facto* in war are not to be convicted of treason against the king *de iure*. By an Act of 1702 it is treason to endeavour to hinder the next successor to the crown from succeeding, and by the Succession to the Crown Act 1707 it is treason maliciously, advisedly and directly by writing or printing to maintain and affirm that any person has a right to the crown otherwise than according to the Acts of Settlement and Union, or that the Crown and parliament cannot pass statutes for the limitation of the succession to the crown. By the Treason Act 1796, made perpetual in 1817, the definition of treason is extended so as to include plots within or without the realm to cause the death or destruction, or any bodily harm tending to the death, destruction, maiming, or wounding, imprisonment or restraint of the king, his heir or successors, if such plots are expressed by publishing any printing or writing, or by any overt act or deed. Since that date no new forms of treason have been created.

Punishment.—The punishment of treason at common law was barbarous in the extreme. The sentence in the case of a man was that the offender be drawn on a hurdle to the place of execution, that there he be hanged by the neck but not till he be dead, and that while yet alive he be disembowelled and that then his body be divided into four quarters, the head and quarters to be at the disposal of the Crown. Until 1790 at common law a woman was drawn to the place of execution and there burned In that year hanging was substituted for burning in the case of female traitors. In 1814 the part of the sentence relating to hanging and to disembowelling was altered to hanging until death supervened. Drawing and beheading and quartering after hanging were abolished in 1870. The Act of 1814 in the case of men enables the Crown by warrant under the sign manual, countersigned by a secretary of State, to change the sentence to beheading. Attainder and forfeiture for treason are abolished by the Forfeitures Act 1870, except where the offender has been outlawed.

Trials for treason in Great Britain and Ireland were at one time frequent and occupy a large part of the numerous volumes of the *State Trials* Some of the more interesting may be mentioned. Before the Statute of Treasons were those of Gaveston and the Despensers in the reign of Edward II. on charges of accroaching the royal power. After the statute were those (some before the peers by trial or impeachment, most before the ordinary criminal courts) of Empson and Dudley, Fisher, More, the earl of Surrey, the duke of Somerset, Anne Boleyn, Lady Jane Grey, Sir Thomas Wyatt, Cranmer, Mary Queen of Scots, Sir Walter Raleigh, Strafford, Laud, Sir Henry Vane and other regicides, William Lord Russell, Algernon Sydney, the duke of Monmouth, and those implicated in the Pilgrimage of Grace, the Gunpowder, Popish, Rye House and other plots. Occasionally the result of a trial was confirmed by statute. In some of these trials, as is well known, the law was considerably strained in order to ensure a conviction Since the Revolution there have been the cases of those who took part in the risings of 1715 and 1745, Lord George Gordon in 1780, Thomas Hardy and Horne Tooke in 1794, the Cato Street conspirators in 1820, Thomas Frost in 1840, Smith O'Brien in 1848.

Recent Trials.—Most of the early treason trials are reported in Howell's *State Trials* and the *New Series of State Trials*. There are, however, two recent trials for high treason which may be referred to. A case arising out of the South African War was the trial at bar of Arthur Lynch for high treason in 1903 (*Rex* v. *Lynch*, 20 Cox C C. 468). It was there decided that the Naturalization Act 1870 does not permit naturalization in a foreign State at war with Great Britain, and therefore a British subject who renounces his allegiance and attempts to procure himself to be naturalized in an enemy's country in time of war is guilty of high treason. It was ruled that a person cannot become naturalized in a State with which his country is at war, for the act of becoming naturalized under such circumstances is itself an act of treason The accused was sentenced to death, but the sentence was afterwards commuted and he subsequently received a pardon. The most important case dealing with high treason in recent years was that of *Rex* v. *Casement*, the trial at bar being reported 25 Cox C.C. 480, and the decision of the court of criminal appeal in the same volume on p. 503 Sir Roger Casement was charged with high treason during the World War, and it was there held by the court of criminal appeal, affirming the decision of the king's bench division at the trial at bar, that if a man is adherent to the king's enemies in his realm by giving to them aid and comfort in the realm, or if he is adherent to the king's enemies elsewhere, that is, by giving them aid and comfort elsewhere, he is in either case adherent to the king's enemies, and commits the offence declared to be high treason by the Treason Act 1351. It was also held by the king's bench division that if a man—a British subject—does any act which strengthens or tends to strengthen the enemies of the king in the conduct of a war against the king, or if he does any act which weakens or tends to weaken the power of the king and of the country to resist or attack the enemies of the king and the country, he commits the offence of giving aid and comfort to the king's enemies, and is guilty of high treason. Sir Roger Casement was convicted, sentenced to death, and executed.

No amount of residence abroad exempts a British subject from the penalty of treason if he bears arms against the king, unless he has become naturalized as the subject of a foreign State before the

outbreak of the war in which he bears arms. To become naturalized as the subject of an enemy during a war is (as decided in *Rex* v. *Lynch*) in itself an act of treason. It is well established that an alien resident within British territory owes local allegiance to the Crown and may be indicted for high treason, and there are numerous instances of prosecution of foreigners for treason, the most recent being *de Jager* v. *Attorney-General of Natal* (1907, A.C. 326).

Court of Trial.—Four modes of trying high treason still remain, viz., impeachment, trial of a peer by his peers, trial by court-martial, and trial by jury on indictment before the High Court (generally at bar) or a court of assize or a special commission The offence is not triable at quarter sessions. At common law and under the Act of 1543 a peer, and, by an Act of 1441, a peeress in right of her husband, are triable for treason before the House of Lords, or, when parliament is not sitting, in the court of the lord high steward.

Procedure.—In certain cases of treason the procedure on the trial is the same as upon a charge of murder. Those cases, which are statutory exceptions from the statutory procedure prescribed for the trial of high treason and misprision thereof, are: (*a*) Assassination or killing of the king, or any heir or successor of the king, or any direct attempt against his life or any direct attempt against his person whereby his life may be endangered or his person may suffer bodily harm (1800, 1817); (*b*) attempts to injure in any manner the person of the king (1842).

In all other cases of treason the procedure is regulated by Acts of 1695, 1708 and 1825. A copy of the indictment must be delivered to the accused ten days at least before his arraignment, with a list of the witnesses for the prosecution (1708) and a list of the petty jury, except in the High Court, where the petty jury list is to be delivered ten days before the trial (1825). The accused is entitled to be defended by counsel, and on application to the court may have two counsel assigned to him (1695), a right extended in 1746 to impeachments for treason Witnesses for the defence have since 1702 been examinable upon oath. The accused may by the Criminal Evidence Act 1898 consent to be called as witness for the defence. It is doubtful whether the wife or husband of the accused is a compellable witness for the Crown (*Archb. Crim. Pleading*, 27th ed., 477).

Prosecutions for treason must be begun within three years of the offence, except in cases of attempts to assassinate the king. The rules as to the indictment are stricter than in the case of felony and misdemeanour, much of the modern statutory power of amendment not extending to indictments for the graver offence. No evidence may be given of any overt act not expressly stated in the indictment The accused is entitled to peremptory challenge of 35 of the jurors summoned for the petty jury; but they need not now be freeholders. The accused can be convicted only on his own confession in open court, or by the oath of two witnesses either both to the same overt act charged, or one to one overt act and the other to another overt act of the same treason. If two or more treasons of different kinds are charged on the same indictment, one witness to prove one treason and another to prove another are not sufficient for a lawful conviction. Persons charged with treason are not admitted to bail except by order of a secretary of State or by the High Court (K.B d.) or a judge thereof in vacation. Witnesses for the defence are examined on oath and their attendance is secured in the same way as that of witnesses for the Crown (1695).

Finally it must be noted that there can be no accessories before or after the fact to treason. Every person who incites, aids or abets treason is a traitor, and must be indicted as a principal.

Misprision of Treason.—This consists in the concealment or keeping secret of any high treason. This offence was in 1552 declared to be high treason, but the former law was restored in 1553–54. It is an indictable common law misdemeanour, not triable at quarter sessions, and the procedure for the trial of misprision of treason is the same as in the case of high treason The punishment is imprisonment for life and forfeiture of the offender's goods and of the profits of his lands during his life. The forfeitures are not abolished by the Forfeitures Act 1870. There is no case of prosecution of this offence recorded during the last century.

The necessity of prosecutions for treason has been greatly lessened by a series of statutes beginning in 1744 which provide for the punishment as felonies of certain acts which might fall within the definition of treason, *e.g.*, piracies (1744), incitement to mutiny (1797), unlawful oaths, including oaths to commit treason (1797, 1812), and aiding the escape of prisoners of war (1812). By the Treason Act 1842 it is a high misdemeanour, punishable by penal servitude for seven years, wilfully to discharge, point, aim or present at the person of the king any gun or other arms, loaded or not, or to strike at or attempt to throw anything upon the king's person, or to produce any firearms or other arms, or any explosive or dangerous matter, near his person, with intent to injure or alarm him or to commit a breach of the peace. The offence is one of the few for which flogging may be awarded.

By the Treason Felony Act 1848, s. 1, it was made a felony punishable by penal servitude for life within or without the United Kingdom to plot (*a*) to deprive or depose the king from the style, etc., of the imperial crown of the United Kingdom, (*b*) to levy war against the king in any part of the United Kingdom in order by force or constraint to change his measures or counsels or to put force or constraint on or to intimidate or overawe either or both houses of parliament, (*c*) to move or stir any foreigner with force to invade the United Kingdom or any of the king's dominions The plot to be within the Act must be expressed by publishing in printing or writing or by an overt act or deed For other offences more or less nearly connected with treason reference may be made to the articles. Libel and Slander; Oath; Petition; Riot, Sedition.

The Act of 1848 does not abrogate the Treason Act of 1351, but merely provides an alternative remedy But with the exception of the case of Lynch in 1903 and of Casement in 1916 all prosecutions in England for offences of a treasonable character since 1848 have been for the felony created by the Act of 1848. The procedure in the case of all the offences under the Act of 1848 is governed by the ordinary rules as to the trial of indictable offences, and the accused may be convicted even though the evidence proves acts constituting high treason. Principals in the second degree and accessories before the fact are punishable as principals, and accessories after the fact by two years' hard labour.

(W. F. C.; W. de B. H.)

UNITED STATES

The extent to which the crime of treason had been warped in early English history played an important part in restricting the character of the crime in America by constitutional means. The United States Constitution expressly forbids Congress and the States from passing bills of attainder or ex post facto laws. It further defines the crime of treason as follows. "Treason against the United States shall consist only in levying war against them, or in adhering to their enemies, giving them aid and comfort. No person shall be convicted of treason unless on the testimony of two witnesses to the same overt act, or on confession in open court. The Congress shall have power to declare the punishment of treason, but no attainder of treason shall work corruption of blood, or forfeiture except during the life of the person attainted." This definition embraces only treason against the United States. Treason against a State is also possible and as such is governed by State laws or constitutions. Treason against a State, however, usually involves an attempt to withdraw the State from the Union and thereby prevent the exercise of national sovereignty within the limits of the State, and thus becomes merged in treason against the United States. Consequently the crime of treason against a State is little known in American law.

The constitutional definition of treason is, in part, taken from the old English Statute of 24 Edw. III. Congress in 1790 and 1862 provided for its punishment by prescribing the death penalty as a maximum and a minimum penalty of five years' imprisonment and a $10,000 fine, provisions which have been carried forward into the existing laws (*U.S Code, Tit. 18, §2*). Congress has no power to enlarge the constitutional definition, though it may make other

offences which are treasonous in character felonies and punishable as such. Thus misprision of treason, or the failure to disclose knowledge of the commission of acts of treason, is made a felony. (*U.S. Code, Tit. 18*, §3), trading with the enemy, seditious utterances, insults to the flag, obstructing recruiting, and like offences have been made Federal crimes. None of these, however, carries the death penalty.

The question of what acts constitute treason was brought to the forefront in the heated trial of Aaron Burr for treason in 1807. The opinion of Chief Justice Marshall in this case of *U.S.* v *Burr*, 4 Cranch 470, 25 Fed. Cas. 2, sitting as circuit judge in the circuit court of Virginia, remains the landmark of American law upon the subject of treason. Under the principles there laid down, levying war must comprise more than a conspiracy to make war or an intention to go to war. There must be an actual going to war, proved by open deed. The employment and exhibition of force thus becomes necessary. A secret furtive assembly without the appearance of force nor in a condition to make war, however treasonable its purpose, cannot constitute treason. It is not essential that any blow be struck provided that the assemblage be in a condition to use force and have the intention to carry out their purpose by violence. A procurement to commit treason is also treason, for the American law accepts the English principle that what will make a man an accessory in felony makes him a principal in treason. But in such a case it is the act of procurement of the treasonous assemblage, not the acts of the assemblage, which is the overt act of treason that must be testified to by two witnesses in order to convict him. The difficulty of proving the procurement in this manner, as procurement is generally a secret transaction, has made conviction for procurement of treason a practical impossibility. This ruling of Chief Justice Marshall, severely criticized at the time, was responsible for Burr's acquittal upon the charge of treason.

The second element in the constitutional definition of treason, adhering to the enemies of the United States and giving them aid and comfort has caused less difficulty. Furnishing the enemy with such facilities as are needed for the prosecution of war, such as ammunition, supplies, and means of transportation, constitutes treason. The acts which constitute treason need not be done by a citizen of the United States, but inasmuch as any alien temporarily resident within the United States and under the protection of the sovereign owes it a duty of allegiance so long as he remains within the United States, his breach of allegiance can constitute treason. *Carlisle* v. *United States*, 16 Wall. 147 (1872).

Prosecutions for treason, as any Federal crime, are cognizable solely by the Federal courts. Such prosecutions occurred mainly during three periods in American history. During the American Revolution they were cognizable only by the State courts, no Federal courts for the trial of criminal cases being in existence at the time. The Whiskey Rebellion in Pennsylvania, shortly after the organization of the Federal Government, brought forth a few cases. The opposition of the New England States to the War of 1812 brought to pass additional prosecutions for treason. The Civil War, of course, was most prolific of treason, but the President's proclamation of 1868 of pardon and amnesty brought all treason prosecutions to an end. The World War developed no treason cases, though numerous prosecutions for seditious utterances and conduct were initiated under the Espionage and Trading with the Enemy Acts. The most famous cases of treason concerned Aaron Burr, John Brown of Harper's Ferry fame, and Jefferson Davis, president of the Confederate States Brown was convicted and hanged; the President's proclamation of pardon reprieved Davis before he came to trial. (J. M. Ls.)

TREASURE TROVE, the legal expression for coin, bullion, gold or silver articles, found hidden in the earth, for which no owner can be discovered.

As feudalism spread over Europe and the prince was looked on as the ultimate owner of all lands, his right to the treasure trove became, according to Grotius, *jus commune et quasi gentium*, in England, Germany, France, Spain and Denmark. In England for centuries the right to treasure trove has been in the Crown, who may grant it as a franchise. It is the duty of the finder, and indeed of any one who acquires knowledge, to report the matter to the coroner, who must forthwith hold an inquest to find whether the discovery be treasure trove or not. Concealment is an indictable offence. In the statute *De officio coronatoris* 1276 the coroner is enjoined to inquire as to treasure trove, and the Coroners Act of 1887 continues this power as heretofore. In Scotland the law is similar. Such articles are presumed to have once had an owner, and, in his absence, they belong, not to the finder but to the King. Their concealment is not a criminal offence unless accompanied by intent to appropriate. In India the Treasure Trove Act (16 of 1878) defines treasure as "anything of value hidden in the soil." The finder has three-fourths and the owner of the land one-fourth.

In the United States the common law, following English precedent, would seem to give treasure trove to the public treasury, but in practice the finder has been allowed to keep it In Louisiana one-half goes to finder and one-half to owner of land. Modern French law is the same, as it is also in Germany, Italy and Spain.

See Blackstone's *Commentaries;* J. Chitty, *Prerogatives of the Crown* (1820), J. Rankine, *Landownership* (new ed., 1909); J. Murray, *Archaeological Survey of the United Kingdom* (1896), containing copious references to the literature of the subject; R. Henslowe Wellington, *The King's Coroner* (1905-06).

TREASURY DEPARTMENT: *see* GOVERNMENT DEPARTMENTS.

TREATIES. A treaty is an instrument binding two or more states under international law. The word is derived, through the French *traité* (Fr. *traiter*, to negotiate) from the Latin *tractatus*, the term which from the end of the 17th century began to be used in diplomacy instead of the older technical terms *conventio publica* and *foedus*. According to modern diplomatic usage the term "treaty" is confined to the more important international agreements and those of lesser or subordinate importance have been called "conventions," "agreements," "arrangements," "protocols" and "acts" but all of these conform to the definition of "treaty" given above.

Form.—In making a treaty it is not essential to employ any special form. A treaty often takes the form of a contract, but it may take the form of a joint declaration or of an exchange of notes (as in the case of the Rush-Bagot agreement between the United States and Great Britain in 1817 for mutual disarmament on the Great Lakes). It is, however, customary to draw up all important treaties on a fixed plan. First comes the preamble, giving the names and styles of the high contracting parties, a statement of the general objects which they have in view, the names and official designations of the plenipotentiaries charged with the negotiation and a statement that their full powers have been verified Then follow the articles containing the stipulations agreed upon. If the treaty is concluded for a definite period, this is next stated or, if it be in form perpetual, there may be a provision inserted that either party may "denounce" (*i.e.*, give notice to terminate) the treaty. Next follows an article providing for ratification and for the time and place for the exchange of ratifications. At the end is a clause stating that "in witness whereof (*en foi de quoi*) the respective plenipotentiaries have affixed their names and seals." The signatures follow, with the place and date. "Additional articles" are often appended and signed by the plenipotentiaries, with the declaration that they have the same force and value as if they had been included in the body of the treaty or convention.

General Treaties.—Treaties with a large number of parties, called general, multilateral or multipartite treaties, often have the character of legislation rather than of contract. They have frequently been negotiated at permanent or periodic conferences such as the League of Nations assembly (*see* LEAGUE OF NATIONS), the United Nations general assembly or the conferences of the specialized agencies under the United Nations (*q.v.*), or in special conferences called to deal with a particular subject such as the San Francisco conference on the United Nations organization. Treaties which emerge from such conferences usually refer to the conference in the preamble, though frequently the high contracting parties are individually listed as in bilateral treaties. The democratic tendency of diplomacy during the 19th century can be detected in

the increasing utilization of such treaties in preference to bilateral treaties and in the references to popular participation as in the Kellogg-Briand pact in which the high contracting parties "solemnly declare in the names of their respective peoples" and in the United Nations Charter the preamble of which begins with the phrase "We the peoples of the United Nations determined . . ." In the interpretation of such treaties there is a tendency to make less use of preparatory discussion which usually discloses the views of only a few of the parties and to rely mainly on the customary or legal meaning of terms and on general rules of construction. Among important treaties of this type mention may be made of the Declaration of Paris, 1856; the Geneva Convention on the Red Cross, 1864; the Convention of the Universal Postal Union, 1874; The Hague Conventions, 1899 and 1907, the League of Nations Covenant, 1919; the Constitution of the International Labour Organization, 1919; the Statute of the Permanent Court of International Justice, 1920; the Geneva Protocol for the Pacific Settlement of International Disputes, 1924, the General Act of Geneva for the Pacific Settlement of International Disputes, 1928; the Treaty for the Renunciation of War (Kellogg-Briand pact), 1928; the United Nations Charter, 1945; the Agreement for the Establishment of an International Military Tribunal and the Charter for the International Military Tribunal, 1945; the Convention on the Crime of Genocide, 1948; and the International Covenant on Human Rights, of which a draft was submitted in 1950. These instruments, it may be observed, have a great variety of designations. To these may be added numerous agreements, acts, arrangements, declarations, mandates, protocols, regulations, resolutions, rules and trusteeships proceeding from international conferences or organizations and often having the character of treaties. Manley O. Hudson lists 257 multipartite instruments made from 1864 to 1919 and 700 made from 1919 to 1946. D. P. Myers estimated in 1920 that about 30,000 treaties, both bilateral and general, had been concluded among civilized states of which about one-fifth were then in force. More than 5,000 treaties have been concluded since 1920 and published in the treaty series of the League of Nations or of the United Nations.

Classification of Treaties.—International jurists have classified treaties on a variety of principles. Aside from the distinction between general and bilateral treaties already referred to, the distinction has been drawn between those which represent a definite transaction such as a cession of territory (*Rechtsgeschäft*) and those which seek to establish a general rule of conduct, such as the "renunciation of war" (*Rechtssatz*). They may be classified in a more practical way according to their object, as follows: (1) political, such as treaties of peace, of alliance, of cession of territory, of pacific settlement and of disarmament; (2) commercial, including tariff, consular, fishery and navigation conventions; (*see* COMMERCIAL TREATIES) (3) constitutional and administrative such as the conventions establishing and regulating international unions, organizations and specialized agencies; (4) relating to criminal justice, as treaties defining international crimes and providing for extradition (*q.v.*); (5) relating to civil justice, as conventions for the protection of human rights, trade-marks and copyright, and the execution of the judgments of foreign courts; (6) codifying international law such as procedures for the peaceful settlement of international disputes, rules for the conduct of war and definitions of the rights and duties of states. In practice it is often difficult to assign a particular treaty to any one of these classes.

Antiwar Treaties.—Treaties for the renunciation of war, for disarmament, and for pacific settlement of international disputes might be called "treaties of peace" but that term has been employed to refer to treaties which end a particular war rather than to treaties which are intended to prevent future wars. Antiwar treaties belong in the class of political treaties, but they often contain provisions of administrative or codifying character. Arbitration clauses have often been included in commercial and other treaties and numerous bilateral treaties of arbitration and conciliation have been made providing either for the submission of past controversies to pacific settlement, or for the submission of classes of future controversies. The Hague Conventions (1899, 1907), the League of Nations Covenant (1919), the Statutes of the Permanent Court of International Justice (1920) and the International Court of Justice (1945), The General Act (1928), and the United Nations Charter (1945), provided procedures and institutions for pacific settlement. The optional clause of the court statute, which has been ratified by a large number of states, including the United States, the United Kingdom and France, provides for compulsory jurisdiction of the court in legal disputes on application of one party.

Bilateral disarmament treaties have been made, such as the Rush-Bagot Agreement of 1817 disarming the Great Lakes. Defeated powers have often been compelled to disarm partially in treaties of peace. General treaties for limited disarmament have been made as the Washington Treaties of 1922 and the London Treaty of 1930. Efforts at general disarmament in the League of Nations Conference of 1932 failed, as have efforts to achieve general elimination of atomic weapons under the United Nations Charter (*See* DISARMAMENT)

Treaties for the renunciation of war may apply to particular areas such as neutralized states or boundaries, or to limited periods of time as the Bryan "cooling off treaties" negotiated by the United States in 1913–14 with many countries and providing for commissions of conciliation to function for a period of a year during which the parties agreed not to resort to hostilities. This idea was included in article 12 of the League of Nations Covenant. By the Kellogg-Briand Pact of 1928, 63 states, all in the world except a few Latin American states, condemned war, renounced it as an instrument of national policy and agreed *never to seek the settlement of any dispute or conflict except by pacific means.* This treaty did not prevent hostilities, but it did "outlaw war" in the sense that war was no longer regarded as a situation which could be initiated by a sovereign state and which equally entitled both belligerents to employ armed force. Third states were no longer obliged to be impartial but were free to differentiate between the "aggressor" and the "victim." As a consequence, states were not free to recognize that the aggressor's conquest gave legal title; nonbelligerents were free to discriminate against the aggressor; and high officers of government instituting hostilities in violation of the pact were potentially liable and unable to defend themselves behind the alleged "act of state" of the aggressor state War in the material sense continued, but the legal sense of war, as understood in the 19th century, a condition which equally permits two or more states to settle their controversies by the test of armed force, had been so altered that it is proper to say war had been "outlawed." (*See* OUTLAWRY OF WAR.)

Validity.—1 A treaty, like a contract in private law, is only valid when made between competent parties, normally sovereign states. Nonsovereign states such as protectorates, vassal states and members of federations may make valid treaties within the range of their international capacity. The British dominions are recognized to have sovereign capacity in international relations.

2. In principle a treaty is not valid unless accepted in accord with the treaty making procedure of each state as determined by its municipal law. A government, however, can understand the provisions of foreign constitutions concerning treaty making only through communications with the foreign office of that state. Consequently, treaties made in accord with the procedure which the foreign office, acting in the name of the representative authority of the state, considers constitutional are deemed internationally valid The Permanent Court of International Justice said in the *East Greenland* case that a reply "given by a Minister of Foreign Affairs on behalf of his government in response to a request falling within his province is binding upon the country to which the minister belongs." Judge Dionisio Anzilloti in a separate opinion concurred on this point but clarified the phrase "within his province" by saying it was the foreign minister's "duty to refrain from giving his reply until he had obtained any assent that might be requisite" under his country's law. (3 *World Court Reports* 191, 200) In Great Britain the treaty-making power resides in the executive. *In* the United States, treaties in the constitutional sense, though negotiated by the president through the state department, can only be concluded "with the advice and consent of the Senate." In practice the senate has shown itself very jealous of its right to insist on reservations or amendments before ratification The two-thirds vote required by the constitution has added to this tendency because it normally makes it necessary to gain the consent of many senators of the minority party. The president has therefore increasingly made use of executive agreements which he can make on his own responsibility if his independent powers are adequate to execute them, or with support of a simple majority of both houses of congress if the normal legislative powers of congress are sufficient to provide for their execution. Yet as the main obligation of the treaty is the payment of money or tariff regulation, the latter method has normally been used. In many countries, the treaty-making power is shared between the executive and the legislature only for certain purposes. In France, for instance, treaties of peace, treaties of commerce and those involving financial obligations or relating to the rights of French citizens are not valid until ratified by a majority in both chambers.

3. A treaty, to be valid, must be the expression of an agreement. Unlike a private contract, however, under customary international law a treaty was not voidable on proof that one of the parties to it

had been subject to duress, but only if it could be proved that the individual negotiator had been so subject. Thus a treaty imposed by the victor upon the vanquished remained valid, though signed under pressure of force The Stimson doctrine held that this rule was modified among the parties to the Kellogg-Briand Pact for the renunciation of war if the treaty had been made through coercion in violation of that pact, on the principle that rights do not arise from wrongs (*jus ex injuria non oritur*).

4. In modern practice a treaty, though executed by agents with full powers is not valid until it has been ratified by both parties and ratifications have been exchanged or, in the case of a general treaty, ratifications have been deposited at a designated place This applies only to instruments subject to ratification. Many agreements, protocols, and exchanges of notes become valid when signed.

5. Article 18 of the covenant of the League of Nations provided that every treaty or international agreement entered into after the signature and ratification of the covenant, by any member of the League, should be forthwith registered with the secretariat and should as soon as possible be published by it; and that no such treaty or international agreement should be binding until so registered A similar provision in article 102 of the United Nations Charter merely declares that a party to an unregistered treaty may not invoke it before any organ of the United Nations.

6. Article 20 of the covenant provided that treaty obligations among the members were abrogated if inconsistent with the covenant and such obligations with nonmembers should be terminated by members Article 105 of the United Nations Charter merely provides that the obligation of members under the charter shall in case of conflict supersede their obligations under any other international agreement.

Interpretation and Application.—1. Treaties are to be interpreted in accord with international law. That law gives guidance as to the meaning of technical terms and establishes presumptions useful for construction such as that against sacrifices of sovereignty by the parties. However, evidence in the negotiations or subsequent practice may overrule these presumptive meanings or constructions by indicating that the parties had a different intention in the particular instance. Such historical evidence is, however, more useful in the case of bilateral than of general treaties.

2 The question of the language employed in treaties has often caused trouble. In the 16th century international treaties were drawn up in Latin, more rarely in French. It was not till the 18th century that the latter was generally accepted (except by the pope and the emperor) as the language of diplomacy The Anglo-French commercial treaty of April 11, 1713, was in Latin Before World War I general conventions were usually drawn up in French, but the League of Nations and the United Nations adopted both English and French as working languages and treaties related to these organizations were official in both languages The San Francisco conference recognized, in addition, Spanish, Russian and Chinese as offical languages and the United Nations Charter appears officially in five languages, though it was added to French and English as a working language by the United Nations in 1949. Bilateral treaties are usually in two texts, one in each language, both of which are signed by the plenipotentiaries of the two parties. Such bilingual treaties have sometimes been accompanied by a third version in French, to be decisive in case of a difference of opinion arising as to the precise meaning of the language of the other texts.

3. Treaties are in first instance interpreted and applied by the parties. Constitutions of some countries (*e.g.*, the United States) make treaties automatically the supreme law of the land to be applied by courts and administrative officers, while others (*e.g.*, Great Britain) do not consider treaties applicable rules of municipal law until the legislature has acted giving domestic force to the provisions of the treaty. This distinction, however, is in reality one of degree. In all countries some treaties are in some circumstances, "self-executing" while others are not Thus in Great Britain treaties dealing with maritime captures are automatically applied in prize courts and in the United States, treaties requiring appropriations or modifications of criminal law are not applicable until congress has acted

4. The ultimate interpretation of treaties is an international question Because of the lack of certainty that a dispute concerning interpretation and application of the treaty will be decided through diplomatic negotiation, treaties frequently include a "compromissory clause" by which the parties agree to submit such questions to arbitration or judicial settlement. The optional clause of the Statute of the International Court of Justice (art. 36, par. 2) provides for the compulsory jurisdiction of the court in "all legal disputes concerning the interpretation of a treaty." This applies only among states which have deposited with the secretary-general of the United Nations a declaration accepting the clause

5. A treaty sometimes provides for acts intended to secure its due performance; *e.g.*, the occupation of the German Rhine provinces by the Allied powers pending the payment of the reparations imposed by the Treaty of Versailles (arts. 428–431). The enforcement of treaties is in general secured by the mutual interests of the parties and the right of each to abrogate on nonobservance by the other, and by the procedures of customary international law and the United Nations for the maintenance of obligations of states under International law.

Duration of Treaties.—The question of when, and in what circumstances, the obligations incurred under treaties come to an end has been the subject of much debate A treaty may lapse naturally by the destruction of one of the states party to it, by the object of the agreement ceasing to exist, by the conclusion of a new agreement among the parties abrogating or superseding it or by denunciation by one of the parties under powers reserved in the treaty itself Treaties are also in most cases suspended, if not terminated, by war between the contracting parties, and are therefore usually revived in express terms at the treaty of peace. More debatable is the proposition upheld by certain jurists, *e.g.*, Cornelius van Bynkershoek, that the condition *rebus sic stantibus* is implicit in every treaty. Bismarck, in his *Reminiscences*, considered it self-evident that treaties were valid only as long as they are useful to the parties. In practice this was certainly often the case even after the London Protocol of 1871, which laid down the principle that "no Power can liberate itself from the engagements of a treaty, nor modify the stipulations thereof, unless with the consent of the contracting Powers, by means of an amicable agreement." Article 19 of the League of Nations Covenant provided that "the Assembly may from time to time advise the reconsideration by members of the League of treaties which have become inapplicable" The same purpose is intended by article 14 of the United Nations Charter, though it does not specifically refer to treaties. It authorizes the general assembly "to recommend measures for the peaceful adjustment of any situation, regardless of origin, which it deems likely to impair the general welfare or friendly relations among nations." Jurists, however, recognize these procedures as political measures for modifying undesirable or dangerous treaties and not as applications of the jural principle *rebus sic stantibus*. The latter holds that treaties may be declared at an end by proper proceedings which find that conditions deemed by the negotiators essential to the agreement have changed

Abrogation or Renewal of Treaties After War.—Highly technical points are raised by this question It is clear that in the case of bilateral treaties, if state A can force state B to sign a treaty of peace after the war, A can renew or refuse to renew with B all the prewar treaties that it chooses. Germany did not question this right after World War I in respect to bilateral treaties with the allied powers The Allies, however, claimed the right to refuse permission to Germany and other enemy powers to keep in force treaties with states not actually then engaged in the war such as the Soviet Union, or with neutrals who had not been in the war at all though they had severed diplomatic relations with Germany, such as Peru and Ecuador The Allies also maintained and inserted in the German peace treaties their right to "reapply" all "multilateral treaties which seemed to them to be compatible with the new conditions arising out of the war," and "to indicate which of these treaties with Germany they intended to revive or allow to come into force or be revived." (Treaty of Versailles, art. 289) The Allies particularly insisted on making Germany grant them most-favoured nation treatment in commerce (art 264) and other benefits (arts 297, 294) granted to Germany's friends or to neutrals But they did not demand that Germany should be prevented from negotiating new instruments with states other than the Allies. After having been compelled to abrogate the treaties of Brest-Litovsk with Soviet Russia (art. 292), Germany negotiated the Treaty of Rapallo with that state on April 16, 1922

The provisions of the treaties of peace after World War II were similar but less complicated. Each Allied power was entitled to notify Italy within six months which bilateral treaties it wished to preserve. Treaties not so notified would be considered abrogated Express provisions were included in regard to certain general treaties. For example Italy renounced its interest in the mandate system, but the situation of general treaties was not covered comprehensively. The treaties of peace with Bulgaria, Hungary, Rumania and Finland had similar provisions.

The Inviolability of Treaties.—Since much of the structure of international relations, as regulated by law, is based upon treaties, it follows that anything that tends to weaken men's faith in, and respect for, treaties must loosen this structure. For this reason it is important that treaties, once made, should be kept in the letter and in the spirit. The principle *pacta sunt servanda* is considered basic in international law Maintenance of this principle, however, requires that nothing should be included in a treaty which the parties to it are not reasonably sure that they and their successors will be able to carry out in any circumstances. This principle led British statesmen during the 19th century from Pitt and Lord Castlereagh onward to avoid commitments "for external exertion" in circumstances which could not be foreseen. For the same reason, in the days of the old diplomacy, there was in the language of the treaties of peace, and of other solemn intercourse generally, a studied avoidance of anything that might keep open old sores by any unnecessary wounding of the feelings of the vanquished. In this respect the Treaty of Versailles of 1919 compared unfavourably with the Treaty of Versailles of 1783. In the former the defeated nation was compelled to confess its "war-guilt" whether it believed itself guilty or not, and the terms of the penance which was to be the price of its restoration to the communion of nations were built into the very foundations of the new international organization. This rankled in the minds of the Germans, and contributed to the causes of World War II. Article I of the treaty of 1783, on the other hand, ends with the words: "There shall be complete oblivion of, and amnesty for, all that may have been done or

committed before or during the war which has now come to an end."

This change is a manifestation of the shrinking of the world, the increasing destructiveness of war, and the democratization of the conduct of international relations. These conditions have led to the concept of a world community, sustaining principles of peace and justice the violation of which ought to be universally condemned War crimes trials, applied much more extensively after World War II than after World War I, provided evidence of this change. The newer view considers treaties by analogy to municipal law, while the old considered them instruments of power politics. Some international jurists, including Theobald von Bethmann-Hollweg, adhering to the new view, held that Germany was guilty of a breach of international law in invading Belgium in defiance of the treaty of 1839. Others, among whom was Sir Ernest Satow, adhering to the older view, maintained that Germany by violating Belgium in 1914 merely gave any other guarantee ng state the right to attack it. In other words, Germany risked its existence but did not specifically break international law. The difference between these two views is that the first relies upon law to establish the sanctity of treaties, and the latter relies upon the balance of forces. The difficulty of the first view lies in the fact that the community of nations may lack the solidarity necessary to maintain its law. For instance, it was thought to have been established in 1871 that no great power which had joined the other great powers in signing a treaty could violate the provisions of that treaty without the consent of the other signatories, that is without a European conference. But in 1908 Austria-Hungary violated article 25 of the Treaty of Berlin (1878) by annexing Bosnia and Hercegovina, and refused the demand for a conference. The other powers acquiesced.

The peacemakers of 1919, therefore, set up a state of things whereby the sanctity of treaties would be upheld by the general cooperation of all states. Pres. Woodrow Wilson condensed this aspiration into a single sentence, "What we seek is the rule of law sustained by the organized opinion of mankind." The League of Nations Covenant attempted to give a general guarantee of territorial integrity and independence to all the members of the League. This general guarantee, embodied in article 10 of the covenant, was, however, in fact succeeded by a system of special or regional guarantees, including the Treaty of Locarno (1925) and the Little Entente (1920–21) Similarly it was recognized in article 26 of the covenant that the Monroe doctrine was "a regional understanding," which meant a practical admission by the principal powers that the United States guaranteed other states on both American continents against the aggression of non-American neighbours. The violation of both general and regional guarantee in the 1930s and the temporary acquiescence in these violations by the powers indicated a continued lack of solidarity of the community of nations.

The United Nations Charter agreed to at the end of World War II sought to strengthen the universal guarantees of the League of Nations by making them less rigid and more organized, and sought also to strengthen the outlawry of war formally established by the Kellogg-Briand Pact in 1928. The Security council was given the power to decide what measures to take when it found that aggression had occurred or was threatened (article 39) and members were obliged to act accordingly (articles 25, 48). Provision was made for a General Staff committee to organize forces provided by advance commitment of the members. The veto given the great powers in the Security council and the consequent inability of that body to function satisfactorily has, as in the interwar period, resulted in a new resort to regional agreements and pacts for "collective self-defense" authorized by the charter (articles 51, 52). The transition from a regime of treaties subject to the exigences of power politics to a regime of treaties supported by a law enforcing community of nations has not yet been effected.

Treaties and the World Order.—Many treaties containing what were technically known as "transitory provisions" with reference to recognition, boundaries or cessions of territory, have become, as it were, the title deeds of the nations to which they relate. This may be said to date from the treaties of Osnabrück and Münster (Westphalia) in 1648, which were the work of the first international congress, and were recognized as giving a new juridical basis to the territorial system of Europe. Although, in the 18th century, treaties were more honoured in the breach than in the observance, it was considered expedient to veil even the most flagrant acts of aggression under legal forms, as in the case of the three partitions of Poland which, as Friedrich von Gentz observed, set an unhappy precedent for the aggressions of Revolutionary France.

The treaties concluded between the powers after the downfall of Napoleon (I. Paris, 1814; Vienna, Final Act, 1815; II Paris, 1815; and Frankfurt, 1819), represented an attempt to reorganize the European territorial system on a sound basis by endowing the reconstituted states with unimpeachable title-deeds and ensuring their stability by establishing a balance of power among them. Other treaties—the treaty of Chaumont in March 1814, and the treaty of alliance of Nov. 20, 1815 which was based upon it—provided for the continuance of the Quadruple Alliance for the purpose of watching over and safeguarding the settlement thus made. And, though this "federal system" for Europe broke down for various reasons (*see* EUROPE), the idea of the treaties as the foundation of the European system, and of the concert of Europe as their guardian, survived long enough to secure an unprecedented period of peace. The principle that the treaties could not be altered without the consent of "Europe" was also more or less effectively asserted effectively in the case of the treaties of 1831 and 1839 which separated Belgium from the Netherlands, ineffectively in the protests of France and Great Britain against Russia's violation of the terms of the Treaty of Vienna by its treatment of the Poles in 1830 and 1863.

The principle of the solidarity of Europe in the matter of territorial changes was [illegible] extended to the questions arising out of the disintegration of the Ottoman empire. [illegible] the treaties of 1856 and 1871 [illegible] the Treaty of London (1867) [illegible] the Treaty of Berlin (1878) and [illegible] had the Vienna settlement of 1815 been [illegible] the great powers, in the case of Belgium, 1830, 1831, and in the Constantinople treaty of 1841 [illegible] and [illegible] Paris, London, 1856, Berlin, 1878, treaties with reference to Montenegro, Roumania, Serbia, Bulgaria, the Ottoman empire, Egypt, Greece, Crete, the Balkan states. The [illegible] of Nations and the United Nations were more effective [illegible] but depended in the last resort, as Europe broke up in the interwar period, on the good faith of the signatories and upon the [illegible] the [illegible] and upon the [illegible] the conference and [illegible] among [illegible].

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TREATY, COMMERCIAL; *see* COMMERCIAL TREATIES.

TREBIA (mod. *Trebbia*), a river of Cisalpine Gaul, a tributary of the Padus (Po), into which it falls some 4 mi. west of Placentia (Piacenza). Its valley is followed past Bobbio by the modern high road from Piacenza to Genoa (88 mi.). It is remarkable for the victory gained on its banks by Hannibal over the Romans in 218 B.C. Kromayer's investigations make it clear that Polybius's account, according to which the battle took place on the left bank of the river, is to be preferred to that of Livy (see *Antike Schlachtfelder*, iii, 1 [Weidmann, 1914], 47 *sqq.*). T. Frank in *Journal of Roman Studies*, ix, 202 (1919), suggests that the Placentia referred to in both accounts lay west of the river; *i.e.*, about 15 mi. west of the later Placentia, refounded in 190.

Scipio (the father of Scipio Africanus) had advanced to meet Hannibal two days' march west of Pavia, but was defeated in a cavalry engagement, and in a forced night march recrossed the Ticinus and the Padus (probably at Placentia) and then took up a new position near Clastidium on the south bank of the latter river, about 20 mi. west of Placentia: while Hannibal, finding himself unable to cross the Ticinus, marched westward up the Padus until he could cross it, and came up with the Romans and offered battle, which was, however, not accepted; and he therefore encamped 5 mi. away from them. Scipio, however, in consequence of the desertion of more than 2,000 of his Gaulish auxiliaries, retreated to the further bank of the Trebia, where he was joined by Sempronius, the other consul, who had brought his army from Ariminum. Hannibal followed them and encamped once more about 4 mi. from them: and as a decisive victory was imperative, in order that he might win over the Gauls to his side, and he had about 40,000 men, or as many as the two armies together, he did nothing to prevent their junction. A successful cavalry skirmish with the Carthaginian foragers encouraged Sempronius to overcome his colleague's objections to a general engagement, and the Romans marched across the Trebia. The battlefield was almost flat, but on the south was rising ground traversed by a number of fairly deep, broad stream beds, in one of which Hannibal concealed a force of 2,000 men under his young brother Mago, which was to have a decisive effect on the fortunes of the day. At the same time he sent his 8,000 light troops out to cover the advance

of his main body of infantry, consisting of 20,000 Iberians, Celts and Libyans, while his cavalry (over 10,000, including his Celtic allies) were placed on the wings, with the elephants in advance of them. The Roman cavalry was soon driven back, and the Carthaginian light troops, Numidian cavalry and elephants attacked the Roman infantry on the flanks, so that the wings were put to flight and driven into the river, while Mago's force suddenly fell on the rear of the Roman centre and worked destruction on the rear ranks. The front ranks of the Roman centre, on the other hand, to a number of some 10,000 men broke through the Carthaginian centre with great slaughter, but seeing that the wings had been completely driven back, they took no further part in the battle but marched in good order into Placentia, where they were joined by the cavalry. The greater part of the rest of the army, entirely surrounded by superior numbers, met its death in the river itself. The battle has been rightly described as a Cannae on a small scale, and the similarities are certainly striking, as will be seen by a comparison of the two accounts. (T. A.)

TREBIZOND or TRABZON (Gr. *Trapezus*), city of Turkey, on the Black sea, near its southeastern angle. From the time of its foundation as a Greek colony to the present day, it has always been a considerable emporium of commerce, and it was for two centuries and a half the capital of an empire. Its importance is due to its command of the point where the chief trade route from Persia and central Asia to Europe, over the tableland of Armenia by Bayezid and Erzerum, descends to the sea. Its safety also was secured by the barrier of rugged mountains (7,000 to 8,000 ft.) which separates its district from the rest of Asia Minor. So complete is the watershed that no streams pass through these ranges, and there is hardly any communication in this direction between the interior of Asia Minor and the coast. For the same reason, together with its northern aspect, the climate is humid and temperate, unlike that of the inland regions, which are exposed to great extremes of heat in summer and cold in winter. The position which was occupied by the Hellenic and mediaeval city is a sloping table of ground (whence the original name of the place, Trapezus, the "Tableland"), which falls in steep rocky precipices on the two sides, where two deep valleys, descending from the interior, run parallel at no great distance from one another down to the sea. The whole is still enclosed by the Byzantine walls, which follow the line of the cliffs and are carried along the sea-face; and the upper part of the level, which is separated from the lower by an inner cross wall, forms the castle; while at the highest point, where a sort of neck is formed between the two valleys, is the keep which crowns the whole. On each side, about halfway between the keep and the sea, these ravines are crossed by massive bridges, and on the farther side of the westernmost of these, away from the city, a large tower and other fortifications remain. The area of the ancient city is now called the Kaleh; eastward of this is an extensive quarter, and beyond this again a low promontory juts northward into the sea, partly covered with the houses of a well-built suburb, which is the principal centre of commerce. The harbour lies on the eastern side of this promontory, but it is an unsafe roadstead, being unprotected towards the northeast and having been much silted up, so that vessels cannot approach within a considerable distance of the shore. From here the caravans start for Persia. The population in 1940 was 32,789.

History.—The city of Trapezus was a colony of Sinope, but it first comes into notice at the time of the Retreat of the Ten Thousand, who found repose there. Notwithstanding its commercial importance, the remoteness of its position prevented it from being much known to fame either in the Hellenic or the early mediaeval period. Its greatness dates from the time of the fourth crusade (1204), when the Byzantine empire was dismembered and its capital occupied by the Latins. During the confusion that followed that event, Alexius Comnenus escaped into Asia and, having collected an army of Iberian mercenaries, entered Trebizond, where he was acknowledged as the legitimate sovereign, and assumed the title of Grand Comnenus. Though only 22 yr. of age, Alexius was a man of ability and resolute will, and he succeeded without difficulty in making himself master of the greater part of the southern coast of the Black sea.

The empire thus founded continued to exist until 1461, when the city was taken by Mohammed II. Trebizond was able to defy both the Seljuks and the Ottomans and to maintain its independence against the emperors of Nicaea and Constantinople. But for the same reason its policy was always narrow, so that it never exercised any beneficial influence on the world at large. It was chiefly in the way of matrimonial alliances that it was brought into contact with other states. Members of the imperial family were renowned for their beauty, and the princesses of this race were sought as brides by Byzantine emperors of the dynasty of the Palaeologi, by western nobles and by Mohammedan princes, and the connections thus formed originated a variety of diplomatic relations and friendly or offensive alliances.

The palace of Trebizond was famed for its magnificence, the court for its luxury and elaborate ceremonial, while at the same time it was frequently a hotbed of intrigue and immorality. The Grand Comneni were also patrons of art and learning, and in consequence of this Trebizond was resorted to by many eminent men, by whose agency the library of the palace was provided with valuable manuscripts and the city was adorned with splendid buildings. The writers of the time speak with enthusiasm of its lofty towers, of the churches and monasteries in the suburbs and especially of the gardens, orchards and olive groves. It excited the admiration of Gonzales Clavijo, the Spanish envoy, when he passed through it on his way to visit the court of Timur at Samarkand (Clavijo, *Historia del gran Tamorlan*); and Cardinal Bessarion, who was a native of the place in the latter part of his life when the city had passed into the hands of the Mohammedans and he was himself a dignitary of the Roman Church, was so impressed with Trebizond that he wrote a work entitled *The Praise of Trebizond* (Ἐγκώμιον Τραπεζοῦντος). Little was known of the history of the empire of Trebizond until the subject was taken in hand by Professor Fallmerayer of Munich, who discovered the chronicle of Michael Panaretus among the books of Cardinal Bessarion, and from that work and other sources of information which were chiefly unknown up to that time, compiled his *Geschichte des Kaiserthums von Trapezunt* (Munich, 1827). From time to time the emperors of Trebizond paid tribute to the Seljuk sultans of Iconium, to the grand khans of the Mongols, to Timur the Tatar, to the Turkoman chieftains and to the Ottomans, but by means of skilful negotiations they were enabled practically to secure their independence.

They are found also at war with many of these powers and with the Genoese, who endeavoured to monopolize the commerce of the Black sea. The city was several times besieged, the most formidable attack being that which occurred in the reign of Andronicus I, the second emperor, when the Seljuks, under the command of Melik, the son of the great sultan Ala-ed-din, first assaulted the northern wall in the direction of the sea and afterwards endeavoured to storm the upper citadel by night. They failed, however, in both attempts; and in the latter, owing to the darkness and to the occurrence of a violent storm which suddenly swelled the torrents in the ravines, their force was thrown into inextricable confusion, and they were compelled to abandon their camp and make the best of their escape from the country. So great was the strength of the fortifications that Mohammed II might have experienced much difficulty in reducing it, had it not been for the pusillanimous conduct of David, the last emperor, who surrendered almost unconditionally.

Ancient Memorials.—Several interesting monuments of this period remain at Trebizond in the form of churches in the Byzantine style of architecture. One of these is within the area of the old city, viz., the church of the Panaghia Chrysokephalos, or Virgin of the Golden Head, a large and massive but excessively plain building, which is now the Orta-hissar mosque. On the farther side of the eastern ravine stands a smaller but very well-proportioned structure, the church of St. Eugenius, the patron saint of Trebizond, now the Yeni Djuma djami, or New Friday mosque.

Still more important is the church of Haghia Sophia, which occupies a conspicuous position overlooking the sea, about 2 mi.

west of the city. The porches of this are handsomely ornamented, and about 100 ft. from it rises a tall campanile, the inner walls of which have been covered in parts with frescoes of religious subjects, though these are now much defaced. But the most remarkable memorial of the middle ages that exists in all this district is the monastery of Sumelas, which is situated about 25 mi. from Trebizond, at the side of a rocky glen, at a height of 4,000 ft. above the sea. Its position is most extraordinary, for it occupies a cavern in the middle of the face of a perpendicular cliff 1,000 ft. high, where the white buildings offer a marked contrast to the brown rock which forms their setting. It is approached by a zigzag path at the side of the cliff, from which a flight of stone steps and a wooden staircase give access to the monastery. An antiquity of 1,500 yr. is claimed for the foundation of the monastery, but it is certain that the first person who raised it to importance was the emperor Alexius Comnenus III of Trebizond, who rebuilt it in 1360.

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TREBONIUS, GAIUS (*d.* 43 B.C.), Roman general and politician. The son of an aristocrat, he favoured the conservative party during his quaestorship (60 B.C.), the first public office he held; but by the time he became tribune (55 B.C.), he had switched political beliefs and was a strong supporter of Caesar's party. He was responsible for the passage, over the opposition of the conservatives, of the so-called Lex Trebonia, which he sponsored at the instigation of the consuls of the year, Pompey and Crassus. This act provided that the provinces of Spain should be given to Pompey and the province of Syria to Crassus for an additional five years and that the two should have the power to levy troops both in the provinces and in Italy.

During the period of the Gallic Wars, Trebonius served as a general under Caesar, and at the final battle at Alesia he was one of Caesar's most trusted and valuable aides. During the Civil War he commanded three legions at the successful siege of Massilia. He was praetor in 48 B.C. and the following year was governor of farther Spain, a position he was forced to abandon when some of his troops mutinied.

In 45 B.C. Caesar made him consul, promising him also the governorship of Asia, but notwithstanding his friendship and patronage, Trebonius was one of the leaders in the conspiracy which resulted in Caesar's death. His assignment was to engage Mark Antony in conversation outside the senate while the other conspirators assassinated Caesar, and this duty he performed successfully. In 43 B.C. he became proconsul in Asia but had been in office only a short time when Publius Cornelius Dolabella, then governor of Syria, murdered him.

TRÉBUCHET, a mediaeval siege engine, employed either to batter masonry, or to throw projectiles over walls. It was developed from the post-classical Roman *onager* (wild ass), which derived its name from the kicking action of the machine. It consisted of a frame placed on the ground to which a vertical frame of solid timber was rigidly fixed at its front end. Through the vertical frame ran an axle, which had a single stout spoke; on the extremity of the spoke was a cup to receive the projectile. In action the spoke was forced down, against the tension of twisted ropes or other springs, by a windlass, and then suddenly released. The spoke thus kicked the crosspiece of the vertical frame, and the projectile at its extreme end was shot forward. In the trébuchet the means of propulsion was a counterweight. The axle which was near the top of a high strutted vertical frame served as the bridge of a balance, the shorter arm of which carried the counterweight and the longer arm the carrier for the shot. An alternative name for the trébuchet is the mangonel (*mangonneau*). (*See* also ENGINES OF WAR.)

TREBULA, the name of five ancient towns in Italy. (1) TREBULA in Samnium, a town of the Caraceni, on the left bank of the Sangro, some 20 mi. below Castel di Sangro. It appears to have been a *municipium*, but we know only of its existence in Hadrian's time. (2) TREBULA in Campania, between Saticula and Suessula. The site is probably identical with the hills (about 1,000 ft. above sea level) above the entrance to the valley of Maddaloni. It is possibly the citizens of this Trebula who received Latin rights in 303 B.C. Its territory extended as far as the Via Appia, and its place was taken in imperial times by the Vicus Novanensis, on the road itself, near Suessula. (3) TREBULA BALLIENSIS, also in Campania, 22 mi. north of Capua, in the mountains, about 1,000 ft. above sea level. It revolted to Hannibal and was reduced to obedience by Fabius. Remains of walls, aqueduct and tombs exist. Its territory was mentioned in the projected distributions of land in Cicero's time and its wine was well thought of under Nero. It was a *municipium*. (4) TREBULA MUTUESCA in the Sabine country, 2 mi. east of the point where the Via Caecilia diverges from the Via Salaria. It lies about 1 mi. southwest of the modern Monteleone, and an amphitheatre and other remains are visible. In a dedication made there by the consul Mummius in 146 B.C. it is spoken of as a *vicus*, but when the *praefecturae* were abolished it became a *municipium*. The post station of Vicus Novus on the Via Salaria belonged to its territory. (5) TREBULA SUFFENAS is generally placed 6 mi. south of Reate (mod. Rieti, *q.v.*) on the Via Quinctia, but is with considerable probability identified with Ciciliano, 10 mi. east of Tivoli, 2,030 ft. above sea level, by O. Cuntz. There are remains of an ancient road with substructures in rough polygonal work ascending to it in zigzags.

TRÉCUL, AUGUSTE-ADOLPHE-LUCIEN (1818–1896), French botanist, was born in Mondoubleau, Loir-et-Cher, on Jan. 8, 1818. In 1848 he went to the United States where he remained for two years, studying the flora of the western and southern states, travelling as far west as the Rocky mountains and as far south as Texas and Mexico. He specialized particularly in plant morphology, being among the first to pursue this study systematically. His principal work is *Observations sur le fruit du prismatocarpus* (1842). The genus Treculia of the family Moraceae was named for him and contains, most notably, *T. africana*, the African breadfruit. Trécul died in Paris, Oct. 15, 1896.

TREDEGAR, an urban district of Monmouthshire, England, on the Sirhowy, 7 mi. E.N.E. of Merthyr Tydfil; on the G.W.R and L.M.S. Rys. Pop. (1938) 20,890. Area 12.7 sq.mi. It stands about 1,000 ft. above sea level and owes its existence to the establishment in the beginning of the 19th century of important iron works. With the use of coal for smelting purposes the region developed industrially.

After the beginning of the 20th century, remoteness from the sea affected the iron industry, and coal exporting became more important, although this was seriously affected by the trade depression following World War I.

TREE, ELLEN (1805–1880), English actress, was born of English parents in southern Ireland in Dec. 1805. She first appeared as an actress in Covent Garden in May 1823, as Olivia in Shakespeare's *Twelfth Night*. From 1824–26 she performed at Bath, from 1826–29 at Drury Lane and from 1829–36 at Covent Garden. From 1836–39 she travelled in America, playing in Covent Garden again on her return (1839–42). In 1842 she married the actor, Charles John Kean (*q.v.*) and the two were closely associated for the remainder of his life. In 1845 they returned to America, touring the country and taking the leading roles in many of the plays in their extensive repertoire. In 1850 Kean and a friend leased the Princess theatre, where he and his wife filled most of their engagements thereafter. In 1868, when Kean died, his wife retired from the stage.

Mrs. Kean was considered to be one of the finest actresses of her day, her best part having been that of Gertrude in *Hamlet*. She created numerous roles, most notably the feminine leads in several of the plays of James Sheridan Knowles. She died in London, Aug. 20, 1880.

TREE, SIR HERBERT BEERBOHM (1853–1917), English actor and manager, was born in London on Dec. 17, 1853, the son of Julius Beerbohm, a London merchant of German parentage; his half-brother, Max Beerbohm (*q.v.*) became well-

known as a writer and caricaturist. Taking the stage name of Beerbohm Tree he made his first professional appearance in London in 1876. He made a striking success in 1884 as the curate in *The Private Secretary*. In Sept. 1887 he became lessee and manager of the Haymarket theatre, London, where his representations of melodramatic "character" parts, as in *Jim the Penman*, *The Red Lamp* and *A Man's Shadow*, were highly successful. He played in many modern dramas, such as H. A. Jones's *Dancing Girl*, but also in romantic parts such as Gringoire and in the production of so essentially a literary play as Henley's *Beau Austin;* and in classic parts his ability as a comedian was shown in *The Merry Wives of Windsor*, in which he played Falstaff, and as a tragedian in *Hamlet;* his presentations of Shakespeare carried further forward the improvements in staging inaugurated at the Lyceum under Irving.

In 1897 Tree moved to the new Her Majesty's theatre, where his chief successes were in Stephen Phillips's poetical dramas and in his splendid revivals of Shakespeare (especially *Richard II* and the *Merchant of Venice*). The magnificence of the mounting, the originality and research shown in the "business" of his productions and his own versatility in so many different types of character made his management memorable in the history of the London stage. In the year 1907 Tree established a school of dramatic art, for the training of actors, in London; and in this and other ways he was prominent in forwarding the interests of the stage. He was knighted in 1909. In 1913 he published *Thoughts and Afterthoughts*, a book of essays. Tree died in London on July 2, 1917.

See Max Beerbohm, *Herbert Beerbohm Tree* (1920); Lady Tree, *Herbert and I* (1920).

TREE, a woody, perennial, seed-bearing plant which at maturity is at least 20 ft. tall and which is characterized by a single trunk that terminates in a well defined crown. Several ferns indigenous to lush, tropical rain-forests attain the stature of trees, but they are not usually regarded as such since reproduction of plants of this category is accomplished by means of spores.

The distinction between small trees and large shrubs is often effected with difficulty and is occasionally further complicated by the fact that many tree species assume shrub-like habits at or near the extremities of their range or when growing under severe adverse conditions. It is of interest also to record that a few forms, as for an example, the strangler fig, are vine-like (lianas) during the early stages of their development and become tree-like only as they approach maturity.

Plants of arborescent proportions are found in both of the two major divisions of the spermatophyta; *i.e.*, the gymnosperms and the angiosperms (*qq.v.*). The gymnosperms are of very ancient lineage, and by means of fossil remains have been traced backward 300,000,000 yr through the Carboniferous to the Devonian, where they occurred in great profusion and in vast unbroken forests over the land surfaces from pole to pole. There remains only a vestige of this once great flora; countless forms have long since become extinct.

The modern gymnosperms comprise a group of four orders which include the cycads, the gnetums and their allies, the ginkgo and the conifers. Of these only the conifers are of primary economic importance. Several of them, notably the pines, spruces, Douglas-firs, redwood, cypresses, cedars, podocarps, araucarias and cryptomerias are productive of excellent timber. Coniferous wood, because of its long fibres and high cellulose content, is especially suited for pulp and paper manufacture. The wood of the spruces, balsam-firs, hemlocks, Douglas-fir and yellow pines is used in quantity for such conversion. Much of the cellulose employed in the manufacture of cellulose-acetate and cellulose-nitrate plastics is a highly purified form of spruce pulp. Naval stores, oils, resins, waxes, pharmaceutical compounds and gums are other derived products. Because of their pleasing symmetry, showy evergreen foliage and ready response to horticultural treatment, many conifers are prized for decorative purposes.

The angiosperms are the commonest and most widely distributed plants inhabiting the surface of the earth. Fossil evidence indicates that they are of comparatively recent origin, dating back only to the Jurassic (160,000,000 yr.). Since their evolution they have developed very rapidly; and today there are over 150 000 species, many of which are arborescent. This division of the seed-bearing plants is divided into two classes, the *Monocotyledoneae* and *Dicotyledoneae*, respectively. The former comprises but 8 orders; the latter, 32. Palms, yuccas and their allies are arborescent moncots. As a group they are of little value as timber trees, although certain species are sometimes cut and used in the ground for piling. This group of trees is better known for its food products which include the coco-nut, banana, date and sabal starch. The large fern-like leaves of many tropical species are used by aborigines for thatching huts.

Arborescent dicots are legion. Many are productive of excellent cabinet timbers, of tannin, dye principles, oils, waxes, perfumes, powerful alkaloids, pharmaceutical compounds, varnish components, gums and palatable fruits such as the citrus forms, apple and its allies, bread-fruit, mango, persimmon, pomegranate and a host of others.

Lumbermen, in an attempt to distinguish the broad-leaved species from the conifers, have designated them as the hardwoods and softwoods, respectively. These two terms are used merely to distinguish between classes of material and have no mechanical significance whatever since the range of mechanical properties manifested in each group is very broad.

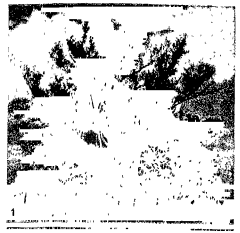
The various species of trees are treated under their individual titles; *e.g.*, oak, ash, elm, etc.; the articles FIR and PINE treat of two large groups of conifers; general information is provided by the articles PLANTS AND PLANT SCIENCE and GYMNOSPERMS. Tree cultivation will be found under FORESTS AND FORESTRY and HORTICULTURE, and the various types of trees whose wood enters into commerce under TIMBER. *See* also LANDSCAPE ARCHITECTURE and LUMBERING.

(E. S HR.)

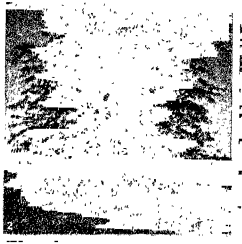
Tree planting involves the removal of a tree from one location and planting in another. In its original position the tree maintains a growth balance between the trunk and branches above ground and the roots below. The roots absorb water and mineral nutrients from the soil, and the growth of the top is limited by the amount of these materials which can be supplied. A portion of the water is transpired by branches (especially when in full leaf), and the remainder, together with the mineral nutrients, is the raw material from which organic food is synthesized. When a tree is lifted from the soil to be transplanted, a large part (25%-75%) of the root system must be cut off. Unfortunately, the terminal parts left behind are the most effective absorbing organs. The balance normally maintained between the top and the roots is, therefore, upset when a tree is lifted. For that reason it is advisable to prune off approximately ¼ of the branches of a transplant. Roots normally extend far beyond the base of the tree trunk, depending upon the species, the physical condition of the soil and the water supply. For example, a willow tree 4 ft. high growing in sandy soil was found to have a lateral root system 50 ft. in length. A much larger tree in a clayey soil with a high water level had a root system only 10 ft. long. Some species like pine, spruce and holly have what is known as "tap roots"; that is, primary roots which tend to taper off from the trunk and grow straight down from the tree. Other species have semi-tap roots with many lateral roots which grow in all directions but not far below the surface of the soil.

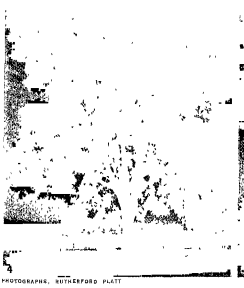
The immediate problem in transplanting shrubs or trees is to provide a set of conditions which will keep the plants from drying out until new roots can be regenerated. The top of the plant must remain more or less at a standstill until the new roots are formed and begin to function as absorbing organs. When the natural balance between the roots and the top has been reestablished, new branches with green leaves appear and the tree resumes natural growth.

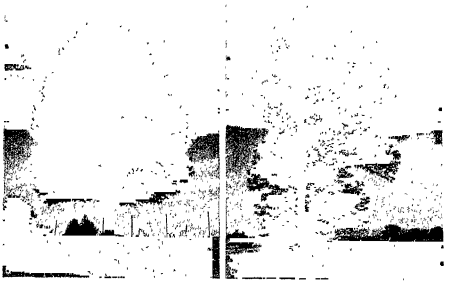
The best time to transplant deciduous trees such as elm, apple, cherry, maple, linden and oak is when they are dormant, without leaves. In the temperate zone of the United States fall and spring planting is practised. In the southern part of the zone, where the ground rarely freezes, planting may be practised during the winter. In tropical or subtropical regions, planting can be done at











PHOTOGRAPHS, RUTHERFORD PLATT

TREES OF NORTH AMERICA

1 Black willow *(Salix nigra)* This tree reaches a height of 120 ft and a trunk diameter of 3 ft.

2 Common honey locust *(Gleditsia triacanthos)* The maximum height is 75–140 ft; the trunk usually has a diameter of 2 or 3 ft, sometimes 5 or 6 ft.

3 Quaking or American aspen *(Populus tremuloides)*, often called a poplar, to which genus it belongs. It has a maximum height of 100 ft and a trunk diameter of 3 ft, but is usually smaller

4. Sugar maple *(Acer saccharum)*. It sometimes grows to a height of 120 ft, with a trunk 4 ft. in diameter

5. A sugar maple in fall

6 White ash *(Fraxinus americana)*. It grows to a height of 120 ft, and often has a trunk diameter of 5 ft

TREE



PHOTOGRAPHS, RUTHERFORD PLATT

TREES OF NORTH AMERICA

1 White oak *(Quercus alba)* Full height, 80–100 ft , trunk diameter, 3–4 ft.

2 White pine *(Pinus strobus).* Some attain a height of more than 200 ft , and a trunk diameter of 4–6 ft or more

3 Linden (Lime), often called basswood There are a number of North American species

4. American elm *(Ulmus americana)* Full height, 100–120 ft ; trunk diameter, 6–11 ft

5. Paper birch *(Betula papyrifera).* Full height, 60–70 ft.; trunk diameter, 2–3 ft.

any season if water and soil requirements are provided.

The size of trees to be planted may vary from 1-year-old seedlings a few inches in height to large trees 6-10 ft. in height. Ten to twenty-year-old trees can be moved, but only with special equipment and by expert workmen.

The size of the hole prepared for planting must be determined by the size of the root system of the tree. A root system with a two-foot spread would require a hole three to four feet wide and two feet deep. When the transplant is in position, the ground level should be from one to five inches above the original level, which can usually be seen on the trunk. The soil which is removed from the hole can be used to refill around the tree. It is often advisable to discard poor soil and replace with good soil to tamp around the roots. Well-rotted manure and fertilizer are sometimes used when trees are transplanted; however, inexperienced gardeners often injure the trees with this practice. If manure and fertilizer are used, they should be mixed well with soil and placed in the bottom of the hole with an inch or more of soil on top. The fertilizer should not come in direct contact with the roots. If used to the extent of one tablespoonful of commercial fertilizer per gallon of soil, it should not injure the tree. After the tree is established, fertilizer can be broadcast on the ground above the roots and turned under with a spade, care being taken not to dig out the roots.

Evergreen trees as pine, spruce, fir, hemlock and holly are far more difficult to transplant than the average nursery stock. Nurserymen usually move such plants with a ball of earth around the roots held together with burlap. If plants are properly root-pruned a year or two before digging, they will have a goodly number of fibrous roots near the plant which can be included in the ball. It is usually best to transplant evergreens growing in the temperate regions of the United States in late summer, but they can be successfully planted also in the spring. The requirements as to the size of the hole in which to set the tree, the soil and fertilizer for evergreens are similar to those described for deciduous trees.

The water supply for transplanted trees is important. More failures result from a water shortage than from most other causes. It is advisable to plant the tree as soon as possible after lifting, and to water it immediately after planting. It is advisable not to fill the hole entirely with soil so that the water will not run off. After the first soaking the tree should be watered at least once a week or more. Thereafter the hole should be filled and the soil kept cultivated until the tree is established. If there is a shortage of rain, it may be necessary to water transplanted trees throughout the summer months. *See* also ARBORICULTURE.

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TREE-BEAR, a name given in west Africa to the tree hyrax (*Dendrohyrax*). *See* HYRACOIDEA.

TREE BURIAL. Among the Andamanese, burial upon a platform placed in a tree is an honourable form of burial and adopted only in the case of a man or woman dying in the prime of life. It is not clear whether this honour is reserved for those who have had children—the point may be significant. A tree sometimes used for this purpose is *Ficus laccifera*, allied to the fig, and the belief of the natives is apparently that the souls of unborn children live in these trees and that if a baby dies before it has been weaned its soul goes back to the tree. (*See* A. R. Brown, *The Andaman Islanders* [1922].)

In Australia tree burial is forbidden to those who violate the law of exogamy—who are thereby excluded from reincarnation. In Indonesia "the position with regard to tree burial may be put in this way, that wherever a myth of origin exists which states that the first men came from trees or bamboos, then it will generally be found that the dead are placed in trees or disposed of in a way derived from tree disposal" (W. J. Perry, *Folklore*, xxvi, pt. 2, p. 147). There are cases of tree burial in central India among the primitive Gonds—the semi-Hinduized Gonds in Bengal tie the corpses of adult males to a *maiua* tree previous to burial. The Oraons "revere the tamarind and bury their dead in its shade. One special rite among the Dravidian races is the *imli ghoutna* or 'the grinding of the tamarind' when the mother of the bridegroom grinds on the family curry stone some pods of the tamarind" (W. Crooke, *Popular Religion of Northern India*, vol. i, p. 109).

TREE-CREEPER, one of the smaller British birds, and generally distributed. It is *Certhia familiaris*, and is remarkable for the stiffened shafts of its long and pointed tail-feathers, aided by which, and by its large feet, it climbs the trunks or branches of trees, proceeding upwards or outwards, generally in a spiral direction, as it seeks the small insects that are hidden in the bark and that form its chief food. It never climbs head-downwards like the nuthatch (*q.v.*). Inconspicuous in its upper plumage of brown mottled with white, buff and tawny—for the silvery white of its underparts is not usually visible—the tree-creeper is more common than the incurious suppose; though a shy singer, its song is loud and sweet. The nest is placed behind a half-detached piece of bark and a mass of material is used to give a sure foundation for the tiny cup, in which are laid from six to nine eggs of a translucent white, spotted or blotched with rust-colour.

The tree-creeper inhabits almost the whole of Europe as well as Algeria and has been traced across Asia to Japan. It is an inhabitant of the greater part of North America. On the European continent a second species, *C. brachydactyla*, is found. This is hardly to be distinguished from *C. familiaris* in appearance but has a quite different song and lives in gardens and parks rather than in woodland.

Allied to the tree-creeper, but without its stiff tail-feathers, is the genus *Tichodroma*, the single member of which is the beautiful wall-creeper (*T. muraria*) of the Alps and some other mountainous parts of Europe and Asia. It is occasionally seen in Switzerland, fluttering up the face of a rock, conspicuous from the scarlet-crimson of its wing-coverts and its white spotted primaries. Its bright hue is hardly visible when the bird is at rest, and it then presents a dingy appearance of grey and black. It is a species of wide range, extending from Spain to China.

The passerine family *Certhiidae* contains a number of genera of birds to which the general name "creeper" is applied; they occur in North America, Europe and Asia, the greater part of Africa, and Australia and New Guinea.

TREE CULTS. Primitive man, observing the growth and death of trees, the elasticity of their branches, the sensitiveness and the annual decay and revival of their foliage, anticipated in his own way the tendency of modern science to bridge the gulf between the animal and the vegetable world. Sober Greek philosophers (Aristotle, Plutarch) thought that trees had perceptions, passions and reason. The beliefs of primitive man were part of a small stock of fundamental ideas which persist in one form or another over a large portion of the world and have found a place in the higher religions.

Trees and Human Life.—Numerous popular stories reflect a firmly rooted belief in an intimate connection between a human being and a tree, plant or flower. Sometimes a man's life depends upon the tree and suffers when it withers or is injured, and we encounter the idea of the *external soul*, already found in the Egyptian "Tale of the Two Brothers" of some 3,000 years ago. Here one of the brothers leaves his heart on the top of the flower of the acacia and falls dead when it is cut down. Sometimes, however, the tree is an *index*, a mysterious token which shows its sympathy with an absent hero by weakening or dying as the man becomes ill or loses his life. These two features easily combine and represent a mysterious sympathy between tree- and human-life, which, as a matter of fact, frequently manifests itself in recorded beliefs and customs of historical times. Thus, sometimes a new-born child is associated with a newly planted tree with which its life is supposed to be bound up; or, on ceremonial occasions (betrothal, marriage, ascent to the throne), a personal relationship of this kind is instituted by planting trees, upon the fortunes of which the career of the individual depends. Sometimes, moreover, boughs or plants are selected; and the individual draws omens of life and death from the fate of his or her choice. Again, a man will put himself into relationship with a tree by

depositing upon it something which has been in the closest contact with himself (hair, clothing, etc.).

The custom of transferring disease or sickness from men to trees is well known. Sometimes the hair, nails, clothing, etc., of a sickly person are fixed to a tree; or they are forcibly inserted in a hole in the trunk, or the tree is split and the patient passes through the aperture. Where the tree has been thus injured, its recovery and that of the patient are often associated. In India when a man is supposed to be tormented by a demon, ceremonies are performed to provide it with a tree where it will dwell peacefully without molesting the patient so long as the tree is left unharmed. Such ideas do not enter, of course, when the rite merely removes the illness, but endangers the health of those who approach the tree. Again, sometimes it is believed that man's personality is mystically united with some healthy and sturdy tree, and in that case we may often presume that such trees already possessed some appropriate reputation. Again hair, nail-clippings, etc., are hung upon a tree for safety's sake lest they fall into the hands of an enemy.

Spirits in Trees.—Among the Arabs the sacred trees are haunted by angels or by *jinn;* sacrifices are made, and the sick who sleep beneath them receive prescriptions. Here, as frequently elsewhere, it is dangerous to pull a bough. This dread of damaging special trees is familiar· Cato instructed the woodman to sacrifice to the male or female deity before thinning a grove (*De re rustica*, 139), while in the Homeric poem to Aphrodite the tree nymph is wounded when the tree is injured and dies when the trunk falls. Early Buddhism decided that trees had neither mind nor feeling and might lawfully be cut; but it recognized that certain spirits might reside in them, and this the modern natives of India firmly believe. Propitiation is made before the sacrilegious axe is laid to the holy trees; loss of life or of wealth and the failure of rain are feared should they be wantonly cut; and there are even trees which it is dangerous to climb. The Talein of Burma prays to the tree before he cuts it down, and the African woodman will place a fresh sprig upon the stump as a new home for the spirit. In the Gold Coast the silk-cotton and odum (poison) trees are especially sacred as the abode of the two deities, who are honoured by sacrifices—even of human victims; these can be felled only after certain purificatory ceremonies. In general, sacred trees must not be injured unless they (*i.e.*, their spirits) have been appeased or means taken to provide the occupant with another abode. That the difference between the sacred *object* and the sacred *occupant* was not always clearly drawn is quite intelligible from those beliefs of much less rudimentary religions which confuse the unessential with the essential.

Forms of Cult.—Often the tree is famous for oracles. One of the best known is the oak of Dodona tended by priests who slept on the ground. The tall oaks of the old Prussians were inhabited by gods who gave responses, and the old Hebrews had their "terebinth of the teacher" (Gen. xii, 6), and "terebinth of the diviners" (Judg ix, 37). Sacred trees are also the object of pilgrimage, one of the most noteworthy being the branch of the Bo tree at Ceylon brought thither before the Christian era. Again, tree-spirits will hold sway over the surrounding forest or district, and the animals in the locality are sacred and must not be harmed. Thus, the pigeons at the grove of Dodona, and the beasts around the north European tree-sanctuaries, were left untouched; even as the modern Dyak allows no interference with the snake by the side of the bush which enshrines a dead kinsman. Sacred fires burned before the Lithuanian Perkuno and the Roman Jupiter; both deities were closely associated with the oak, and, indeed, according to Frazer, the oak seems to have been very commonly used for the perpetual holy fires of the Aryans.

The powers of the tree-deities, though often specially connected with the elements, are not necessarily so restricted, and the sacred trees can form the centre of religious, and sometimes, also, of national life Such deities are not abstract beings but are potent and immediate, and the cultus is primarily as utilitarian as the duties of life itself. They may have their proper ministrants: the chief sanctuary of the old Prussians was a holy oak around which lived priests and a high priest known as "God's mouth"; in Africa there are sacred groves into which the priest alone may enter, and among the Kissil-Bashi (or Kizilbashes) of the Upper Tigris and Euphrates, the holy tree of the village stands in an enclosure to which only the father-priest has access. The trees may be the scene of religious festivals and of periodical fairs and markets. Among the Lousiade group in British New Guinea the religious feasts are held under the sacred tree and a portion is laid aside for the spirit-occupants. That the invisible spirit naturally enjoyed only the *spiritual* part of the offerings is a belief which has been shared by others than the African Negro (Tylor ii, 216). Human sacrifice is known on the Slave Coast and in the Punjab; it was practised among the Druids and at Odin's grave at Uppsala. It is also said that the pollution of old Prussian sacred groves and springs by the intrusion of Christians was atoned for by human victims

Development of Ideas.—As ideas advanced, the spirits associated with trees were represented by posts, idols or masks; altars were added, and the trunk was roughly shaped to represent the superhuman occupant There is reason to believe that the last-mentioned transformation has frequently happened in the development of iconography Indeed, the natives of the Antilles suppose that certain trees instructed sorcerers to shape their trunks into idols and to instal them in temple-huts where they could be worshipped and could inspire their priests with oracles. When the tree-spirit was conceived to be of human shape the numerous stories which associate trees with men or deities of flesh and blood would easily arise, and just as Indian natives have gods which are supposed to dwell in trees, so in higher religions we find a Zeus or a Dionysus *Endendros*, gods, "occupants of trees," who have been identified with one or other of the leading members of a recognized pantheon. Syrian writers speak of a "king of the forest" and of a tall olive tree to the worship of which Satan seduced the people. But these "trees of the demons" were hewn down by zealous Syrian Christians. So also the caliph Omar cut down the tree at Hodaibaya visited by pilgrims lest it should be worshipped, and the Council of Nantes (A.D. 895) expressly enjoined the destruction of trees which were consecrated to demons.

Tradition has preserved some recollections of the overthrow of tree-cult in Europe. Boniface destroyed the great oak of Jupiter at Geismar in Hesse and built of the wood a chapel to St. Peter. (A similar continuity was maintained near Hebron when Constantine destroyed the idols and altars beneath the oak or terebinth of Abraham at Mamre and replaced them by a basilica) On the Heinzenberg near Zell the Chapel of Our Lady stands where the old tree uttered its complaint as the woodman cut it down; and at Kildare (*cilldara*, church of the oak), "Saint" Brigit or Bridget built her church under an oak tree. On the other hand, at Samosata, the sacred tree worshipped in Christian times was honoured as the wood of Christ's cross, and this growth of a new tradition to justify or at least to modify an old survival recurs in Palestine where the holy trees, whether adjoining a venerated tomb or not, are often connected with the names of saints or prophets and sometimes with appropriate traditions

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TREE-FERN. In old and well-grown specimens of some of the familiar ferns of temperate climates the wide-spreading crown of fronds may be observed to rise at a distance often of a good many inches above the ground and from a stem of considerable thickness. The male fern *Dryopteris filixmas* affords the commonest instance of this; higher and thicker trunks are, however, occasionally presented by the royal fern (*Osmunda regalis*), in which a height of 2 ft. may be attained, and this with very considerable apparent thickness, due, however, to the origin and descent of a new series of adventitious roots from the bases of each annual set of fronds.

Some tropical members and allies of this genus become more distinctly tree-like; *e.g.*, *Todea. Oleandra* is branched and shrub-

like, while *Angiopteris* and *Marattia* may also rise to 2 ft. or more. But the tree-ferns proper are practically included within the families Cyatheaceae (*Alsophila, Hemitelia, Cyathea*) and Dicksoniaceae (*Thyrsopteris, Dicksonia, Cibotium*) These 6 genera include about 750 species, of which a few are herbaceous, but the majority arboreal and palm-like, reaching frequently a height of 50 ft. or more, *Alsophila excelsa* of Norfolk Island having sometimes measured 60–80 ft. The fronds are rarely simple or simply pinnate, but usually tripinnate or decompound, and may attain a length of 20 ft., thus forming a splendid crown of foliage

The genera are of wide geographical range, mostly within the tropics; but south Australia, New Zealand and the southern Pacific islands all possess their tree-ferns. In Tasmania *Alsophila australis* has been found up to the snow-level, and in the humid and mountainous regions of the tropics tree-ferns are also found to range up to a considerable altitude. The fronds may either contribute to the apparent thickness of the stem by leaving more or less of their bases, which become hardened and persistent, or they may be articulated to the stem and fall off, leaving characteristic scars in spiral series upon the stem The stem is frequently much increased in apparent thickness by the downgrowth of aerial roots, forming a black coating several inches or even a foot in thickness, but its essential structure differs little in principle from that familiar in the rhizome of the common bracken (*Pteridium*).

Tree-ferns are cultivated for their beauty alone; a few, however, are of some economic applications, chiefly as sources of starch. Thus the beautiful *Alsophila excelsa* of Norfolk Island is said to be threatened with extinction for the sake of its sago-like pith. *Cyathea medullaris* also furnishes a kind of sago to the natives of New Zealand, Queensland and the Pacific Islands. The long silky or rather woolly hairs, so abundant on the stem and frond-leaves in the various species of *Cibotium* have not only been used as a styptic but in the Sandwich Islands furnish wool for stuffing mattresses and cushions.

TREE-FROG. Many groups of tailless Amphibia (*see* Frog) are adapted to arboreal life, as is indicated by adhesive discs on the tips of the fingers and toes. These discs adhere by rapid and intense pressure of the distal phalanx and special muscles upon the lower surface, which is also provided with glands producing a sticky secretion The term in a special sense, or "tree-toad," which is an exact equivalent, is often used for the family Hylidae.

The best-known European tree-frog is the little *Hyla arborea*, often kept in glass cylinders, with a ladder which it is supposed to ascend or descend according to the coming weather. This frog rarely reaches 2 in in length; its upper parts are smooth and shiny, normally of a bright grass-green, which may change rapidly to yellow, brown, olive or black; some specimens lack the yellow pigment that contributes to form the green colour and are sky-blue or turquoise blue; the lower parts are white The commonest North American species is *H. versicolor*, green, gray or brown, with a loud croaking voice.

The family *Hylidae* is related to the *Bufonidae* or toads, being distinguished by the presence of teeth in the upper jaw and by the claw-like shape of the terminal phalanx of the digits. It is a large family, with about 300 species, 250 of which belong to the genus *Hyla*, distributed over Europe, temperate Asia, North Africa, North and South America, New Guinea and Australia. *Gastrotheca* of South America, in the female, develops a broad dorsal pouch in which the eggs undergo their development. *Phyllomedusa*, also from tropical America, has the inner finger and toe opposable to the others; these frogs deposit their spawn between the leaves of branches overhanging water, into which the tadpoles drop and spend their larval life. (K. P. S.)

TREE KANGAROO, the name of certain arboreal marsupials, forming the genus *Dendrolagus* (*see* Marsupialia). Four species are inhabitants of New Guinea while two others are found in north Queensland, in dense scrub high up on the mountains. They are arboreal in their habits and feed on bark, leaves and fruit. Their hinder limbs are shorter than in the true kangaroos and their fore limbs longer and more robust, with strong curved and pointed claws. The flesh of the Queensland species is much prized by the natives.

TREE MARRIAGE. In Chota Nagpur, the tribes who speak languages of the Munda group, and in Bengal, low castes such as the Rautias, Bagdis and Murmis, perform the rite of tree marriage as an integral part of the marriage service. The nuptial pair are fastened to trees by thread. The trees selected are either the *mahua* or the *mango*, the two most important and conspicuous trees in that area. In the marriage rites for a number of castes in Mysore, whose language is Dravidian, the marriage is celebrated in a booth, one of the posts of which is called the milk post This, so we are told, is to secure the continuity of the line, and it has to be cut by the maternal uncle—the male representative of an important social grouping. A fig tree is here specified, while in parts of the Punjab, a branch of a jhand tree, *Prosopis spicigera*, is essential to the due performance of the marriage rites. Quite obviously, trees of such economic importance as the *mahua*, the *mango*, the *jhand* and the fig are selected as conspicuously, essentially fertile, but it is not a general fertility, but a specific fertility, that must be looked for as the reason for their selection. They are associated with the beliefs of the people as to the fate of those who are destined or desired to return and be re-born. In general, too, trees, notably the *peepul*, are in India associated with the spirits, and for this reason barren women walk around them in order that they may be fertilized by a spirit denizen of the tree. In west Africa "nearly all Yoruba believe that souls about to be born live in or among trees, and it is for this reason that women so often pray to the tree spirits to send them children." (P. A. Talbot, *The Peoples of Southern Nigeria*, vol ii, p. 267.)

There are cases where tree marriage affords a means of attaining the social status of marriage, as where a bachelor who seeks to marry a widow is obliged to marry a tree, which is then cut down. He is then a widower, equal in status with his human bride. It may be a substitute and intended to avoid the curse of widowhood, or to confer the status of married woman on a girl, and thus escape the social and religious penalties attaching to those whose daughters do not marry. Lastly, there is the common practice in India of marrying a newly-constructed tank to a plantain tree for the purpose of blessing the tank.

Tree marriage is part of a series of rites by means of which the continuity of the group life is secured

TREE SHREW, an arboreal insectivorous mammal of the family Tupaiidae, found in southern Asia and the Malaysian Islands. They are squirrel-like but have a long pointed muzzle; the teeth are like those of the Insectivora (*q.v.*), and the eye socket is ringed by bone. The common tree shrews (*Tupaia*) are dark olive brown with bushy tails Pen-tailed tree shrews (*Ptilocercus*) are dark gray-brown with a black facial mask and narrow tail, ending in a feather-like tuft; they are found in Malaya, Sumatra, Borneo and Palawan. Slender-tailed tree shrews (*Dendrogale*) occur in Indo-China and Borneo; a similar genus (*Urogale*) is found in Mindanao, the Philippines. Tree shrews feed on insects, with some vegetable matter and the young and eggs of birds They run about during the day Mammals of this type doubtless gave rise to the Primates (*q v.*), and some authorities classify these forms with that order. (J. E. Hl)

TREE-TOAD: *see* Tree-Frog.

TRÉFOUET, JEANNE ALFRÉDINE: *see* Hading, Jane

TREGELLES, SAMUEL PRIDEAUX (1813–1875), English theologian, was born at Wodehouse place, near Falmouth, on Jan 30, 1813. His parents were Quakers, and he himself for many years was in communion with the Darbyite Plymouth Brethren but afterward became a Presbyterian. For a time he worked at the ironworks, Neath abbey, Glamorgan, and then set up as a private tutor in Falmouth, finally devoting himself to a laborious student life, until he was incapacitated by paralysis in 1870. He received the LL.D. degree from St. Andrews and a pension of £200 from the civil list. He died at Plymouth, April 24, 1875.

Most of his numerous publications had reference to his great critical edition of the New Testament (1857–72). They include an *Account of the Printed Text of the Greek New Testament*

(1854), a new edition of T. H Horne's *Introduction* (1860) and *Canon Muratorianus: Earliest Catalogue of Books of the New Testament* (1868). As early as 1844 he published an edition of the Book of the Revelation, with the Greek text so revised as to rest almost entirely upon ancient evidence. Tregelles wrote *Heads of Hebrew Grammar* (1852), translated Gesenius' *Hebrew Lexicon* and was the author of a little work on the *Jansenists* (1851) and of various works in exposition of his special eschatological views (*Remarks on the Prophetic Visions of Daniel*, 1852, new ed. 1864).

TRÉGUIER, a port of western France, in the department of Côtes-du-Nord, 36 mi. N W. of St. Brieuc by road. Pop. (1946) 2,922. Tréguier (*Trecorum*), which dates from the 6th century, grew up round a monastery founded by St. Tugdual. In the 9th century it became the seat of a bishopric, suppressed in 1790 The port is situated about 5½ mi. from the English channel at the confluence of two streams that form the Tréguier river; it carries on fishing and a coasting and small foreign trade. The cathedral (14th and 15th centuries) has three towers over the transept, one of which is surmounted by a fine spire, and a 15th century cloister. Ernest Renan was a native of the town.

TREILHARD, JEAN BAPTISTE (1742–1810), French revolutionary, was born at Brives (Corrèze). In Paris he gained reputation as an avocat at the parlement, and was a deputy to the states-general in 1789. In the constituent assembly he showed great capacity in dealing with the reorganization of the Church and in the nationalization of ecclesiastical property Ineligible, like all the members of the constituent assembly, for the legislative assembly, he became president of the criminal tribunal of Paris, but failed through lack of firmness. The department of Seine-et-Oise elected him to the convention, where he attached himself to the group known as The Mountain (*q.v.*) and voted for the death of Louis XVI. He was a member of the committee of public safety, and became president of the convention on Dec. 27, 1792.

Under the directory Treilhard entered the Council of the Five Hundred (of which he was president during the month of Nivose, year IV), was a member of the Tribunal of Cassation, plenipotentiary at the Congress of Rastatt and became a director in the year VI.

After the coup d'état of 18 Brumaire he became president of the tribunal of appeal and councillor of state He took an important part in drafting the civil code, the criminal code, the code of civil procedure and the commercial code

Treilhard died on Dec. 1, 1810, a senator and count of the empire.

TREINTA Y TRES, a city of S.E. Uruguay, capital of the department of the same name. Pop. (1942 est.) 18,500. Department, pop. 68,371; area 3,682 sq mi. The city is 200 mi N E by railway and road from Montevideo, a short distance N. of the Río Olimar, and is served by the Uruguayan section of the Pan-American highway.

As is the case throughout the country, Treinta y Tres's industry is largely confined to the production of livestock, particularly cattle and sheep.

The Treinta y Tres were a small band of Uruguayan patriots who lived during the first half of the 19th century, at a time when Brazil controlled Uruguay. Under the command of Juan Antonio Lavalleja, they raised an army which, with Argentinian assistance, was able to defeat Brazil and thus win Uruguay's independence.

TREITSCHKE, HEINRICH VON (1834–1896), German historian and political writer, the son of a Saxon officer, was born at Dresden on Sept. 15, 1834. Prevented by deafness from entering the public service, he studied at Leipzig and Bonn, where he was a pupil of Dahlmann. He established himself as a *Privatdozent* at Leipzig, lecturing on history and politics, and at once became very popular with the students, but his political opinions made it impossible for the Saxon government to appoint him to a professorship. He was at that time a strong Liberal; he hoped to see Germany united into a single state with a parliamentary government, and all the smaller states swept away In 1863 he was appointed professor at Freiburg; in 1866, at the outbreak of war, he showed his Prussian sympathies by removing to Berlin, became a Prussian subject, and was appointed editor of the *Preussische Jahrbücher*.

After holding appointments at Kiel and Heidelberg, Treitschke was in 1874 made professor at Berlin; he had already in 1871 become a member of the reichstag, and from that time till his death in 1896 he was one of the most prominent figures in the city. On Sybel's death he succeeded him as editor of the *Historische Zeitschrift*. He had outgrown his early Liberalism and become the chief panegyrist of the house of Hohenzollern

Treitschke did more than any one else to mould the minds of the rising generation, and he carried them with him even in his violent attacks on all opinions and all parties which appeared in any way to be injurious to the rising power of Germany. He supported the government in its attempts to subdue by legislation the Socialists, Poles and Catholics; and he was one of the few men of eminence who gave the sanction of his name to the attacks on the Jews which began in 1878. As a strong advocate of colonial expansion, he was a bitter enemy of Great Britain; and he was to a large extent responsible for the anti-British feeling of German chauvinism during the last years of the 19th century In the reichstag he had originally been a member of the National Liberal party, but in 1879 he was the first to accept the new commercial policy of Bismarck, and in his later years he joined the Moderate Conservatives.

Treitschke died at Berlin on April 28, 1896.

As an historian Treitschke confined himself to those periods and characters in which great political problems were being worked out, above all, he was a patriotic historian, and he never wandered far from Prussia.

His great achievement was the *History of Germany in the Nineteenth Century* (Eng. trans. by E. and C. Paul, 7 vols., 1915–19). The first volume was published in 1879, and during the next 16 years 4 more volumes appeared, but at his death he had advanced only to the year 1847. The work shows extreme diligence and scrupulous care in the use of authorities. It is discursive and badly arranged, but it is marked by a power of style, a vigour of narrative and a skill in delineation of character which give life to the somewhat unattractive period of German history with which he was concerned; notwithstanding the extreme spirit of partisanship and some faults of taste, it remains a remarkable monument of literary ability.

The most important of the essays were collected under the title *Historische und politische Aufsätze* (4 vols, Leipzig, 1896); a selection from his more controversial writings was made under the title, *Zehn Jahre deutscher Kämpfe; neue Folge*. After his death his lectures on political subjects were published under the title, *Politik* (Eng. trans, 2 vols., 1916). He brought out also in 1886 a short volume of poems called *Vaterländische Gedichte*, and another volume in the following year. His *Briefe*, ed. M Cornicelius (3 vols., Berlin, 1859–96), were reprinted at Leipzig (1913–20).

TRELAWNY, EDWARD (1699–1754), British governor of Jamaica, was born in Trelawne, Cornwall, in 1699, the son of Jonathan Trelawny (*q.v.*), bishop of Winchester. He attended Westminster school (1713–17) and Christ Church college, Oxford. In 1732 he entered parliament as member for West Looe, Cornwall. He served as commissioner for victualling the forces (1725) and as commissioner of customs (1732).

In 1736, after several terms in parliament, he was appointed governor of Jamaica. He took office two years later, on April 30, 1738.

Trelawny's first task as governor was to suppress the war between the native Negroes, known as Maroons, and the whites on the island. The struggle was a long-standing one but within a year Trelawny had concluded a peace which gave the Maroons their freedom and assigned to them 1,500 acres of land, the chief town of which was for many years known as Trelawnytown. In return, the Negroes were to assist the colony in the event of war

with an outside power and to agree to deliver fugitive slaves to the government.

Scarcely had this difficulty been settled when England became embroiled with Spain in the War of Jenkins' Ear, so-called because of the alleged amputation of the ear of an English seaman, Robert Jenkins, by Spanish sailors. Trelawny had already strengthened the defenses of the island for this conflict, having foreseen that the West Indies would inevitably become a battle-ground of the war. He now not only assisted Admiral Edward Vernon in mapping strategy in that area but took a personal role in the fighting, participating in the campaigns against Cartagena and Port Louis, part of the time as head of a regiment he had raised.

Trelawny resigned from office in 1751, because of failing health, after one of the longest and most successful governorships in the colony's history. He left Jamaica in 1752, when his successor arrived, and died in London, Jan. 16, 1754.

TRELAWNY, EDWARD JOHN (1792–1881), English sailor and friend of Shelley and Byron, was born in London on Nov. 13, 1792, the son of an army officer. After a short term in the navy and a naval school, he shipped for India but deserted at Bombay For several years he led an adventurous life in India, but about 1813 returned to England, married and settled down. Early in 1822 he met Shelley and Byron at Pisa and passed nearly every day with one or both of them until the drowning of Shelley (*q.v.*) and Williams on July 8. He superintended the recovery and cremation of the bodies, snatching Shelley's heart from the flames. He added the lines from the *Tempest* to Leigh Hunt's "Cor Cordium"; and, finally, he supplied the funds for Mrs. Shelley's return to England. In 1823 he set out with Byron for Greece, to aid in the struggle for independence. Distressed by his companion's dilatoriness, Trelawny left him and joined the insurgent chief, Odysseus, and afterwards married his sister, Tersitza. While in charge of the former's fortress on Parnassus, he was assaulted by two Englishmen and nearly killed. Returning to England, he lived for a time in Cornwall with his mother and afterwards in London, where he became a great social favourite. Permission having been refused him to write the life of Shelley, he began an account of his own life in the *Adventures of a Younger Son* (1835; new ed. by E. C. Mayne, 1925), followed much later by a second part: *Recollections of Shelley and Byron* (1858), which was recast as *Records of Shelley, Byron and the Author* in 1878 (new ed by E. Dowden, 1906). This gives an admirable portrait of Shelley and a less truthful one of Byron. He married a third time, but the irregularity of his life estranged him from his wife. He died at Sompting, near Worthing, on Aug. 13, 1881 The old seaman in Millais's picture, "The North-West Passage," in the Tate gallery, London, gives a portrait of him.

See the Letters of Edward J. Trelawny, edited with Introduction by H Buxton Forman, C B. (1910).

TRELAWNY, SIR JONATHAN, BART. (1650–1721), English prelate, was a younger son of Sir Jonathan Trelawny, bart. (1624–1685), and was born at Pelynt, Cornwall, on March 24, 1650 Educated at Westminster school and at Christ Church, Oxford, Trelawny took holy orders in 1673, and in 1685, his elder brother having died in 1680, became third baronet in succession to his father. Having rendered good service to James II during Monmouth's rebellion, Trelawny was consecrated bishop of Bristol on Nov. 8, 1685. He was loyal to King James until the first declaration of indulgence in April 1687, when, as a bishop, he used his influence with his clergy against the king, and, as a Cornish landowner, resisted the attempt to assemble a packed parliament. In May 1688 Trelawny signed the petition against the second declaration of indulgence and in the following month was imprisoned in the Tower of London with Sancroft and five other bishops, sharing their triumphant acquittal. In spite of Burnet's assertion, it is probable that Trelawny did not sign the invitation to William of Orange, although he certainly welcomed his army into Bristol. Before this James II, anxious to regain the bishop's support, had nominated him to the see of Exeter, but Trelawny lost nothing as this appointment was almost at once confirmed by William III. Unlike five of his colleagues among the "seven bishops," Trelawny took the oaths of allegiance to William and Mary, but he was soon estranged from the new king and sided with the princess Anne, who showed him some favour after she became queen.

In 1707 Trelawny was appointed bishop of Winchester and became prelate of the Order of the Garter, but henceforward he took very little part in politics. He died at his residence at Chelsea on July 19, 1721, and was buried at Pelynt.

When bishop of Exeter, Trelawny, as visitor of Exeter college, Oxford, deprived the rector of his office, a sentence which was upheld on appeal by the House of Lords, and when bishop of Winchester he completed the rebuilding of Wolvesey palace. Trelawny is the hero, or one of the heroes, of the refrain of R. S Hawker's modern ballad:

"And shall Trelawny die,
Here's twenty thousand Cornishmen
Will know the reason why."

TRELEASE, WILLIAM (1857–1945), U.S. botanist, was born at Mt. Vernon, N.Y., on Feb. 22, 1857. He graduated at Cornell university in 1880 and continued his studies at Harvard (Sc.D., 1884). He was professor of botany at the University of Wisconsin, 1883–85, and at Washington university, St. Louis, Mo., 1885–1912, and director of the Missouri Botanical garden, 1889–1912. He was professor and head of the botany department, University of Illinois, 1913–26 He died Jan. 1, 1945.

He edited (with Asa Gray) *The Botanical Works of George Engelmann* and translated Poulsen's *Botanical Microchemistry* and Salomonsen's *Bacteriological Technology*. He wrote *Agave in the West Indies* (1913), *The Genus Phoradendron* (1916), *Plant Materials of Decorative Gardening* (1927), *Winter Botany* (1918), *The American Oaks* (1925) and numerous papers on botany and entomology. (*See* BOTANY, GARDEN.)

TREMATODES (flukes), a class of Platyhelminthes (*q.v.*), in which the body is unsegmented and without a cellular epidermis or external cilia, and an alimentary canal is present. All the members of the group are parasitic

General Morphology.—The body is generally flattened and leaf-like or ribbon-like in shape, but may be relatively stout and oval or circular in transverse section. One or more muscular suckers are usually present on the ventral surface. In general structure the Trematodes closely resemble the free-living Turbellaria (*q.v.*) They differ from them in the development of suckers and other organs for attachment to the host, and in the absence (in the adult) of a ciliated epidermis.

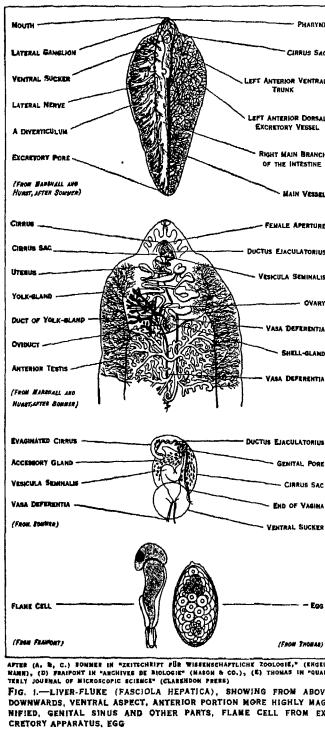
The external covering is a stout cuticle, often armed with spines, below which is a subcuticular layer containing unicellular glands. The number and arrangement of the suckers are very variable. Usually there is an anterior sucker or pair of suckers, and a posterior sucker, or a posterior disk-like organ of attachment provided with subsidiary suckers or with cuticularized hooks of various kinds. The complex development of the posterior organ of attachment is characteristic of the ectoparasitic forms (Monogenea). In endoparasitic forms (Digenea) the posterior sucker is usually a simple muscular disk or cup and may be situated at the posterior end of the body, but is more often displaced anteriorly so as to lie in front of the middle or even close behind the oral sucker.

Pigment is rare in Trematodes, but occurs in the parenchyma of certain species, more especially among the Monogenea. The body of endoparasitic species may, however, appear more or less brightly coloured on account of the contents of the intestine and uterus, and the vitelline glands, showing by transparency.

The musculature usually consists of an outer circular and an inner longitudinal layer of fibres. Oblique and dorso-ventral fibres are also frequently present.

Except in one family, the mouth is situated at or near the anterior extremity. It may open through an anterior, or oral, sucker or, in certain ectoparasitic forms, may be flanked by a pair of adoral suckers. The alimentary canal may be a simple, blind sac, but usually consists of a relatively short median anterior portion and two posterior branches arising by the bifurcation of the former. These branches may be simple or secondarily branched, and may join again posteriorly, or may remain distinct.

In the great majority of forms they are without any posterior opening, but in a few species they have been found to open to the exterior by one or a pair of pores. The median anterior portion of the gut may be differentiated into a muscular sucking



AFTER (A, B, C,) SOMMER IN "ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE," (ENGELMANN), (D) FRAIPONT IN "ARCHIVES DE BIOLOGIE" (MASON & CO.), (E) THOMAS IN "QUARTERLY JOURNAL OF MICROSCOPIC SCIENCE" (CLARENDON PRESS)

FIG. 1.—LIVER-FLUKE (FASCIOLA HEPATICA), SHOWING FROM ABOVE DOWNWARDS, VENTRAL ASPECT, ANTERIOR PORTION MORE HIGHLY MAGNIFIED, GENITAL SINUS AND OTHER PARTS, FLAME CELL FROM EXCRETORY APPARATUS, EGG

bulb, or pharynx, and a simple tubular portion between this and the bifurcation, called the oesophagus.

The whole of the space between the wall of the alimentary canal and the external cuticle is filled up with a spongy connective tissue, or parenchyma, in which the other organs are embedded, as in other classes of Platyhelminthes. The nervous system consists of a pair of central ganglionic masses (the "brain"), situated anteriorly and dorsally, and longitudinal nerve-cords (of which there may be as many as four pairs) running posteriorly throughout the body, and connected at intervals by transverse commissures. Eyes are present in some of the ectoparasitic forms, and in the larval stages of some endoparasitic species, but are absent in the adults of the latter There may also be "tactile cones" on the surface of the cuticle, consisting of small elevations surmounted by groups of stiff cilia.

The excretory system is composed, as in other Platyhelminthes, of branching canals whose smallest branches end in flame-cells. There are usually two main longitudinal canals, which may open independently, through a pair of excretory sacs, on to the dorsal surface, or may lead into a common posterior "bladder."

With few exceptions, the Trematodes are hermaphrodite. The complex system of genital organs is arranged on the same general plan as in other groups of Platyhelminthes, but is subject to much variation in details, and is of great importance from the taxonomic standpoint. The testes are almost invariably paired, and are usually compact organs, though they may be deeply lobate or even elaborately branched. The male ducts unite and open through a muscular intromittent organ, or cirrus, which is usually contained in a special pouch (the cirrus-sac). The ovary is single, and, like the testes, may be compact or more or less branched. The vitellaria generally consist of two lateral series of follicles, those of each side being connected by branching ducts with a main yolk-duct, and the two main ducts crossing the body to join in the median region, near the shell-gland.

In ectoparasitic forms there is a vagina, opening to the exterior by a pore quite distinct from that of the uterus, or there may be a pair of such structures. The uterus, in the Trematodes, is a continuation of the oviduct, and is a more or less convoluted tube usually opening side by side with the male duct, often into a common atrium. In forms without a separate vagina it functions as a fertilization canal as well as a reservoir for eggs and a duct for their expulsion. In some of the ectoparasitic Trematodes a "genito-intestinal canal" connects the oviduct with the intestine. In the endoparasitic forms (Digenea) this connection is lost, but a duct, known as Laurer's canal, springing from the oviduct and either opening on the surface of the body or ending blindly below the skin, is usually present. The eggs, after being fertilized and supplied with yolk, are enclosed in a cuticularized shell of variable form, sometimes stalked or with terminal filaments, and very commonly provided with an operculum at one end.

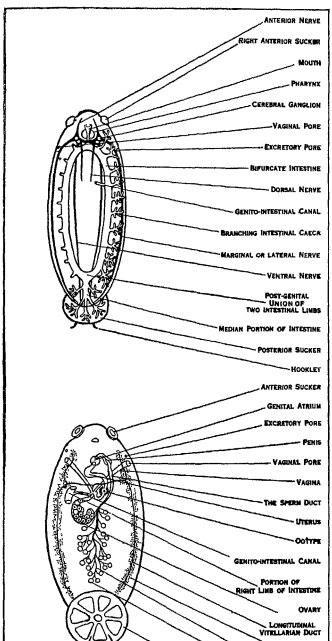
Classification.—The division of the class Trematoda into two main orders, Monogenea and Digenea, proposed by van Beneden in 1858, is still accepted by modern authorities. These orders represent two well marked groups differing fundamentally in structure, habits and life-history.

The order Monogenea comprises forms of almost exclusively ectoparasitic habit, without an alternation of generations in their life-history, and having the following structural peculiarities, among others. The mouth is simple and is not surrounded by an oral sucker, though paired accessory suckers may be present in its neighbourhood. The posterior sucker may be single (but in this case is usually of complex structure and often provided with accessory cuticularized organs of attachment) or there may be a number of paired posterior suckers, which also have cuticularized armatures. There is a vagina, or a pair of vaginae, distinct from the uterus, and there are usually paired excretory pores situated dorsally near the anterior end of the body.

These forms live mainly on the external surface or on the gills of fishes and other cold-blooded aquatic animals, and feed on mucus and other matter, or occasionally on the blood of the host. The order includes 13 families, among which are the Tristomatidae, Gyrodactylidae, Polystomatidae and Octocotylidae.

The order Digenea includes all the forms which live as endoparasites within the bodies of other animals. These have a complex life-history involving an alternation between a sexual phase and an asexual or polyembryonic phase of multiplication. They have an oral sucker surrounding the mouth, and usually a posterior sucker which is a simple muscular organ without armature. There is no vagina, as distinct from the uterus, and the excretory pore is usually single and posterior. The adult forms occur in all classes of vertebrates, the larval forms in both vertebrates and invertebrates.

The suborder Gasterostomata includes a single family (Bucephalidae), in which the mouth is placed towards the middle of the ventral surface All the other families (of which there are about 60) are placed in a second suborder, Prosostomata, in which the mouth occupies its normal anterior position. The great majority of the forms in this suborder are placed in the

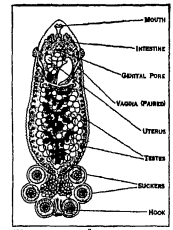


AFTER LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)

FIG. 2.—SCHEMATIC FIGURE OF A MONOGENETIC TREMATODE, ILLUSTRATING STRUCTURE (AFTER BENHAM)

tribe Fasciolοidea, and have a general resemblance in form to the well known liver-fluke (*Fasciola*). Among the best known families may be mentioned the Fasciolidae, Dicrocoeliidae, Lepodermatidae, Opisthorchidae, Cyclocoelidae (Monostomidae), Echinostomatidae, Schistosomatidae and Paramphistomidae.

The old order Aspidocotylea, for many years merged with the Prosostomata, is again recognized as distinct It comprises a few genera, as *Aspidogaster* and *Cotylaspis*, parasitic in molluscs, fish and turtles, with simple life cycles and with or without alternation of hosts They are distinguished by the large ventral sucker subdivided into longitudinal rows of compartments

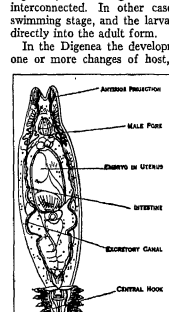


FROM "ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE" (ENGELMANN)

FIG. 3.—VENTRAL VIEW OF POLYSTOMUM INTEGERRIMUM (AFTER ZELLER)

Development and Life-histories.—The eggs of the Monogenea are either deposited in water or attached to the host by means of stalk-like processes. In some cases (*Gyrodactylus*, a parasite of the gills of minnows and other fishes) but a single egg is produced at a time, and this develops within the body of the parent into an embryo, within which another embryo is formed before its birth There may be a ciliated free-swimming larval stage, as in *Polystomum* (a form inhabiting the bladder of frogs and toads). The larva of this form invades the gill-chamber of tadpoles, and migrates by way of the alimentary canal to its definitive habitat. *Diplozoon* (found on the skin of the minnow) also has a free-swimming stage, and is remarkable for the fact that two larvae (called *Diporpae*) unite, each holding the other by its ventral sucker, and fuse into a single X-shaped organism, the two original sets of genitalia becoming permanently interconnected. In other cases there appears to be no free-swimming stage, and the larvae hatching from the eggs develop directly into the adult form.

In the Digenea the development is indirect, and may involve one or more changes of host, and sometimes a free-swimming stage. The life-history of the liver-fluke of the sheep and other animals may be taken as typical. This form, as an adult fluke, inhabits the bile-ducts of the vertebrate host. The eggs are passed out of the host's body with the faeces, and hatch in a short time in the open if the conditions of moisture and temperature are suitable. The embryo, on escaping from the egg, is a ciliated organism known as a *miracidium*, provided with a pair of eye-spots and an anterior boring organ. It swims about until it meets with a suitable intermediate host (certain snails—in Europe, *Limnaea truncatula*). Boring its way into this through the skin, it sheds its ciliated coat and penetrates into the internal organs. Here it grows into an irregular, sac-like body known as a *sporocyst*. Within this there are formed by budding numerous bodies called *redae*. The redia has an oral sucker and a sac-like intestine. Each redia gives rise, by internal budding, either to a further generation of rediae or to larvae of a different type, called *cercariae*. The cercaria is somewhat tadpole-like, having a broad body and a narrow tail It has two suckers and a bifurcate intestine. The cercaria escapes from the snail and swims or wriggles about in water, finally coming to rest on some solid body, such as a blade of grass, where it loses its tail and secretes



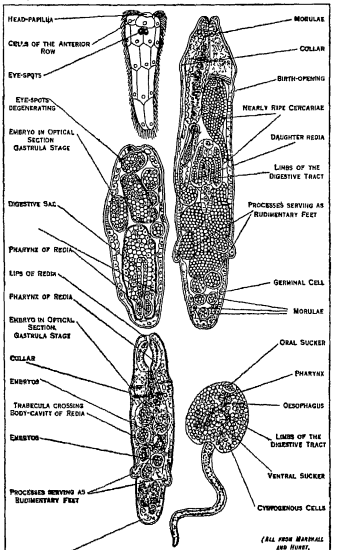
FROM "ARCHIV FÜR ANATOMIE, PHYSIOLOGIE UND WISSENSCHAFTLICHE MEDIZIN" (DE GRUYTER & CO.)

FIG. 4.—VENTRAL VIEW OF GYRODACTYLUS ELEGANS (AFTER WAGNER)

round itself a "cyst." Should this be swallowed by a suitable vertebrate animal, the cercaria is liberated from the cyst and migrates into the body-cavity and thence into the liver, where it grows into an adult fluke.

An interesting modification of the life-history is found in the genus *Leucochloridium*. The sporocyst of this form sends branches into the head and tentacles of its snail host. The branches are brightly coloured and capable of pulsating movements, making the snail conspicuous and particularly liable to the attacks of birds. The transference of the cercariae contained within the snail to suitable final hosts among the birds is thus ensured.

In most genera the cercariae, instead of remaining passive until swallowed, swim about in water and penetrate actively through the skin either of the final or of a second intermediate

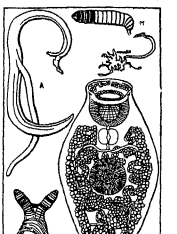


FROM THOMAS IN "QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE" (CLARENDON PRESS)

FIG. 5.—FIVE STAGES IN THE LIFE-HISTORY OF THE LIVER-FLUKE
Above, the miracidium; left centre, a sporocyst containing young redíae; right centre, adult redía containing daughter redía and two almost mature cercariae; left bottom, a young redía; right bottom, a free cercaria (all highly magnified)

host. The fork-tailed cercariae of the blood-flukes (*Schistosoma*) thus attack man and other warm-blooded vertebrates, and the adults inhabit the blood-vessels. The human lung-fluke, *Paragonimus*, leaves its first intermediate host (a mollusc) as a cercaria, and enters certain freshwater crabs and crayfishes, in which it becomes encysted. Human infection, in the Orient, is acquired by eating these animals. Several small flukes belonging to the genera *Opisthorchis*, *Clonorchis* and *Metagonimus* make use, in a similar manner, of freshwater fishes as second intermediate hosts, the first host being always, so far as is known, a snail.

Economic Importance.—Schistosomiasis (or Bilhárziosis) is probably the most important of the human diseases caused by Trematodes. In Egypt and many other parts of Africa two species of *Schistosoma*, *S. haematobium* and *S. mansoni*, are prevalent The former also occurs in Asia, certain localities in the south of Europe, and Australia, and the latter in the West Indies and South America. In the Far East their place is taken by a third species, *S japonicum*. These flukes inhabit the mesenteric and portal veins, and their eggs cause obstruction and rupture of the capillaries either in the wall of the bladder or in that of the bowel, with consequent haemorrhage and ulceration.



AFTER (A) LEUCKART, "DIE PARASITEN DES MENSCHEN" (DE GRUYTER & CO.) (B, C, D.) SELLER IN "ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE" (ENGELMANN)

FIG. 6.—TYPES OF TREMATODES
A Schistosoma haematobium, male carrying the more slender female in the ventral groove, B. Leucochloridium macrostomum, adult form, C Snail (Succinea) with sporocysts of Leucochloridium in its tentacles, D. Sporocyst removed from tentacle of Succinea

The common liver-fluke (*Fasciola hepatica*) is an important parasite of sheep, sometimes causing serious and fatal outbreaks of the disease known as "liver-rot." As a human parasite this worm is rare, but certain smaller liver-flukes (*Opisthorchis* and *Clonorchis*) are not uncommon in eastern countries.

The lung-fluke, *Paragonimus westermani*, is a human parasite of some importance in the Far East, and occurs also in South America and Mexico. The various species of flukes which occur in the alimentary canal of man and domestic animals appear to be, on the whole, of relatively little economic significance. (H A B ; X.)

TREMOLITE, a mineral of the amphibole (*q.v.*) group, of the composition $CaMg_3(SiO_3)_4$, and crystallizing in the monoclinic system Tremolite (named in 1796 from the Val Tremola, St Gotthard, where it was first found) always contains water in solid solution in amounts varying up to 2·5% and is not prepared from dry melts. It is usually developed in fibrous and bladed crystals of white or grey colour Solid solutions of tremolite and the corresponding iron compound, $CaFe_3(SiO_3)_4$, are known as actinolite. They are distinguished by their green colour. Tremolite is a common mineral of metamorphosed carbonate sediments Typical examples occur in the dolomite of Campolongo (Tessin) and in limestone at Russell, New York (C. E. T.)

TRENCH, FREDERICK HERBERT (1865–1923), Irish poet and playwright, was born at Avoncore, Co. Cork, on Nov. 12, 1865. Educated at Haileybury and at Keble college, Oxford, he was elected a fellow of All Souls' college, and from 1891–1908 was an examiner in the Board of Education. This appointment he gave up in 1908 in order to devote himself to literary work. In 1908 he became director of the Haymarket theatre, London, where he staged *King Lear* and Maeterlinck's *Blue Bird* His first volume of poems, *Deirdre Wedded*, appeared in 1901. It was followed by further poems, notably "Apollo and the Seaman," included in *New Poems* (1907), and *Lyrics and Narrative Poems* (1911). Among his later publications were an *Ode from Italy in Time of War* (1915); *Poems: with Fables in Prose* (1918); and a poetic play *Napoleon* (1919), which was produced in London by the Stage Society in 1919 He died on June 11, 1923. His collected works, edited by H. Williams, were published in 1924, and a volume of selected poems in the same year.

See Abel Chevalley, *Herbert Trench: Notice sur sa Vie et ses Oeuvres* (1925).

TRENCH, RICHARD CHENEVIX (1807–1886), Anglican archbishop and poet, was born at Dublin on Sept. 9, 1807. He was educated at Harrow, and Trinity College, Cambridge. While incumbent of Curdridge Chapel near Bishops Waltham, Hants, he published (1835) *The Story of Justin Martyr and Other Poems*, which was favourably received, and was followed in 1838 by *Sabbation, Honor Neale, and other Poems*, and in 1842 by *Poems from Eastern Sources*. He became rector of Itchenstoke (1843), Hulsean Lecturer (1845–46) and professor of divinity at King's college, London In 1851 he wrote *The Study of Words*, followed by *English Past and Present* (1855) and *A Select Glossary of English Words* (1859). All have gone through numerous editions and have contributed much to promote the historical study of the English tongue. His paper, read before the Philological Society "On some Deficiencies in our English Dictionaries" (1857), gave the first impulse to the great Oxford *New English Dictionary*. His advocacy of a revised translation of the New Testament (1858) aided to promote another great national undertaking. In 1856 he published a valuable essay on Calderon, with a translation of a portion of *Life is a Dream* in the original metre. In 1841 he had published his *Notes on the Parables*, and in 1846 his *Notes on the Miracles*, popular works which are treasuries of erudite and acute illustration

In 1856 Trench was raised to the deanery of Westminster. Here he instituted evening nave services. In January 1864 he was advanced to the more dignified but less congenial post of archbishop of Dublin. He died in London on March 28, 1886.

See his *Letters and Memorials* (2 vols., 1886).

TRENCHARD, HUGH MONTAGUE TRENCHARD, 1ST VISCOUNT, G.C.B. (1873–), British air marshal, was born on Feb. 3, 1873. Commissioned in the Royal Scots Fusiliers in 1893, he served in the South African War with the Imperial Yeomanry and the Canadian Scouts. From 1903 to 1910 he served in West Africa. In 1912 he qualified as an air pilot and became an instructor at the central flying school at Upavon, where he was appointed assistant commandant the following year On the outbreak of the World War Trenchard assumed charge at Farnborough, but before the end of 1914 was summoned to France, and became head of the military wing of the Royal Flying Corps. His strong personality, foresight and power of command made his name a household word in France, and with the expansion of the air service he rose from major to major-general in little over a year. After the formation of the Royal Air Force he became, in March 1918, chief of the air staff. This position he resigned a month later, owing to disagreement with the first air minister, Lord Rothermere. But a few weeks later he received command of the newly formed independent air force, whose mission was to raid Germany. He was Commissioner of the Metropolitan Police, 1931–35. He was created K.C.B. 1918, G.C.B. 1924, G.C.V.O. 1935, baronet 1919, baron 1930, viscount 1936.

TRENCK, FRANZ, FREIHERR VON DER (1711–1749), Austrian soldier, was born on Jan. 1, 1711, of a military family Educated by the Jesuits at Sopron (Oldenburg), he entered the Imperial army in 1728 but resigned in disgrace three years later. He then married and lived on his estates for some years Upon the death of his wife in 1737 he offered to raise an irregular corps of "Pandours" against the Turks, but this offer was refused and he then entered the Russian army. But after serving against the Turks for a short time as captain and major of cavalry he was accused of bad conduct, brutality and disobedience, and condemned to death, the sentence being commuted by Field Marshal Munnich to degradation and imprisonment. He returned to Austria, where his father was governor of a small fortress, but there too came into conflict with every one and actually "took sanctuary" in a convent in Vienna. But Prince Charles of Lorraine obtained for him an amnesty and a commission in a corps of irregulars, where he rose to be lieutenant-colonel (1743) and colonel (1744). But at the battle of Soor he and his irregulars plundered when they should have been fighting and Trenck was accused (probably falsely) of having allowed the king of Prussia himself to escape. He was court-martialled in Vienna, and condemned to death; but the sentence was commuted by the queen into one of cashiering and imprisonment. The rest of his life was spent in mild captivity in the fortress of Spielberg, where he died on Oct. 4, 1749.

His cousin, FRIEDRICH, FREIHERR VON DER TRENCK (1726–1794), the writer of the celebrated autobiography, was born on Feb. 16, 1726, at Königsberg, his father being a Prussian general. He was educated at the University of Königsberg, entered the Prussian army in 1742 and became an orderly officer on Frederick's own staff. But within a year he fell into disgrace because of a love affair—whether real or imaginary—with the king's sister Princess Amalie, and in 1743 Frederick had him arrested and confined in the fortress of Glatz, whence in 1746 he escaped. Making his way home and thence to Vienna, in the vain hope of finding employment under his now disgraced cousin, he finally entered the Russian service. On succeeding to the family estates on his cousin's death, he returned to Germany. In 1754 he visited Prussia, but was there arrested and confined in Magdeburg for ten years, making frequent attempts, of incredible audacity, to escape. After the close of the Seven Years' War, Maria Theresa requested his release. Trenck then spent some years in Aix-la-Chapelle, and eventually returned to his Hungarian estates Here he composed his celebrated autobiography and many other writings, and undertook various diplomatic or secret service missions. He went to Paris in 1791 to witness the Revolution. He was denounced as an Austrian spy and guillotined on July 24, 1794.

His autobiography first appeared in German at Berlin and Vienna (13 vols.) in 1787. Shortly afterwards a French version, by his own hand, was published at Strasbourg. His other published works, in eight volumes, appeared shortly after the autobiography at Leipzig A reprint of the autobiography appeared in 1910 in "Reclam's Universal Series."

See Wahrmann, *Leben und Thaten des Franz, Freiherr von der Trenck und Friedrich, Freiherrn von der Trencks Leben, Kerker und Tod* (both published at Leipzig, 1837).

TRENDELENBURG, FRIEDRICH ADOLF (1802–1872), German philosopher and philologist, was born on Nov. 30, 1802, at Eutin, near Lubeck. He was educated at the universities of Kiel, Leipzig and Berlin. He became more and more attracted to the study of Plato and Aristotle, and his doctor's dissertation (1826) was an attempt to reach through Aristotle's criticisms a more accurate knowledge of the Platonic philosophy (*Platonis de ideis et numeris doctrina ex Aristotele illustrata*). He spent seven years as tutor in a private family, occupying his leisure in preparing a critical edition of Aristotle's *De anima* (1833; 2nd ed. by C Belger, 1877). In 1833 Altenstein, Prussian minister of education, appointed Trendelenburg extraordinary professor in Berlin, and four years later he was advanced to an ordinary professorship. In 1865 he engaged in an acrimonious controversy on the interpretation of Kant's doctrine of Space with Kuno Fischer, whom he attacked in *Kuno Fischer und sein Kant* (1869), which drew forth the reply *Anti-Trendelenburg* (1870). He died on Jan. 24, 1872.

Trendelenburg's *Naturrecht* may be taken as in a manner the completion of his system, his working out of the Ideal as present in the real. The ethical end is taken to be the idea of humanity, not in the abstract as formulated by Kant, but in the context of the State and of history. Law is treated throughout as the vehicle of ethical requirements. In Trendelenburg's treatment of the State, as the ethical organism in which the individual (the potential man) may be said first to emerge into actuality, we may trace his nurture on the best ideas of Hellenic antiquity.

Trendelenburg was also the author of the following: *Elementa logices Aristotelicae* (1836; 9th ed., 1892; Eng. trans., 1881), a selection of passages from the *Organon* with Latin translation and notes, containing the substance of Aristotle's logical doctrine, supplemented by *Erläuterungen zu den Elementen der Aristotelischen Logik* (1842; 3rd ed. 1876); *Logische Untersuchungen* (1840; 3rd ed. 1870), and *Die logische Frage in Hegels System* (1843), important factors in the reaction against Hegel; *Historische Beiträge zur Philosophie* (1846–67), in three volumes, the first of which contains a history of the doctrine of the Categories; *Das Naturrecht auf dem Grunde der Ethik* (1860); *Lücken im*

Völkerrecht (1870), a treatise on the defects of international law, occasioned by the war of 1870.

On Trendelenburg's life and work *see* H. Bonitz, *Zur Erinnerung an F.A.T.* (1872); P. Kleinert, *Grabrede* (1872); E. Bratuschek, *Adolf Trendelenburg* (1873); C. von Prantl, *Gedächtnissrede* (Munich, 1873); G. S. Morris in the *New Englander* (1874), xxxiii.

TRENT, the chief river in the midlands of England, the third in length in the country, exceeded only by the Thames and Severn. It rises in north Staffordshire, and discharges through the Humber into the North Sea, having a course of about 170 m. The source is on Biddulph Moor. The course is first southerly, and it skirts the Potteries, passing Stoke-on-Trent. Passing Stone, the course becomes south-easterly, and the united waters of the Sow and the Penk are received on the right. Near Rugeley the direction becomes easterly, and near Alrewas the Trent receives the Tame (right), and turns to the north-east. The river now passes Burton-on-Trent, in this part of its course forming the boundary between Staffordshire and Derbyshire. The valley opens out as the stream, dividing into several channels at Burton and receiving on the left the Dove, enters Derbyshire. It then separates that county from Leicestershire and Nottinghamshire, receives in succession the Derwent (left), Soar (right) and Erewash (left), enters Nottinghamshire, and passes Nottingham, 81½ m. from the mouth. The next important town is Newark; the Devon (right) joins here. The valley becomes flat, though the river is rather deeply entrenched in some parts. Forming the boundary between Nottingham and Lincolnshire, the Trent passes Gainsborough, receives the Idle (left) and, entering Lincolnshire and skirting the Isle of Axholme, joins the Yorkshire Ouse near Faxfleet. The lower part of the valley resembles the Fens in character. The highest tides are about 40 m. up river, and the phenomenon of a bore is seen rising on spring tides to a height of 4 or 5 ft., 15 m. above the mouth of the river.

The Trent is navigable for 94¾ m. from its junction with the Ouse, to a point a short distance above the junction of the Derwent. It is also navigable for barges of 120 tons as far as Nottingham. There are eight locks. Below Gainsborough the navigation is open, and vessels drawing 9 ft. can reach this point on spring tides. From the Derwent mouth the Trent and Mersey Canal follows the Trent valley upward, and gives connection with the inland navigation system of the midlands and west of England. Short canals give access to Derby and the Derwash valley; the Leicester Navigation, following the Soar, connects with the Grand Junction canal; and the Grantham Canal carries a little traffic between that town and Nottingham. The Fossdyke, connects the Trent with Lincoln and the Witham, and lower down the Sheffield and South Yorkshire canal joins the river from the west at Keadby. There is also a canal, little used, to Chesterfield.

TRENT (ITALY): *see* TRENTO.

TRENT, COUNCIL OF. The Council of Trent (1545–1563) has a long antecedent history of great significance for the fortunes of the Catholic Church. During the 15th and the earlier half of the 16th century, the conception of an "ecumenical council" remained an ideal of which the realization was expected to provide a solution for the serious ecclesiastical difficulties which were then prevalent. The emperor Charles V. urged on the papacy the necessity of convening a general assembly of the church. The passive resistance of the Curia was so stubborn that the decisive step was postponed time and again. But the goal was finally attained, and this result was the work of Charles, aided by three powerful cardinals.

The bull *Laetare Hierusalem* (November 19, 1544) fixed the meeting of the council for March 15, 1545, in Trent, and assigned it three tasks: (1) the pacification of the religious dispute by doctrinal decisions, (2) the reform of ecclesiastical abuses, (3) the discussion of a crusade against the infidels.

The opening of the council was deferred once again. Towards the end of May 1545, twenty bishops were collected at Trent; but there was no sign of action, and the papal legates—Del Monte, Corvinus and Reginald Pole—delayed the inauguration, the emperor and the pope being at cross purposes as to procedure. In the eyes of Paul III. the council was simply the means by which he expected to secure a condemnation of the Protestant heresy, in hopes that he would then be in a position to impose the sentence of the Church upon them by force. For him the question of ecclesiastical reform possessed no interest whatever. In contrast to this, Charles demanded that these very reforms should be given precedence, and the decisions on points of dogma postponed till he should have compelled the Protestants to send representatives to the council. The pope however, alarmed by the threat of a colloquy in Germany, at last ordered the synod to be opened (December 13, 1545).

The procedure adopted secured the predominance of the Roman chair from the first. As the voting was not to be by nations, as at Constance, but by individuals, the last word remained with the Italians, who were in the majority.

The council began its work in the region of dogma by defining the doctrines of the Church with reference to the most important controversial points—a procedure which frustrated the emperor's hopes for a reconciliation with the Protestants. The doctrines dealt with, up to March 1547, were the Holy Scriptures and tradition (*sessio* iv.), original sin (*sessio* v.), justification (*sessio* vi.), and the sacraments in general, and baptism and confirmation in particular (*sessio* vii.). In March the council was moved to Bologna on the pretext that an epidemic was raging in Trent (*sessio* viii.), though, at the imperial command, part of the bishops remained behind. But on the 2nd of June the council of Bologna resolved (*sessio* x.) to adjourn its labours. At the Diet of Augsburg the emperor secured a *modus vivendi*, leavened by the Catholic spirit, between the adherents of either religion; and this provisory settlement—the so-called *Interim* of Augsburg—was promulgated as a law of the empire (June 3, 1548), and declared binding till the council should reassemble. But the confusion of ecclesiastical affairs had grown worse confounded through the refusal of the pope to continue the council, when his death (November 10, 1549) changed the situation.

Pope Julius III., the former legate Del Monte, caused the council to resume its labours on May 1, 1551 (*sessio* xi.), under the presidency of Cardinal Crescentio. The personnel was, for the most part, different; and the new members included the Jesuits, Laynez and Salmeron. The French clergy had not a single delegate, while the Spanish bishops maintained an independent attitude under the aegis of the emperor, and Protestant deputies were on this occasion required to appear at Trent. Their participation, however, was useless, for the discussion of doctrine on the basis of Holy Writ was from the Catholic standpoint impossible; and the revolt of the elector Maurice of Saxony (March 20, 1552) compelled the emperor to leave Innsbruck, and dissolved the conclave. Its dogmatic labours were confined to doctrinal decrees on the Lord's Supper (*sessio* xiii.), and on the sacraments of penance and extreme unction (*sessio* xiv.). On April 28, 1552, the sittings were suspended.

Ten years elapsed before the council reassembled for the third time in Trent. During the intervening period, the religious problem in Germany had received such a solution as the times admitted by the peace of Augsburg (1555); and the equality there guaranteed between the Protestant estates and the Catholic estates had left the former nothing to hope from a council. The incitement to continue the council came from another quarter. It was no longer anxiety with regard to Protestantism that exercised the pressure, but a growing conviction of the imperative need of more stringent reforms within the Catholic Church itself. In France and Spain—the very countries where the Protestant heresy had been most vigorously combated—a great mass of discontent had accumulated; and France already showed a strong inclination to attempt an independent settlement of her ecclesiastical difficulties in a national council. Pius IV. therefore announced (Nov. 29, 1560) the convocation of the council; and on Jan. 18, 1562, it was actually reopened (*sessio* xvii.)

The Protestants indeed were also invited but the Evangelical princes, assembled in Naumburg, withheld their assent. To secure freedom of action, France and the emperor Ferdinand required that it should rank as a new council; Pius IV., however, designated it a continuation of the earlier meetings. Ferdinand, in

addition to regulations for the amendment of the clergy and the monastic system, demanded above all the legalization of the marriage of the priesthood, while France and Spain laid stress on the recognition of the divine right of the episcopate, and its independence with regard to the pope. In consequence of these reformatory aspirations, the position of the pope and the council was for a while full of peril But the papal diplomacy, by concessions, threats, and by exploiting political and ecclesiastical dissensions, broke the force of the attack. In the third period of the council, which, as a result of these feuds, witnessed no session from September 1562 to July 1563, doctrinal resolutions were also passed concerning the Lord's Supper *sub utraque specie* (*sessio* xxi), the sacrifice of the Mass (*sessio* xxii.), the sacrament of ordination (*sessio* xxiii), the sacrament of marriage (*sessio* xxiv.), and Purgatory, the worship of saints, relics and images. On Dec. 4, 1563, the synod closed.

The dogmatic decisions of the Council of Trent make no attempt at embracing the whole doctrinal system of the Roman Catholic Church, but present a selection of the most vital doctrines, partly chosen as a counterblast to Protestantism, and formulated throughout with a view to that creed and its objections.

The reformatory enactments touch on numerous phases of ecclesiastical life—administration, discipline, appointment to spiritual offices, the marriage law (*decretum de reformatione matrimonii "Tametsi," sessio* xxiv.), the duties of the clergy, and so forth. The resolutions include many that marked an advance; but the opportunity for a comprehensive and thorough reformation of the life of the Church—the necessity of which was recognized in the Catholic Church itself—was not embraced. No alteration of the abuses which obtained in the Curia was effected, and no annulment of the customs, so lucrative to that body and deleterious to others, was attempted.

The Council of Trent in fact enjoyed only a certain appearance of independence. For the freedom of speech which had been accorded was exercised under the supervision of papal legates, who maintained a decisive influence over the proceedings and could count on a certain majority in consequence of the overwhelming number of Italians That the synod figured as the responsible author of its own decrees (*sancta oecumenica et generalis tridentina synodus in spiritu sancto legitime congregata*) proves very little, since the following clause reads *praesidentibus apostolicae sedis legatis;* while the legates and the pope expressly refused to sanction an application of the words of the Council of Constance—*universalem ecclesiam repraesentans.*

The whole course of the council was determined by the presupposition that it had no autonomous standing, and that its labours were simply transacted under the commission and guidance of the pope. This was not merely a claim put forward by the Roman see at the time, It was acknowledged by the attitude of the synod throughout. The legates confined the right of discussion to the subjects propounded by the pope, and their position was that he was in no way bound by the vote of the majority. In difficult cases the synod itself left the decision to him, as in the question of Clandestine Marriages and the Administration of the Lord's Supper *sub utraque specie*. Further, at the close of the sessions a resolution was adopted, by the terms of which all the enactments of the council *de morum reformatione atque ecclesiastica disciplina* were subject to the limitation that the papal authority should not be prejudiced thereby (*sessio* xxv *cap.* 21). Every doubt as to the papal supremacy is removed when we consider that the Tridentine Fathers sought for all their enactments and decisions the ratification (*confirmatio*) of the pope, which was conferred by Pius IV. in the bull *Benedictus Deus* (January 26, 1564); and in its last meeting (*sessio* xxv.) the synod transferred to the pope a number of tasks for which their own time had proved inadequate. These comprised the compilation of a catalogue of forbidden books, a catechism, a short conspectus of the articles of faith and an edition of the missal and the breviary. Thus the council presented the Holy See with a further opportunity of extending its influence and diffusing its views. The ten rules *de libris prohibitis* were published in March 1564; the *Professio fidei tridentinae* in November 1564; and the *Catechismus ex decreto concilii tridentini ad parochos*, early in 1568.

The oecumenical character of the council was never seriously questioned. On the motion of the legates, the resolutions were submitted to the ambassadors of the secular powers for signature, the French and Spanish envoys alone withholding their assent. The recognition of the council's enactments was, none the less, beset with difficulties. So far as the doctrinal decisions were concerned no obstacles existed; but the reformatory edicts—adhesion to which was equally required by the synod—stood on a different footing. In their character of resolutions claiming to rank as ecclesiastical law they came into conflict with outside interests, and their acceptance by no means implied that the rights of the sovereign, or the needs and circumstances of the respective countries were treated with sufficient consideration. The consequence was that there arose an active and, in some cases, a tenacious opposition to an indiscriminate acquiescence in all the Tridentine decrees, especially in France, where only those regulations were recognized which came into collision neither with the rights of the king nor with the liberties of the Gallican Church. In Spain, Philip II. allowed, indeed, the publication of the *Tridentinum*, but always with the reservation that the privileges of the king, his vassals and his subjects, should not thereby be infringed.

In his official confirmation Pius IV. had already strictly prohibited any commentary on the enactments of the council unless undertaken with his approval, and had claimed for himself the sole right of interpretation. In order to supervise the practical working of these enactments, Pius created (1564) a special department of the Curia, the *Congregatio cardinalium concilii tridentini interpretum;* and to this body Sixtus V. entrusted the further task of determining the sense of the conciliar decisions in all dubious cases. The *resolutiones* of the congregation—on disputed points—and their *declarationes* on legal questions—exercised a powerful influence on later development of ecclesiastical law.

The Council of Trent attained a quite extraordinary significance for the Roman Catholic Church; and its pre-eminence was unassailed till the *Vaticanum* subordinated all the labours of the Church in the past—whether in the region of doctrine or in that of law—to an infallible pope. On the theological side it fixed the results of mediaeval scholasticism and drew from it all that could be of service to the Church. Further, by pronouncing on a series of doctrinal points till then undecided it elaborated the Catholic creed; and, finally, the bold front which it offered to Protestantism in its presentation of the orthodox faith gave to its members the practical lead they so much needed in their resistance to the Evangelical assault. It showed the Church as a living institution, capable of work and achievement; it strengthened the confidence both of her members and herself, and it was a powerful factor in heightening her efficiency as a competitor with Protestantism and in restoring and reinforcing her imperilled unity. Indeed, its sphere of influence was still more extensive, for its labours in the field of dogma and ecclesiastical law conditioned the future evolution of the Roman Catholic Church.

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mation, i (Stuttgart, 1889); P. Tschackert, *s.v.* "Trienter Konzil," in Herzog-Hauck, *Realencyklopädie für protestantische Theologie* (1908), vol. xx, ed. 3. (C. Mt.; X)

TRENTE ET QUARANTE or ROUGE ET NOIR, a gambling game of cards played at Monte Carlo and at French casinos Players place their bets upon a layout such as the one illustrated; the table usually carries two identical layouts. All betting is done against the house, or bank SIX packs of 52 cards are used, shuffled together by a dealer representing the bank and cut by one of the players. The dealer then lays out a row of cards known as the *nour* (black), adding the values of the cards until the total is 31 or more, court cards and tens counting 10 each, aces 1 each, and each other card the number of pips on its face. A second row, representing the *rouge* (red) row is then dealt below the first. A bet on black or red wins if the row of that designation counts nearer to 31. A bet on *couleur* wins if the first card dealt is of the colour designating the winning row, while a bet on *inverse* wins if the first card dealt is of opposite colour. The croupier invariably announces the result for red and colour only, thus: *rouge gagne* (wins) or *rouge perd* (loses); *couleur gagne* or *couleur perd*

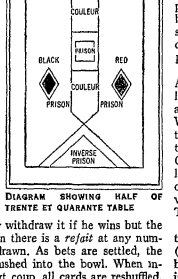


DIAGRAM SHOWING HALF OF TRENTE ET QUARANTE TABLE

If both rows count the same, it is a *refait*. When there is a *refait* at 31, the bank takes half of all stakes; or a player may, if he prefers, put his bet in prison, leaving it to be decided by the next coup, whereupon he may withdraw it if he wins but the bank takes it all if he loses When there is a *refait* at any number except 31, all bets are withdrawn. As bets are settled, the cards dealt for that coup are brushed into the bowl. When insufficient cards remain for the next coup, all cards are reshuffled.

A *refait* occurs at 31 more frequently than at any other number. Estimates of its frequency vary from once in 45 coups (which would give the bank an advantage of 1.1%) down to once in 31 coups (1.6% advantage to the bank).

TRENTINO, a mountainous area of North Italy, extending E. and W. of the middle course of the Adige. Before World War I it was part of the Austrian province of Tirol. The Trentino frontier, which had been delimited after the war of 1866, was strategically most unfavourable to Italy, as it left the mountain ranges in Austrian hands and formed a wedge whence a dozen military roads branched outward threatening the richest and most fertile parts of Italy. It also left 400,000 Italians under Austrian rule During World War I the Trentino was the scene of heavy fighting, which extended from the Stelvio pass to the Ampezzo valley and spread over into the Asiago plateau within the borders of Italy Early in the war the Italian troops occupied a number of positions beyond the frontier, especially east of the Adige, whence their line extended from north of Mori, along the Terragnolo valley, Costa d'Agra, across the Astico, Cima Mandriolo, across the river Brenta in the Val Sugana to the Cima d'Asta; farther east all the Ampezzo valley was occupied to the Tofana and Cristallo groups. There were many engagements in the autumn and winter of 1915, especially north of the Cadore and at the head of the Cordevole valley round the Col di Lana, the attacks on which caused serious losses to the Italians, until in April 1916 the summit was blown up by an Italian mine and the hill remained in Italian hands. The fighting on the Stelvio, the Adamello, the Ampezzo group and the peaks round San Martino di Castrozza was at a very high altitude, and the troops had to perform what even in ordinary times would be regarded as notable mountaineering exploits amid ice, snow and extremely difficult rocky terrain, exposed to intense cold, severe storms and heavy enemy fire, the Austrians usually holding the most favourable positions. Roads had to be built up the most precipitous mountains and heavy guns dragged up to a height of 2,000 to 3,000 feet. The Italians managed to capture many of these positions, although at the cost of heavy losses, but in May 1916 the Austrians, after an intense artillery preparation with masses of heavy guns, launched a formidable attack on the Terragnolo–Val Sugana –Folgaria–Asiago area and drove the Italians back for a considerable distance. The object was to debouch into the Vicenza plain and cut the communications with the Isonzo army. There was desperate fighting along the whole line, but the key positions of Coni Zugna, Passo Buole and the Pasubio to the west and the peaks on the outer edge of the Asiago plateau on the east held firm.

By June 16 the momentum of the Austrians had exhausted itself, and an Italian counter-attack recovered most of the lost ground. After the Austrian break-through at Caporetto in Oct. 1917, an attempt was made to effect a breach also in the Asiago plateau. The Ampezzo and Cadore areas had to be evacuated by the Italians, and in the heavy fighting through Nov. and Dec some of the positions on the plateau were again lost, but the outer edge was held, and the Austrians failed to descend into the plain.

In the battle of June 1918, when the west sector of the Asiago area was held by British troops, another attack was delivered there, and although the Austrians at first broke through at several points they were driven back to their original line. When the final battle of the war began (Oct. 23, 1918) the Italians, together with British and French forces, carried out a demonstrative action to prevent the enemy from shifting reserves to the Grappa and Piave areas where the main attacks were being delivered. It was from the Asiago plateau that the victorious troops on Nov. 1 poured into the Val Sugana, while the 1st army advanced up the Adige valley and the two forces converged on Trento, which was reached on Nov. 3.

TRENTO (Lat. *Tridentum;* Ger. *Trent* or *Trient*), the capital of a province in the district of Venezia Tridentina, Italy Pop. (1936) 37,290 (town), 56,017 (commune). It stands on the left bank of the Adige where this river is joined by the Fersina, and is a station on the Brenner railway, 35 mi. S. of Bolzano and 56½ mi. N. of Verona, while a railway runs along the Fersina valley and the Val Sugana to Bassano (60 mi.). There is also an electric railway to Malè (45 mi. N.). It has a very picturesque appearance, especially when approached from the north, with its embattled walls and towers filling the whole breadth of the valley. A conspicuous feature in the view is the isolated rock Doss Trento (the site of the Roman *Verruca*), that rises on the right bank of the Adige to a height of 308 ft. above the city. The cathedral (dedicated to San Vigilio, the first bishop) was altered at various times between the 11th and 15th centuries, and was restored in 1882–89.

Outside is the fine fountain of Neptune (1767–69). The Renaissance church of Santa Maria Maggiore, built in 1520–39, was the scene of the sessions of the famous Oecumenical Council (*see* p. 454) which lasted, with several breaks, from 1545 to 1563, during the episcopate of Cristoforo Madruzzo. To the east of the city rises the Castello del Buon Consiglio, for centuries the residence of the prince-bishops, which is decorated with interesting frescoes, and contains the museum of antiquities and fine arts for the district. Opposite the railway station a statue of Dante by Zocchi was erected in 1896.

Tridentum, the capital of the Tridentini, was a station on the great road from Verona to Veldidena (Innsbruck) over the Brenner. It was later ruled by the Ostrogoths (5th century) and the Lombards (6th century) after the conquest of whom by the Franks (774) Trento became part of the mediaeval kingdom of Italy. But in 1027 the emperor Conrad II bestowed all temporal rights in the region on the bishop (the see dates from the 4th century) and transferred it to Germany. Venetian attacks were finally repulsed in 1487, and the bishop retained his powers till 1803, when they passed to Austria until 1809. From 1810 to 1814 Trento was part of the Napoleonic kingdom of Italy, and capital

of the Alto Adige province. In 1814 the Trentino was annexed to the Austrian province of Tirol and in 1918 was ceded to Italy.

TRENTON, a town in southeastern Michigan, U.S.A., Wayne county. It is situated on the Detroit river, between Detroit and Lake Erie. The altitude is 588 ft; the land area 7.2 sq mi.; the population was 6,214 in 1950 and 5,284 by the federal census of 1940. The town is largely industrial, with chemical, refining, steel and power plants. It has a president-council form of government. It was founded on the site of a Pottowatami Indian village. Major Abram Caleb Truax acquired the site in 1816 and in 1827 the village was platted under the name of Truaxton. It became a port of call when steam navigation was begun on the Great Lakes and was an important shipbuilding centre until wooden vessels became obsolete. The village was incorporated under the name of Trenton in 1875.

TRENTON, a city of Missouri, U.S., 100 mi. N.E. of Kansas City, on the east fork of the Grand river; the county seat of Grundy county. It is on federal highway 65 and state highway 6, and is served by the Rock Island railway. The population was 6,110 in 1950 and 7,046 in 1940 by the federal census. The Rock Island railway has repair shops there. Trenton was platted as the county seat in 1841, incorporated as a town in 1857, and chartered as a city in 1893.

TRENTON, the capital city of New Jersey, U.S., and the county seat of Mercer county; on the Lincoln highway and the east bank of the Delaware river, 30 mi. N.E. of Philadelphia and 55 mi. S.W. of New York city. It has a county airport, and is served by the Pennsylvania and the Reading railways, numerous motorbus and truck lines and small steamers and barges on the Delaware river. Pop 127,867 in 1950, 124,697 in 1940 and 123,356 in 1930 (22% foreign-born white).

Trenton is at the head of navigation on the Delaware, which falls 8 ft. at this point. Three miles of the water front are occupied by Riverside park, and there are municipal terminals, wharves and warehouses. The city has an area of 7.7 sq.mi., of which 266 ac. are in public parks; an assessed valuation of about $165,000,000; and a commission form of government, adopted in 1911. It is the seat of a state teachers' college (1855), the state library, the state school for the deaf, the state home for girls, a state hospital for the insane (1848) and the state prison (1836). The State House stands on high ground not far from the river. In Mahlon Stacy park, adjoining the capitol grounds, are the "Hessian" barracks, erected by the colony in 1758 to mitigate the evils of billeting, and occupied by British troops during the Seven Years' War, and at different times during the Revolution by British, Hessian and American troops.

Washington's crossing of the Delaware on Christmas night, 1776, took place 8 mi. above Trenton, and in the centre of the city stands a granite column 150 ft. high, marking the spot where he planted his guns in the battle of Trenton on the following day. Among the interesting old houses are "Woodland" (formerly called "Bloomsbury Court"), built early in the 18th century by William Trent, "The Hermitage," and "Bow Hill," a quaint colonial mansion in the suburbs, which for some time before 1822 was the home of Joseph Bonaparte. Trenton is the see of Roman Catholic and Protestant Episcopal bishops. There are 100 churches in the city, 23 public and 17 parochial schools, 7 hospitals and a number of homes and other charitable institutions under religious auspices.

The Trenton Municipal colony, on the outskirts of the city, is an assemblage of the city's institutions for the care of the sick and the aged, in connection with a farm of 25 ac. There are two daily papers: the *Trentonian*, established in 1945, and the *Evening Times* (1882).

Trenton is an important industrial city, with 296 manufacturing establishments in 1947, employing 30,000 workers, producing goods valued at $153,500,000. In addition there are 100 other industries in the Trenton area (employing 10,000 workers), located just outside the city limits. Bank clearings in 1949 aggregated $427,513,000.

In 1680 Mahlon Stacy, a Quaker of Burlington, erected a mill on the Delaware there, at the mouth of the Assanpink creek, and by 1685 a small settlement had grown up around it. In 1714 Stacy sold his plantation at "The Falls" to William Trent, later chief justice of New Jersey, after which the village came to be known as Trent-town, or Trenton. In 1745 Trenton was incorporated as a borough by a royal charter, but in 1750 the citizens voluntarily surrendered this privilege, deeming it "very prejudicial to the interest and trade" of the community. In 1783 Trenton was proposed by the New Jersey delegates in congress for the seat of the federal government, and in Nov. 1784, while it was under consideration, congress met there for a brief period. It became the capital of the state in 1790 and was chartered as a city in 1792.

The modern pottery industry dates from 1852. In 1860 the population was 17,228; in 1880, 29,910; in 1900, 73,307; in 1910, 96,815 and in 1920, 119,289. There were no annexations of territory after 1900

TRENTON AND PRINCETON, BATTLES OF (1776–1777). These battles in the War of American Independence are noted as the first successes won by George Washington in the open field. Following close upon a series of defeats their effect upon his troops and the population at large was marked. After the capture of Ft. Washington on Manhattan Island, on Nov. 16, 1776, the British general, Sir William Howe, forced the Americans to retreat through New Jersey and across the Delaware into Pennsylvania. Howe then went into winter quarters, leaving the Hessian general, Rahl, at Trenton on the river with a brigade of 1,200 men. Although Washington's army was discouraged by the year's disasters, it could still be trusted for a promising exploit, and by reinforcements had been brought up to 6,000 effectives. Ascertaining that the Hessians at Trenton were practically unsupported, the American general determined to attempt their capture. He planned to recross the Delaware with three columns, but only his own got across. The passage was made on the night of Dec. 25, 1776, through floating ice, to a point 9 mi. above the enemy, whom he expected to reach at dawn of the following day, the 26th. Dividing his force of 2,500 men into two divisions under Gen. John Sullivan and Gen. Nathanael Greene, he approached the town by two roads, surprised the Hessian outposts, and then rushed upon the main body before it could form effectively. The charge of the American troops and the fire of their artillery and musketry completely disconcerted the enemy. All avenues of retreat being closed and their general mortally wounded, the latter to the number of 950 quickly surrendered.

Elated by this success and eager to harass the enemy's advanced posts at other points, Washington again crossed the Delaware on Dec. 30, and occupied Trenton. Hearing of this move Lord Cornwallis at Princeton, 10 mi. north of Trenton, marched down with about 7,000 troops upon the Americans on Jan. 2, 1777, and drove them across the Assanpink, a stream running east of the town. The Americans, who encamped on its banks that night, were placed in a precarious position, as the Delaware, with no boats at their disposal at that point, prevented their recrossing into Pennsylvania, and all other roads led toward the British lines to the northward. Washington accordingly undertook a bold manœuvre. Fearing an attack by Cornwallis on the next morning, he held a council of war, which confirmed his plan of quietly breaking camp that night and taking a byroad to Princeton, then cutting through any resistance that might be offered there and pushing on to the hills of northern New Jersey, thus placing his army on the flank of the British posts. His tactics succeeded. At Princeton (*q.v.*) he came upon three British regiments, which for a time held him at bay. The 17th foot especially, under Col. Charles Mawhood, twice routed the American advanced troops, inflicting severe loss, but were eventually driven back toward Trenton. The other regiments retreated north toward New Brunswick, and Washington continued his march to Morristown, N.J. There he was on the flank of the British communications with New York, and hence Cornwallis retired to New Brunswick. Washington, besides his success in breaking through Howe's lines, had placed himself in an advantageous position for recruiting his army and maintaining a strong defensive in the next campaign. These two affairs of Trenton and

Princeton put new life into the American cause, and established Washington in the confidence of his troops and the country.

See W. S. Stryker, *The Battles of Trenton and Princeton* (Boston, 1898); and Varnum L. Collins, ed., "A Contemporary Account of the Battles of Trenton and Princeton," *Princeton Hist. Assoc.*, Extra pub. No. 1 (Princeton, N.J., 1906).

TREPOV, DIMITRI FEODOROVICH (1855–1906), Russian general, chief of the imperial police, born at St. Petersburg (Leningrad), was city prefect of Moscow. In the disturbances of 1905 he was placed in command of St. Petersburg, when he immediately took steps to expel all those who had taken part in the procession led by Father Gapon to the Winter Palace. The result was an epidemic of strikes throughout the empire. In the railway strike (Oct. 20) Trepov gave the famous order to the troops "not to spare their cartridges." He was now made commandant of the imperial police, and used his great power to undermine the authority of Count Witte with the tsar. He then became assistant-minister of the interior An unsuccessful attempt to assassinate him was made on March 30, 1905. He died on Sept. 15, 1906.

TRESCOT, WILLIAM HENRY (1822–1898), American diplomatist, was born in Charleston, S.C., on Nov. 10, 1822. He graduated at Charleston college in 1840, studied law at Harvard, and was admitted to the bar in 1843 In June, 1860 he was appointed assistant secretary of State, and he was acting secretary of State in June-October, during Gen. Lewis Cass's absence from Washington. His position was important, because of his intimacy with President Buchanan and his close relations with the secession leaders in South Carolina. He opposed the re-enforcement of Ft. Sumter and used his influence to prevent any attack on the fort by South Carolina before the meeting of the State's convention called to consider the question of secession. He returned to Charleston in Feb. 1861, served as colonel on the staff of Gen. Roswell S. Ripley during the Civil War; and later returned to Washington. He was counsel for the United States before the Halifax Fishery commission in 1877; was minister to Chile in 1881–82 and in 1882 with Gen. U. S. Grant negotiated a commercial treaty with Mexico. He died at Pendleton, S C., on May 4, 1898.

His writings include *The Diplomacy of the Revolution* (1852), *An American View of the Eastern Question* (1854) and *The Diplomatic History of the Administrations of Washington and Adams* (1857).

TRESPASS, in law, any transgression of the law less than treason, felony or misprision of either. The term includes a great variety of wrongs committed to land, goods or person. Up to 1694 the trespasser was regarded, nominally at any rate, as a criminal, and was liable to a fine for the breach of the peace, commuted for a small sum of money, for which 5 Will. and Mar. c 12 (1693) substituted a fee of 6s 8d. recoverable as costs against the defendant. Trespass is not now criminal except by special statutory enactment, *e.g.*, the old statutes against forcible entry, the game acts, and the private acts of many railway companies. When, however, trespass is carried sufficiently far it may become criminal, and be prosecuted as assault if to the person, as nuisance if to the land. At one time an important distinction was drawn between trespass general and trespass special or trespass on the case, for which *see* TORT.

In its more restricted sense trespass is generally used for entry on land without lawful authority by either a man, his servants or his cattle. To maintain an action for such trespass the plaintiff must have possession of the premises. The most minute invasion of private right is trespass. In addition to damages for trespass, an injunction may be granted by the court.

Trespass may be justified by exercise of a legal right, as to serve the process of the law, or by invitation or licence of the owner, or may be excused by accident or inevitable necessity, as deviation from a highway out of repair.

In Scots law trespass is used only for torts to land. By the Trespass (Scotland) Act 1865 trespassers are liable on summary conviction to fine and imprisonment for encamping, lighting fires, etc., on land without the consent and permission of the owner.

In the United States, common law doctrines as to trespass hold in most of the States. It means, more particularly, an injury to the person, property or rights of another, as the immediate result of a wrongful act committed with actual or implied force. The statutes have provided for criminal trespass in many States, but not to the extent as existed prior to 1694 in England. Trespass on the realty of another often is a criminal offence, through statutory enactment in the States.

TRES TABERNAE (Three Taverns), an ancient village of Latium, Italy, a post station on the Via Appia. It is probable that it stood at Cisterna, where a branch road running from Antium joins the Via Appia. Tres Tabernae is best known as the point to which St Paul's friends came to meet him on his journey to Rome (Acts xxviii. 15). It became an episcopal see, but this was united with that of Velletri in 592.

TRESVIRI or **TRIUMVIRI,** in Rome, a board of three, either ordinary officials or extraordinary commissioners.

1. *Tresviri capitales,* whose duty it was to assist the higher magistrates in their judicial functions, especially criminal, were first appointed about 289 B C. They possessed no criminal jurisdiction or *ius prensionis* (right of arrest) in their own right They kept watch over prisoners and carried out the death sentence; took accused or suspected persons into custody; and exercised general control over the city police. They went the rounds by night to maintain order, and had to be present at outbreaks of fire. They assisted the aediles in burning forbidden books. They had to collect the *sacramenta* (deposit forfeited by the losing party in a suit) and examined the plea of exemption put forward by those who refused to act as jurymen. In imperial times most of their functions passed into the hands of the *praefectus vigilum.*

2. *Tresviri epulones,* a priestly body, assisted at public banquets. They were first created in 196 B.C. to superintend the *epulum Iovis* (banquet of Jupiter) on the Capitol, but their services were also requisitioned on the occasion of triumphs, imperial birthdays, the dedication of temples, games given by private individuals, and so forth, when entertainments were provided for the people

3. *Tresviri monetales* were superintendents of the mint, up to the Social War occasional, afterwards permanent, officials. As they acted for the senate they only coined copper money under the empire, the gold and silver coinage being under the exclusive control of the emperor.

4. *Tresviri reipublicae constituendae* was the title bestowed upon Octavianus, Lepidus and Antony for five years by the lex Titia, 43 B C. The coalition of Julius Caesar, Pompey and Crassus has also been called a "triumvirate," but they never had the title *tresviri,* and were not a formally appointed commission.

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TREVELYAN, GEORGE MACAULAY (C.B.E. 1920), English historian (1876–), third son of Sir George Otto Trevelyan (*q.v.*), was born on Feb. 16, 1876, and educated at Harrow and at Trinity college, Cambridge During the World War he served as Commandant of the 1st British Ambulance unit for Italy (1915–18). In 1927 he became regius professor of modern history at Cambridge. He received the O.M. in 1930.

His numerous publications include: *England under the Stuarts* (1907); *Garibaldi and the Making of Italy* (1911); *The Life of John Bright* (1913); *Lord Grey of the Reform Bill* (1920); *British History of the Nineteenth Century, 1782–1901* (1922); *Manin and the Venetian Revolution of 1848* (1923); *History of England* (1926) and *England Under Queen Anne* (1930).

TREVELYAN, SIR GEORGE OTTO, O.M. 1911 (1838–1928), English historian, was born on July 20, 1838, at Rothley Temple, Leicestershire, the son of Sir C. E. Trevelyan and his wife Hannah More Macaulay. He had a brilliant career at Harrow, which he entered in 1851, and at Trinity College, Cambridge. In 1862 he went to India as his father's private secretary, and while there wrote two humorous books, *The Dawk Bungalow,* and *The Competition Wallah,* and in 1865 his first serious work, *Cawnpore.* In 1864 he was again in London, and the following year was returned as Liberal M.P. for Tynemouth. From 1868 to 1887 he represented the Hawick Burghs, and from

1887 until his retirement in 1897, the Bridgeton division of Glasgow. In 1868 he had become a civil lord of the Admiralty, but resigned two years later. He then completed his *Life* of his uncle Lord Macaulay, which was immediately recognised as a masterpiece of biography. He was for two years (1880–82) secretary to the Admiralty, and then became for a year chief secretary for Ireland, after the murder of Lord Frederick Cavendish. The strain of this position told severely on his health, and he returned in 1884, and was given the office of the duchy of Lancaster, with a seat in the cabinet. He was credited with a large share in the authorship of the measure extending household suffrage to the counties (1885). He was secretary for Scotland in the first Home Rule parliament, but resigned with Chamberlain two months later. With Chamberlain he joined the Round Table Conference on the Irish question at Harcourt's house. Finding, however, that Liberal Unionism could not stand alone, he took office under Gladstone in 1892 as secretary for Scotland, a post which he held also in Lord Rosebery's government. His many honours were crowned in 1911 with the Order of Merit.

His *Life and Letters of Lord Macaulay* (1876) still holds its place as a biography of the first importance, and a new edition was issued in 1923. His next work was *The Early History of Charles James Fox* (1880). The second volume which he intended to write, was put aside in favour of his history of *The American Revolution*. This history led to a long and interesting correspondence with Roosevelt, to whom he sent a copy in 1904, some of Roosevelt's letters being published later in *Scribner's Magazine*.

He married in September, 1869, Caroline, daughter of R. N. Philips. He died on Aug. 16, 1928, and was succeeded in the baronetcy by his eldest son, Charles Philips Trevelyan, M.P. (b. 1870) who was minister for education in Ramsay MacDonald's two administrations, in 1924 and 1928. His second son, Robert Calverley Trevelyan, is the author of admirable translations from the Greek drama, and of original verse. His third son was George Macaulay Trevelyan (*q.v.*).

TREVES, SIR FREDERICK (1853–1923), British surgeon, was born at Dorchester on Feb. 15, 1853, and was educated at Merchant Taylor's school, London, and the London hospital, where he became surgical registrar. In 1881 he was appointed as professor of pathology and in 1885 as professor of anatomy at the Royal College of Surgeons, subsequently going into private practice. He served as consulting surgeon during the South African War in 1900, and was made surgeon extraordinary to Queen Victoria in that year and surgeon to King Edward VII. in 1901. He operated on King Edward VII. when he fell ill in June 1902. He was created K.C.V.O. in 1901 and a baronet in 1902, and later serjeant-surgeon to King George and surgeon in ordinary to Queen Alexandra. During the World War he assisted in the founding of the British Red Cross.

His publications include several surgical and medical books, of which *Surgical Applied Anatomy* (1883) is well known, as well as a number of more popular books such as *The Tales of a Field Hospital* (1900), *The Riviera of the Corniche Road* (1921), *The Lake of Geneva* (1922), and *The Elephant Man and Other Reminiscences* (1923).

TREVET (or **TRIVET**), **NICHOLAS** (*c.* 1258–*c* 1328), English chronicler, was the son of Sir Thomas Trevet (d 1283), a judge, and became a Dominican friar. After studying at Oxford and in Paris, he spent most of his subsequent years in writing and teaching, and died about 1328. His chief work is his *Annales sex regum Angliae*, a chronicle of English history covering the period between 1135 and 1307; this is valuable for the later part of the reign of Henry III. and especially for that of Edward I.

The *Annales* were published in Paris in 1668, in Oxford in 1719, and were edited by Thomas Hog for the English Historical Society in 1845. Manuscripts are at Oxford and in the British Museum.

TREVI (anc. *Trebiae*), a town of the province of Perugia, Italy, 30 m. S.E. of Perugia and 5 m. S. of Foligno by rail. Pop. (1936) 1,092 (town); 6,631 (commune). The town stands on a steep hill 1,355 ft above sea-level. Several of its churches are architecturally interesting, especially the Madonna delle Lacrime (1487) outside the town, and most of them (and also the municipal picture gallery) contain paintings by artists of the Umbrian school—notably Io Spagna, a pupil of Perugino. The cathedral (S. Emiliano) has a group of three altars decorated with fine sculptures by Rocco da Vicenza (1521).

TREVISO (anc. TARVISIUM), a town and episcopal see of Venetia, Italy, capital of the province of Treviso, 49 ft. above sea level. Pop. in 1936, 43,949 (town); 53,886 (commune). It is on the plain between the Gulf of Venice and the Alps, 18 mi. by rail north of Venice, at the confluence of the Sile with the Bottenigа. The former flows partly round its walls, the latter through the town; and it has canal communications with the lagoons. It has narrow irregular colonnaded streets and old frescoed houses. The cathedral of San Pietro, dating from 1141 and restored and enlarged in the 15th century by Pietro Lombardo, with a classical façade of 1836, has seven domes. It contains a fine "Annunciation" by Titian (1519), an important "Adoration of the Shepherds" by Paris Bordone (born at Treviso in 1500), and frescoes by Pordenone. There are also sculptures by Lorenzo and Battista Bregno and others. The baptistery is Romanesque. The Gothic church of San Nicolò (1310–52) contains important works of art, including a large altarpiece by Fra Marco Pensabene and others; in the church and adjoining chapter-house are frescoes by Tommaso da Modena (1352), some frescoes by whom (life of S. Ursula) are also in the Museo Civico. The churches of S. Leonardo, S. Andrea, S. Maria Maggiore, and S. Maria Maddalena also contain art treasures. The Piazza dei Signori contains picturesque brick battlemented palaces—the Palazzo dei Trecento (*c.* 1207) and the Palazzo Pretorio (1218–68). The loggia dei Cavalieri (1195) is also fine.

The ancient Tarvisium lay off the main roads, and is hardly mentioned by ancient writers. In the 6th century it appears as an important place and was the seat of a Lombard duke. Charlemagne made it the capital of a marquisate. It joined the Lombard league, and was independent after the peace of Constance (1183) until, in 1339, it came under the Venetian sway. From 1318 it was for a short time the seat of a university. Its walls and ramparts were renewed under the direction of Fra Giocondo (1509), two of the gates, the Porta Mazzini and Porta Cavour, dating from 1517–18. Treviso was taken in 1797 by the French under Mortier (duke of Treviso). In March 1848 the Austrian garrison was driven from the town by the revolutionary party, but in the following June the town was bombarded and compelled to capitulate.

See A. Marchesan, *Trevisо medioevale* (Treviso, 1923).

TREVITHICK, RICHARD (1771–1833), English engineer and inventor, was born on April 13 in the parish of Illogan, Cornwall, and was the only son of Richard Trevithick (1735–97), manager of the Dolcoath and other important Cornish mines. His earliest invention of importance was his improved plunger pole pump (1797) for deep mining, and in 1798 he applied the principle of the plunger pole pump to the construction of a water-pressure engine, which he subsequently improved in various ways. Two years later he built a high-pressure non-condensing steam-engine, which became a rival of the low-pressure steam-vacuum engine of Watt. He was a precursor of George Stephenson in the construction of locomotive engines. On Christmas Eve 1801 his common-road locomotive carried the first load of passengers ever conveyed by steam, and on March 24, 1802 he and Andrew Vivian applied for a patent for steam-engines in propelling carriages. In 1803 another steam vehicle made by him was run in the streets of London, from Leather Lane along Oxford Street to Paddington, the return journey being made by Islington. He next built a steam locomotive for tramways, and in Feb. 1804 at Pen-y-darran in Wales he worked a tramroad locomotive which was able to haul 20 tons of iron; a similar engine was supplied to the Wylam colliery (Newcastle) in the following year. In 1808 he constructed a circular railway in London near Euston Square, on which the public were carried at the rate of 12 or 15 miles an hour round curves of 50 or 100 ft. radius. Trevithick applied his high-pressure engine with great success to rock boring and breaking, as well as to dredging. In 1806 he contracted with the board of Trinity House, London, to lift ballast from the bottom of the Thames, at the rate of 500,000 tons a year, for a payment of 6d. a ton. Trevithick

was the first to recognize the importance of iron in the construction of large ships, and in various ways his ideas also influenced the construction of steamboats. He was a pioneer in the application of steam to agriculture. A high-pressure steam threshing engine was erected by him in 1812 at Trewithen, while in the same year, in a letter to the Board of Agriculture, he stated his belief that every process in agriculture might be performed by steam, and that such a use of the steam-engine would "double the population of the kingdom and make our markets the cheapest in the world." In 1814 he entered on an agreement for the construction of engines for mines in Peru, and to superintend their working removed to Peru in 1816. Thence he went in 1822 to Costa Rica. He returned to England in 1827, and in 1828 petitioned parliament for a reward for his inventions, but without success. He died, penniless, at Dartford on April 22, 1833.

A *Life of Richard Trevithick, with an account of his Inventions* was published in 1872 by his third son, Francis Trevithick (1812–77).

TRIAL: *see* Practice and Procedure.

TRIAL BY BATTLE: *see* Duel.

TRIAL OF ANIMALS, an ancient legal custom which persisted in Europe until recent times and which is continued by various savage or barbaric peoples. There is evidence that it grew out of the popular belief that animals are intelligent and consequently morally responsible for their acts. However, the old doctrine of deodand (*q.v.*), which penalized inanimate objects that had taken human life, may be germane to the concept of the responsibility of animals, in which case both must be traced to the idea underlying animism: that not only human beings, but all other entities, are endowed with volition and consciousness. An early example of legal procedure against animals is furnished by Exodus xxi, 28. "And if an ox gore a man or a woman to death, the ox shall be surely stoned." Plato, in *The Laws*, prescribed that "If a beast of burden or any other animal shall kill anyone, except while the animal is competing in the public games, the relatives of the deceased shall prosecute it for murder."

In Western Europe procedure against animals was settled, both in the ecclesiastical and civil courts; in all cases they were provided with counsel, were duly summoned to appear, exceptions taken in their favour were considered, and their sentences sometimes commuted on the grounds of relative youth, exiguity of body, or a reputation for respectability: a she-ass condemned to death in France in 1750 was pardoned because of good character.

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TRIANGLE. A triangle, or more precisely a plane triangle, is the geometrical figure composed of three points called the *vertices* (not lying in one straight line), and the three straight lines joining these, called the sides. Since no part of a plane can be inclosed by fewer than three straight lines, the triangle ranks as the simplest figure of its class, and plays a correspondingly important part in both practical and theoretical geometry.

Congruence Theorems.—It is important to recognize the conditions under which two triangles may be known to be *congruent;* that is, alike in all respects except position in space, so that the one triangle is merely the other moved into a new position without change of form. The most important theorems of this character have been known from very ancient times, and were handed down in the first book of Euclid's *Elements*.

Two triangles are congruent if two sides of the one are respectively equal in length to two sides of the other, and if these two sides are in each case inclined at the same angle.

Thus in figure 1, to be sure that the triangles *ABC* and *abc* are exactly alike, it is enough to know that $AB=ab$, $AC=ac$, and the angle at A=the angle at a. It would *not* be enough to know that these same two pairs of sides were equal together with the angles at B and b, since in this case the triangle *ABC* might equally well have had the form of *ABC'* in the figure, and therefore not have agreed with *abc* in form.

Two triangles are congruent if the three sides of the one are equal respectively to the three sides of the other.

Two triangles are congruent if a side of one is equal to a side of the other, and if the angles at the ends of these equal sides are the same in both triangles

Thus the triangles *ABC* and *abc* will be identical in form if

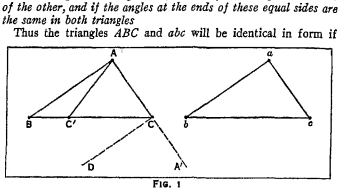


Fig. 1

$BC=bc$, the angle at B=the angle at b, and the angle at C=the angle at c

This theorem supplies the basis for the method of triangulation. If B and C are given stations whose positions are known, the measurement of the angles *ABC* and *ACB* will determine, together with a knowledge of *BC*, the form of the triangle *ABC*, and so the position of A.

Two triangles are congruent if two angles of the one are equal to two angles of the other respectively, and if the sides opposite one of the equal pairs of angles are equal.

This theorem is readily reduced to the one before by means of the property stated at the beginning of the next section. The same consideration prepares us to accept the statement that two triangles may have the angles of one equal to the angles of the other without being congruent. In such a case the triangles are similar in shape, but may be of different sizes

Relations Between the Parts of a Triangle.—The foregoing remarks emphasize the fact that the three sides and the three angles are not six independent magnitudes to which any values whatsoever may be given. For instance it is impossible to draw a triangle in which all the sides are equal and the angles unequal.

The simplest relation connecting the parts of a triangle in general is that *the sum of the three angles is two right angles.* This follows from the fact that, when one side is continued outside the triangle, the angle so formed on the outside is equal to the sum of the angles inside the triangle at the other two vertices. The latter relation is exhibited in figure 1 for the triangle *ABC*, the line *CD*, drawn parallel to *BA*, dividing the exterior angle into two parts, of which *DCA'* is equal to *A*, and *DCC'* to *B*. The relation between the three angles enables one to find the value of the third when two of the angles are known. Thus, if two of the angles are 60° and 70°, the third is 180°–60°–70°=50°.

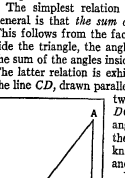


Fig. 2

It is convenient to consider here certain special forms of triangle. A triangle with two equal sides is called *isosceles*. Such a triangle has the angles opposite to these sides also equal This is easily proved by joining the middle point of the unequal side to the opposite vertex and deducing the congruence of the two triangles so formed. The proof given by Euclid was much more elaborate, because Euclid did not permit the use of the middle point at a stage when the problem of finding it had not been taken up; and the theorem was nicknamed the *pons asinorum*, and regarded at one time as a notable obstacle to the beginner in geometry.

A *right triangle* is one which has one of its angles a right angle. In figure 2 the triangle *ABC* has a right angle at *C*. Evidently $CB=AB\times s$, and $AC=AB\times k$, where s and k are proper fractions depending on the angle A, and not on the size of the triangle.

The ratios s and k are called the sine and cosine respectively of the angle A, and their theory constitutes the science of trigonometry (*q.v.*). If CD is perpendicular to AB, by the similarity of the three triangles, $BD=CB\times s=AB\times s^2$, *and* $AD=AC\times k=AB\times k^2$. Since $AD+BD=AB$, it follows that $s^2+k^2=1$. On multiplying this equation by AB^2, it is seen that $BC^2+AC^2=AB^2$. Here the meaning of BC^2 may be understood to be the

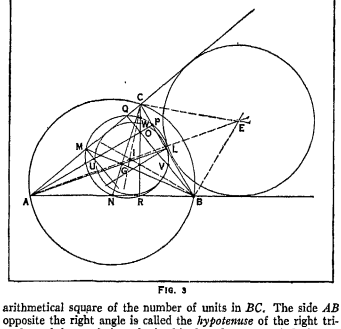


FIG. 3

arithmetical square of the number of units in BC. The side AB opposite the right angle is called the *hypotenuse* of the right triangle, and the result just obtained is that *the square of the hypotenuse is equal to the sum of the squares of the other two sides*, a theorem ascribed to Pythagoras (*q.v.*), and of the utmost importance in geometry.

Allusion may be made to two triangle inequalities. (1) *The sum of any two sides is greater than the third side;* (2) *the greater of two unequal sides has the greater angle opposite to it.*

As supplementing the preceding statement (2) we have the *sine formula.* In fig. 3, if CR is perpendicular to AB, the sines of A and B are respectively $\frac{RC}{AC}$ and $\frac{RC}{BC}$. These are proportional to BC and AC, so that *the sines of angles are proportional to the lengths of the opposite sides.* Also $BC^2=RB^2+RC^2=(AB-AR)^2+(AC^2-AR^2)=AB^2+AC^2-2AB.AR=AB^2+AC^2-2AB.AC.k$, where k is the cosine of A. These two relations are of great importance in triangle computations.

Associated Lines and Circles.—It is only possible to quote summarily a few of the more interesting configurations that arise in connection with the triangle. The construction for the circumscribed circle (which passes through the vertices) reveals that the three straight lines drawn perpendicular to the sides through their middle points meet at a common point, the centre of the circle in question.

The centre of the inscribed circle (which touches the sides and lies between them) is the intersection of another set of concurrent lines, the three internal bisectors of the angles of the triangle.

The bisectors of two exterior angles, as BE and CE in fig. 3, meet at a point on the bisector of the interior angle at the other vertex, this point being the centre of another circle touching the three sides. Four circles in all are found to touch the sides.

The lines joining the vertices to the middle points L,M,N, of the opposite sides meet in a point, G called the *centroid.* The perpendiculars AP, BQ and CR meet in a point O, called the *orthocentre.*

There is the remarkable theorem that the points L,M,N,P,Q,R and the middle points U,V,W of AO, BO, CO lie on a circle (the *nine-point circle*), and the still more striking result (Feuerbach's Theorem) that this circle touches the four circles touching the sides of the triangle.

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TRIANGLE, in music, an instrument of percussion of indefinite musical pitch, consisting of a rod of steel bent into the form of a triangle. Suspended by a loop, it is played by means of a short steel rod. The tone of the triangle is clear and ringing, but it should have no definite pitch.

TRIANON, TREATY OF. The treaty of peace between the Allied and Associated Powers and Hungary was signed at the Trianon on June 4, 1920. Owing to the outbreak of Béla Kun's revolution in Hungary, the delegates of that nation were not summoned to the Peace Conference till Nov. 1919. Previous to that date, however, on June 13, 1919 the Supreme Council had decided upon the new frontiers of Rumania and Czechoslovakia and had published them. The Hungarian Government received the treaty in Jan. 1920 and on June 4 it was signed at Trianon.

Though the separation of Hungary from Austria and its complete independence were recognized, the details of the Hungarian Treaty were otherwise very closely akin to those of the Austrian, the most important difference being that, while the Treaty of St. Germain was signed with the republic of Austria, that of Trianon was signed with Hungary, or with "the national Government of Hungary," a phrase permitting her to be regarded as a Government where the monarchy is temporarily in suspense. Though Charles never abdicated the kingship of Hungary and there is no provision in the treaty for his deposition or for that of any Habsburg, he was formally deposed by a law passed by the Hungarian Assembly (after his attempted *Putsch*, Oct 1921) at the insistence of the Allies. (*See* HABSBURG.) On her admission to the League of Nations in 1922 Hungary submitted to the League a document pledging herself not to restore the Habsburgs without the consent of the Allies, and confirming the undertaking to the Conference of Ambassadors of Nov. 10, 1921.

Territorial Clauses.—The territorial clauses of the Hungarian Treaty reduced her to a population of 7,500,000 (1910 census), of whom approximately 6,250,000 are Hungarians (Magyars); 500,000 are Germans, 500,000 are Jews, 230,000 are Slavs and Slovaks and 50,000 are Rumanians. Fiume was ceded to the principal Allies by article 53 and, after being erected into a free city, was eventually annexed by Italy (1924). Hungary lost to other nations over 3,000,000 Magyars, of whom 1,500,000 go to Rumania, nearly 1,000,000 to Czechoslovakia and 500,000 to Yugoslavia. Much of the Magyar population lost (as *e.g.*, the Székler area) consists of Magyar islands isolated amid a sea of Slavs or Rumanians. The Pécs area, with its valuable coal mines, was returned and a line drawn in this area so as to give Hungary a defensible frontier. For economic reasons the three Magyar towns of Satul-Mare (Szatmár) Oradea-Mare (Nagyvárad) and Arad and the surrounding Magyar zone were given to Rumania.

Part V.—The military, naval and air clauses were almost exactly similar to those of the Austrian Treaty except that Hungary was allowed an army of 35,000 instead of Austria's 30,000. Part VI., *Prisoners of War and Graves*, and Part VII., *Penalties*, were the same as in the Austrian Treaty. (*See* St. GERMAIN, TREATY OF.)

Part VIII.—Reparation.—This section is verbally almost identical with the Austrian section, and both are a close imitation of the German. For various reasons it was not possible to fix the exact amount of reparation. But Hungary was forced to surrender all rights to her merchant ships on "the ton for ton, class for class basis," and her reparations in kind were to be fixed in three months by the Reparation Commission, which was to deliver cattle to Italy, to Rumania, and to the Serb-Croat-Slovene kingdom (Annex iv. to Part viii.).

Financial and Economic Clauses.—Articles 180–199 are mainly concerned with liquidating the Austro-Hungarian National Bank, thus separating the last link with Austria. Part X., the economic clauses, calls for no special remark, nor does Part XI., Aerial Navigation. The economic clauses are the same as the Aus-

trian, the latter like that of both German and Austrian Treaties Part XII, ports, waterways and railways, is mainly concerned with the regulation of the Danube, for which a statute was eventually drawn up. As in the case of the Austrian Treaty (Article 311), the Hungarian in Article 294 provides for the free access of Hungary to the Adriatic, though practically nothing has been done to secure it. Part XIII, labour, is the same in all treaties and Part XIV., miscellaneous provisions, calls for no remark.

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TRIASSIC SYSTEM or **TRIAS,** geological terms used to designate the lowest major division of the Mesozoic era—given by F. von Alberti (1834) owing to the division of the system into a threefold series in Germany, in contradistinction to the twofold division (Dyas) of the underlying Permian.

Like the Permian (*q.v.*) the Trias is represented by two phases of sedimentation, the one continental as in Germany, the other marine—the latter being the normal aspect.

Where the marine facies is developed the division between the Permian and Triassic systems, or in other words between the Palaeozoic and Mesozoic eras, can best be drawn by means of the faunas. Where the continental facies ocurs fossil evidence is scanty, and the general similarity of the deposits, together with their rapid changes in lithological type, makes it difficult to define the boundaries of the two systems. In Britain they are so closely knit that the term New Red Sandstone was formerly suggested by Goodchild for the combined Permo-Trias; and there is a tendency to revert to that grouping.

Records of the continental phase reside in breccias, conglomerates, red and mottled sandstones, marls and clays, with beds of dolomite, limestone and coal, and layers of gypsum, anhydrite or rock-salt. The coarser deposits consist of frost- or sun-riven scree material accumulated almost *in situ*, or as wide-spreading torrential fans Conglomerates afford evidence of transportation by water, whilst the oblique bedding of certain sandstones, coupled with the perfect rounding of many of the grains and the *dreikanter* form of some of the enclosed pebbles, point to the action of wind. Some of the sands may represent dunes, but the majority were deposited with layers of mud in sheets of water which were shallow and subject to frequent desiccation. Of this we have evidence in reptilian footprints, fossil rain-pits, ripple-marks, sun-cracks and precipitated salts Fresh influxes of water are shown by pellets of sun-dried mud and salt-pseudomorphs included in the sandstones.

GERMANY

The Trias occupies a larger area than any other formation in Germany and is classified as follows:—

Keuper	Rhaetic	Sandstones and clays with *Avicula contorta* Bone bed
	Gypsekeuper	Steinmergel and Stubensandstein Gypsekeuper and Schlifsandstein
	Kohlenkeuper	Grenzdolomite Lettenkohlensandstein Dolomitic limestones and marls
Muschelkalk	Haupt-Muschelkalk	Trigonodus beds Nodusus beds Prochiten Kalk
	Anhydrite group, dolomite, and marls and limestones with rock-salt, gypsum and anhydrite	
	Wellenkalk, with Schaumkalk zones near top	
Bunter	Upper or Röth: variegated clays or marls with plants	
	Middle or Hauptsandstein (and Vosgessandstein), with subordinate conglomerates	
	Lower: Sandstones (some clayey) and shales, with oolite (Rogenstein)	

In North and Central Germany the Zechstein clays are succeeded conformably by clayey Bunter beds. In other districts there is unconformity, with overlap of higher members of the Bunter.

The Roth contains rock-salt and bivalve-bearing beds of limestone and dolomite (Rhizocorallum Dolomite)

The Muschelkalk—mainly calcareous—is the only division with a considerable fauna, which is poor, however, in comparison with that of the marine deposits of the Alps. In extent it is inferior to the Bunter, its westward limits stopping short of central France, although it occurs near Toulon and Montpellier In Alsace-Lorraine the Lower Muschelkalk takes on a sandy facies (Muschelsandstein) as does the Middle division in part of Luxembourg The Upper Muschelkalk is the richest in fossils, being characterized by *Ceratites nodosus, C. semipartitus* and *C. enodis*.

The Keuper (*Marnes irisées* of France) comprises red and variegated clays, pale sandstones, limestones, dolomites and impure coals Estuarine conditions in the Kohlenkeuper are shown by *Myophoria goldfussi* and *Estheria minuta* as well as relics of fishes (*Acrodus, Ceratodus,* etc), and terrestrial conditions by Labyrinthodonts and Saurians (*Mastodonsaurus,* etc). The Gypsekeuper contains rock-salt in Lorraine Stubensandstein and Schlifsandstein occur in south Germany The former yields saurian remains (*Aëtosaurus ferratus* and *Belodon kapffi*), the latter plants (*Equisetum arenaceum,* etc)

Rhaetic beds, typical of the Rhaetic Alps, mark the return into western Europe, by a wide-spread marine transgression, of the seas that characterized the subsequent Mesozoic era, and form a passage between Keuper and Lias (Infra-Lias of France), although the molluscan fauna and the flora suggest a Triassic age. In Germany the Rhaetic consists mainly of pale sandstones and grey shales The fauna—with *Avicula* (*Pteria*) *contorta, Protocardium rhaeticum,* and other forms—is not rich, but highly important, because of its great extent. Remarkable features are the bone-beds, a few inches thick, which occur at several horizons, crowded with teeth, bones, scales and coprolites of fishes and reptiles. Here are found *Ichthyosaurus* and *Plesiosaurus,* anticipating their maximum development; while remains of *Belodon* and *Mystriosuchus* serve as a link with Triassic Stegocephalian reptiles. Teeth of *Microlestes antiquus,* the oldest known mammal, occurred near Stuttgart

Trias of German type, including Muschelkalk, extends at intervals beyond the Pyrenees to the south of Spain. Triassic rocks occur in Heligoland and there is an outlier of Upper Triassic in the south of Sweden which includes coal-bearing Keuper and marine Rhaetic Trias with Muschelkalk extends from Silesia into Poland. In north-west Russia the beds belong chiefly to the Tartaric stage—in part only Triassic.

BRITAIN AND IRELAND

As in Germany (excluding the Rhaetic) the Trias of Great Britain is of continental facies Its outcrop in England and Wales is narrow in the south-west, but expands in the Midlands and bifurcates at the southern end of the Pennines, one extension projecting into Durham, the other into Cumberland and Westmorland, whence it extends into parts of south Scotland. Other occurrences are found in the Western Isles and on the opposed shores of Moray firth. Denudation has removed the Trias from all but north-eastern Ireland

No representative of the Muschelkalk has been found.

The deposits usually follow the Permian (where developed) with conformity, although minor discordances occur here and there. Tending to fill up the Permian basins, they spread, in many cases, further afield and rest upon still older rocks, their higher members often overlapping their lower divisions. The typical sequence is as follows, and is compared with that occurring west of the Pennines:

The relationship of Trias to Permian is difficult to determine. As stated elsewhere (*see* PERMIAN) it has been claimed that part, if not all, of the Bunter of Nottinghamshire is equivalent to a great part of the Permian Zechstein of Durham. This awaits more general acceptance or denial: what may be conceded

	S. Lancashire and the Midlands	Maximum thickness	Furness (Lancs.), Westmorland, Cumberland and Isle of Man	Maximum thickness
	Rhaetic beds (marine)		? Rhaetic beds	
Keuper	Marls with gypsum	Over 2,000	(Stanwix Shales (saliferous)	About 1,000
Keuper	Waterstones	200		
Keuper	Lower Sandstones and, 01,	200	? Waterstones	
Keuper	Basement conglomerates and breccias	400		
Bunter	Upper Mottled Sandstone	500		
Bunter	Pebble Beds	700	Kirklinton Sandstone / St. Bees Sandstone	Over 3,000
Bunter	Lower Mottled Sandstone (? Permian).	650	St. Bees Shales, with gypsum (Permian-Trias)	Brockrams 200

is that probably the Lower Mottled Sandstone of South Notts may represent some of the highest Permian strata occurring farther north The Lower Mottled Sandstone of Wirral (Cheshire) is possibly also of Permian age, whilst there are grounds for the belief that the St. Bees Shales (correlated with the Durham Permian Marls) are transition beds and may represent, in part at least, Lower Mottled Sandstone of other areas.

The Mottled Sandstones consist typically of alternations of soft red and variegated sandstones, generally without pebbles. In Nottinghamshire and south Yorkshire the Upper group is absent The Pebble Beds are harder red and brown sandstones, with, in places, strong false-bedding, aeolian sand grains, dreikanter, etc. In some localities they contain abundant quartzose pebbles, probably derived from local sources now concealed. In the Midlands they form undulating country typically expressed in Cannock Chase and Sherwood Forest and furnish a first-class water-bearing horizon In Devon is the "Budleigh Salterton Pebble-bed," with pebbles derived both from Normandy and from a northern local source. These Pebble beds were accumulated chiefly in shallow water, but some of the coarser deposits may represent dune sands. The absence of pebbles, and the finer grade of material, makes it difficult to distinguish the Bunter of north Yorkshire and Durham from the Keuper. The St. Bees and Kirklinton Sandstones also are almost devoid of pebbles. Breccias (Brockrams) were formed continuously to the west of the Cumberland hills both before and during the deposition of the Zechstein, St. Bees Shales, and part of the St. Bees Sandstone —emphasizing the intimacy of these deposits

Keuper deposits extend into most of the above described regions, in places slightly unconformable to the Bunter, beyond the limits of which they frequently extend, and may have local breccias at the base. Of these the best known is the "Dolomitic Conglomerate" (Bristol district), a shore-line breccia of the inland Keuper sea which gradually buried a well-dissected landscape of older rocks. It is largely composed of Carboniferous Limestone set in a dolomitic matrix, but local patches contain Old Red Sandstone. It has yielded reptiles (*Thecodontosaurus, Palaeosaurus*). The Keuper of Charnwood Forest, Leicestershire, conceals mountains of which the tops only are now visible.

Typical Keuper Marl consists of rhythmic alternations of chocolate red marls, red shales and pale dolomitic sandstones (skerries). In the Midlands is the Arden Sandstone with *Estheria, Hybodus, Acrodus*, Labyrinthodonts and plants. The Waterstones are variegated shales and marls with soft red sandstone; whilst the Lower Keuper Sandstones are false-bedded freestones—not always present. In Worcestershire the latter have yielded scorpions, and, near Birkenhead, Cheshire, footprints of reptiles.

At the top of the Keuper is a belt of "tea-green marls" which, in the south-western counties, pass up into fossiliferous grey shales (Sully Beds). These shales have been classed with the Rhaetic.

Gypsum and alabaster appear at several horizons, the most important occurring in the Midlands at 60–70 and 160 ft. respectively below the Rhaetic. They are extensively mined (Newark, Chellaston, etc). In Cheshire and Worcestershire great beds of salt set in at lower horizons, and this mineral appears also at Puriton in Somerset. The Stanwix Shales of the Carlisle district carry gypsum, whilst those of the Isle of Man, Walney Island and Pressall, Lancashire, have deposits of rock-salt.

In Britain the Rhaetic (or Penarth) Beds usually consist of White Lias (well developed in the south-west) on dark *Avicula (Pteria) contorta* Shales. Certain smooth-textured White Lias limestones yield a landscape marble (Cotham): at the top is the sun-bed or "jew-stone." At the base of the *Avicula* Shales is a bone-bed with fossils similar to those of Germany, including the mammal *Microlestes*, which is also found in the Sully Beds.

In South Scotland the Annan Sandstone is correlated with the St. Bees Sandstone, whilst in Arran the Bennan Shales and Auchenshaw Sandstones and Shales are considered to be Bunter, and the overlying marls and shales (Levencorroch and Torr nan Uain) Keuper. At the top are grey-green marls succeeded by Rhaetic Beds. Triassic rocks occur also in Skye, Raasay and Mull—breccias, conglomerates, marls and cornstones, with gypsum in the upper beds—and at Morven and Ardnamurchan (Argyllshire) and Gruinard bay (Ross-shire) There is a complete passage into the Lias here. The Trias of Elginshire south of Moray Firth contains sandstones with a reptilian fauna. That of the lower beds is allied to the Karroo forms, whilst the upper beds (Lossiemouth) contain *Hyperodapedon gordoni, Ornithosuchus woodwardi*, etc., which are undeniably Triassic.

In Ireland existing Triassic deposits have been largely protected by Tertiary basalts. Both Bunter and Keuper are represented (Lagan valley) very similar to that of the Cumberland coast: at Carrickfergus and Kilroot, near Belfast, rock salt is found in the Marls. Rhaetic beds with *Avicula contorta*, etc., link the Keuper with the Lias (Larne; Collenglen, near Belfast).

THE ALPS

The marine Trias is frequently referred to as "Alpine," "Mediterranean" or "Pelagic." In Europe and eastwards through Asia It forms part of the deposits of the great Mediterranean sea, or "Tethys," situated north of Gondwanaland. (*See* article PERMIAN.) The facies is distributed widely in southern Europe, particularly in the eastern Alps, Apennines, Sicily, Balearic Islands, Spain, Balkan Peninsula and part of the Carpathians.

In the Alps, where the rocks form a broad zone on both sides, sandy rocks are subordinate to limestones, dolomites and marls, whilst the fauna makes that of the German Muschelkalk appear poor by comparison. The following divisions are recognized, chiefly in the eastern Alps:—

Keuper	Rhaetic	Dachsteinkalk and Kössener beds	with	*Megalodon triqueter* and *Avicula contoria*.
Keuper	Noric	Dachsteinkalk and Hauptdolomit (or)	„	*Megalodon triqueter, Worthenia solitaria*, etc.
Keuper	Noric	Hallstatterkalk	„	*Pinacoceras metternichi, Cladiscites, Halorites*, etc.
Keuper	Karnic	Raibl beds	„	*Tropites subbullatus* and *Trachyceras aonides*.
Keuper	Ladinic	St Cassian beds	„	*Trachyceras aon*
Keuper	Ladinic	Wengen beds	„	*Daonella lommeli*
Keuper	Ladinic	Buchenstein beds	„	*Protrachyceras reitzi, Ceratites, Arcestes*, etc.
Muschelkalk	Anisic	Alpine Muschelkalk (with Mendoladolomite, etc)	„	*Ceratites trinodosus, Athyris trigonella, Spiriferina fragilis, Pinacoceras, Gervillia socialis*, etc.
Bunter	Scythic	Werfen beds	„	*Myophoria costata, Avicula clarai, Ceratites cassianus, Tirolites*, etc.

The Werfen beds (Salzburg) are conformable to the underlying Permian and consist of red sandy shales and beds of gypsum and rock-salt, with impure limestone in the upper part. The

Alpine Muschelkalk is highly fossiliferous and differs in many respects from that of Germany, being of truly marine character Typically the Ladinic consists of limestones, dolomites, tuffs and lavas, though there is also a calcareous and a dolomitic facies. In the St. Cassian beds the fossils are dwarfed.

The Raibl beds indicate a regression of the sea, evidenced by plant-bearing sandstones (Lunz), and marls with gypsum. The Rhaetic consists generally of marly limestones forming a thin but continuous sheet.

The small masses of limestone of Bogdoberg (Kirghiz Steppes, south Russia) overlying red sandstones and marls are portions of Muschelkalk of Alpine type on the equivalents of the Bunter.

Marine Trias occurs also in Asia Minor, many parts of Asia as far east as China, the Indo-Pacific islands, Japan, Spitsbergen, New Zealand, New Guinea, Timor, Peru, Colombia, Mexico and western North America. With the exception of the last these areas lie north of or on the margins of Gondwanaland. Certain of these occurrences are dealt with below.

ASIA

In India the finest development of marine Trias occurs in the Himalayas. In Spiti (Lilang), Garhwal and Kumaon and on the north-west extension of the same geo-synclinal axis in Kashmir the rocks comprise three subdivisions corresponding to the Alpine Bunter, Muschelkalk and Keuper (with Rhaetic). The Bunter, which rests conformably on the Permian Productus Shales, consists of 50 ft. of shales and limestones with an ammonite fauna (*Otoceras, Ophiceras, Meekoceras*). The Muschelkalk is chiefly concretionary limestones, 400 ft. thick, with *Ceratites, Siberites*, etc., and, at the top a Daonella (lamellibranch) limestone. The Keuper comprises 2,000 ft. of shale and marl beneath thick limestones and dolomites with a cephalopodan fauna. The lower division corresponds to the Karnic and Noric stages, whilst the limestones probably represent the Rhaetic.

In the north-west Himalayas (Sirban Mountains, Hazara) Trias rests unconformably on Devonian shales and limestones (Infra-Trias). Felsitic lavas are succeeded by limestones from 500–1,200 ft. thick, with characteristic fossils.

Trias of reduced thickness and comprising only the Lower and part of the Middle division occurs in the western part of the Salt Range where it caps the Permian Productus Limestone. The Lower division consists of thin limestones with an extraordinary abundance of *Ceratites*. The Middle, or Muschelkalk, contains many cephalopods.

In north Baluchistan shales and slates with a few limestones represent the Rhaetic stage. It contains *Monotis* and cephalopods (*Didymites, Halosites*) and rests unconformably on Carboniferous Fusulina limestone. A similar development occurs in the Arakan Yoma of Burma whilst in the Northern Shan States the Noping beds, with *Avicula contorta*, suggest a Rhaetic age.

Peninsular India was at this time joined up to Australia and Antarctica, Madagascar, South Africa, and South America, and formed part of the continent named Gondwanaland. (*See* article PERMIAN.) The Trias is represented by the Middle Gondwana Series which is divided into three groups:—Panchet, Kamthi and Maleri (or Denwa) corresponding approximately to the divisions of the German Trias. In the type area (Satpura Range) the rocks consist of massive sandstones, conglomerates, grits and shales devoid of coal seams and are unconformable to the Permian Damuda Series. Vegetation, hitherto profuse, became scanty or failed.

The Panchet group (1,500 ft.) is of restricted development and is overlapped by the Kamthi division (3,000–8,000 ft.), whilst the Maleri is of variable thickness and occurs but locally. In the Panchet group vertebrate remains include fishes, Labyrinthodonts (*Stegocephala*), Amphibia (*Glyptognathus*, etc.) and reptiles (*Dicynodon*, etc.), whilst the Kamthi group contains similar forms as well as a flora with *Glossopteris, Gangamopteris, Phyllotheca*, etc. The clayey Maleri group has remains of fishes (*Ceratodus*), Labyrinthodonts (*Gondwanosaurus*) and reptiles (*Hyperodapedon*, etc.). Biologically the fauna agrees closely with the English Trias.

AFRICA

In South Africa the Triassic deposits are continental and form the greater part of the Karroo Beds covering much of what is now the Union. They occur also in south-west Africa, along the borders of the Kalahari, over parts of Rhodesia, Portuguese Africa and regions further north.

In the Cape Province, the Permian Ecca Beds are followed by the Beaufort and Stormberg Series, the former divided into Lower, Middle and Upper Beds, the latter into Molteno Beds, Red Beds, Cave Sandstone and Drakenberg Volcanics. In central Transvaal the Beaufort Series is absent and the Stormberg Series is represented by Bushveld Marls, Sandstone and Amygdaloids. The Lower Beaufort Beds, with their reptilian remains (*Pariasaurus, Dicynodonts*, etc.), are consideerd by du Toit to be Upper Permian and the Volcanics to cover the period from Rhaetic to Lias; the Middle Beaufort are Lower Triassic and the remainder (Upper Beaufort–Cave Sandstone) Upper Triassic.

The Beaufort beds of the Cape are divided by lithological characters agreeing with fossil vertebrate zones. The Middle group consists of mudstones and sandstones, whilst the Upper group has more of the bright coloured mudstones. They contain reptiles (*Erythrosuchus, Cynognathus*, etc.) and Amphibians (*Trematosaurus*, etc). Plants include *Schisoneura*, and, at the top, *Thinnfeldia, Ginkgoites*, etc. Rhodesian representatives are the Upper Wankie Sandstone (with fresh-water beds, *Glossopteris*, and reptiles) and the Madumabisa Shales.

The Stormberg Series occurs in Basutoland and neighbouring parts of the Union. The Molteno Beds, which disappear northwards, contain silicified trunks of Dadoxylon and plant remains (*Thinnfeldia, Ginkgoites, Schizoneura*, etc.). The Red Beds thin northwards, becoming the Bushveld Marls, represented on Rhodesia by Escarpment Grits. Next comes the massive Cave Sandstone, with false-bedding primarily of aeolian origin. Its counterparts are Bushveld Sandstone (Central Transvaal) and the Forest Sandstone (Rhodesia).

The Drakenberg Volcanics are basaltic lavas with, in places, agglomerates and ashes or beds of sandstone near the base At Mont-aux-Sources, Natal, they are 4,500 ft. thick. North of Pretoria (Springbok Flats) they become amygdaloidal basalts, whilst in the Wankie-Zambezi area (Rhodesia) the Batoka Basalts form the picturesque scenery about Victoria Falls. Intrusive into the Karroo system is a phenomenal number of sills and dikes of dolerite.

Beaufort beds have been detected on the west coast of Madagascar overlying coal-bearing beds with *Glossopteris*.

AUSTRALIA

In New South Wales Triassic strata of the Sydney-Blue Mountain area follow the Permian nearly conformably. The district was above sea and extended farther east than at present, the deposits being formed in shallow fresh water lakes. The Hawkesbury Series is divided into Narrabeen, Hawkesbury Sandstone and Wianamatta Stages in upward sequence The Narrowbeen beds thin westwards from the coast, becoming also coarser. *Estheria coghlani* is common at one horizon; *Schizoneura* is abundant; *Glossopteris* is rare.

Hawkesbury Sandstones are strikingly represented near Port Jackson and in the canyons and ravines of the Blue Mountains. They contain plants (*Thinnfeldia, Phyllotheca*), fish (*Ceratodus* and shark) and Labyrinthodonts (*Mastodonsaurus, Platyceps*). The Wianamatta beds are largely clay shales with ferns (*Thinnfeldia, Aethiopteris australis*), Ginkgoales, Cycadaceae, Equisetaceae, fish (*Palaeoniscus*, etc.), a few molluscs and crustacea.

Of slightly later date (Trias-Jura) are the Clarence Series of New South Wales and the Artesian Series of the New England Tableland. They seem to be equivalent to the Ipswich and Burrum Beds of Queensland and the Gippsland and Otway Beds of Victoria. In Tasmania the Knockfofty Series and the overlying Ida Bay Series, near Hobart, possibly represent the Hawkesbury Series.

NEW ZEALAND

Trias forms the lower division of the Hokonui System in New Zealand and consists of sandstones, shales and conglomerates of

estuarine and fluviatile origin (with plant-remains from a continental region to the north-west in the present Tasman sea) intercalated with marine beds containing characteristic species of the Alpine Trias of south Europe and India. The Noric, Karnic and part of the Ladinic stages are represented.

AMERICA

In South America the sea lay westward of Gondwanaland, marine Trias occurring west of the Andes. In Uruguay, Paraguay and south Brazil continental deposits are remarkably like those of parts of South Africa. The Rio do Rasto Beds comprise variegated mudstones and sandstones and pass up through aeolian sandstones into the Botucatu Sandstone, which is covered by basaltic lavas that occupy an enormous region in Paraná, Santa Catherina, Paraguay, etc. *Scaphonyx*, from the Rio do Rasto Beds is allied to *Erythrosuchus* of the Upper Beaufort Beds. The upper groups resemble the Cave Sandstone and Drakenberg Volcanics.

A tillite in eastern Argentina passes up into unfossiliferous beds rather like those of the Falklands, where the thick Lafonian (Permo-Triassic) System covers over one half of the eastern island. Towards the top the facies resembles that of the Beaufort Beds.

The Appalachian revolution in North America resulted in the uplift of the eastern and southern part of the continent with the concurrent formation of continental deposits. Open sea lay on the Pacific border and extended inland to the site of the Rocky Mountains, where the chief deposits were of fresh-water type.

In the Eastern States disconnected and faulted troughs filled mainly with Middle and Upper Triassic deposits extend from Nova Scotia through Connecticut and New Jersey (Newark System) to South Carolina. Deposits are usually red and everywhere unconformable to underlying formations. With them are associated sheets (*e.g.* "palisades" of the Hudson, New Jersey) and dikes of diabase, and basaltic lavas. The Newark System, 20,000 ft thick, is divided into the Stockton-Norriston, Lockatong and Brunswick Groups. The sediments and their scanty fossils (land-plants, fishes and tracks of reptiles) point to deposition under semi-arid conditions.

The finest development of marine Trias is in the Sierras, California, Nevada, Idaho and Oregon, where the deposits are usually calcareous and about 4,000 ft. thick. From Vancouver to Queen Charlotte Islands they increase to 13,000 ft., more than ninetenths being volcanic.

The early Triassic sea stretched eastwards possibly to central Wyoming. In middle times it withdrew westward, whilst later it spread from Alaska to northern Mexico. This sea had connection with Asia by the northern Pacific, and with "Tethys" by way of the northern shores of Gondwanaland. The deposits can be divided in harmony with the Alpine Trias, California possessing the best known development of the Upper Trias. The Noric is represented by two zones, in the lower of which coral reefs (*Astraeidae*) extend from California into Alaska. Almost 25% of the fauna is identical with that of the Mediterranean area.

Throughout the Rocky Mountain region between Canada and western Texas, and in northern New Mexico and Arizona, continental Upper Triassic gypsiferous shales and sandstones overlie older eroded formations often of a similar character. They contain bone conglomerates with amphibia (*Stegocephalia*), crocodilian types (*Mystrosuchus*) and dinosaurs. Silicified wood, as in the petrified forest of Arizona (Flagstaff), is common. Plants include cycads, ferns and conifers. Gingkos were represented by *Baiera* (also in Upper Karroo). The *Glossopteris* flora, so characteristic of Gondwanaland, is absent. (B. Sm.)

TRIBALLI, in ancient geography, a Thracian people whose earliest home was near the junction of the Angrus and Brongus (the east and west Morava), and included towards the south "the Triballian plain" (Herodotus iv. 49), which corresponds to the plain of Kossovo in Turkey. In 424 B.C they were attacked by Sitalces, king of the Odrysae, who was defeated and lost his life in the engagement. On the other hand they were overcome by the Autariatae, an Illyrian tribe; the date of this event is uncertain (Strabo vii. 317). In 376 B.C. a large band of Triballi crossed Mt. Haemus, and were preparing to besiege Abdera when Chabrias appeared off the coast with the Athenian fleet and compelled them to retire. In 339 B.C. when Philip II. of Macedon was returning from his expedition against the Scythians, the Triballi refused to allow him to pass the Haemus unless they received a share of the booty. Hostilities took place, in which Philip was defeated (Justin ix 3), but the Triballi appear to have been subsequently subdued by him. After the death of Philip, Alexander the Great in 334 crossed the Haemus and drove the Triballi to the junction of the Lyginus with the Danube. Their king Syrmus took refuge in Peuce, an island in the Danube, whither Alexander was unable to follow him. The punishment, however, inflicted by him upon the Getae (*q.v.*) induced the Triballi to sue for peace. In spite, however, of misfortunes at the hands of the Gauls, they continued (135–84 B.C.) to cause trouble to the Roman governors of Macedonia. Under Tiberius mention is made of Triballia in Moesia, and the Emperor Maximin (A.D. 235–237) had been commander of a squadron of Triballi.

TRIBE, A tribe is defined by Dr. Rivers as "a social group of a simple kind, the members of which speak a common dialect, have a single government, and act together for such common purposes as warfare." In this definition it is necessary to understand by single government a political unity of a very simple kind, which may not imply the existence of any obvious mechanism of government, such as an hereditary monarchy or an elected council, with which we are familiar amongst civilized peoples.

Although it is usual to regard primitive peoples as always organized in definite tribes (Carveth Read, *The Origin of Man and his Superstitions*, 1925), the tribe as a definite group is often entirely lacking. In the case of pastoral peoples, definite groups with a political function, transcending families and clans, are likely to occur, but a settled population needs no such unification, unless the special demands of industry or the need for united action in warfare necessitate central control or the delimitation of groups. Thus it is often difficult in Melanesia to find any division of the people into distinct political units One district usually shades into another politically, unless there is established enmity between the groups; and the names of groups, which might be thought to be tribal names, are found to be of indefinite extension. In these cases the social and political organization is comprised in the family, clan and local relations; the political solidarity of any given district depends on the sum-total of family, clan, local and personal relationships in that district (W. E. Armstrong, *Rossel Island*, 1928). There is tribal organization but there are no distinct tribes In other places, however, in which social organization is of the same general kind, but in which conditions, such as isolation on a small island, or historical circumstances, have unified a district, on account of economic or other conditions, we can speak of definite tribes In so far as the political unity of such a district becomes dependent on locality, rather than on kinship and other relationships between the members of the district, the tribe passes into a simple form of state. For Indian tribes, *see* North America, *Ethnology*.

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TRIBONIAN, the famous jurist and minister of Justinian, was born in Pamphylia in the latter part of the 5th century. Adopting the profession of an advocate, he came to Constantinople and practised in the prefectural courts there, reaching such eminence as to attract the notice of the emperor Justinian, who appointed him in 528 one of the ten commissioners directed to prepare the first *Codex* of imperial constitutions. When the commission of sixteen eminent lawyers was created in 530 to compile a collection of extracts from the writings of the great jurists of the earlier empire, Tribonian was made president. He had already been raised to the office of quaestor, which at that time was a sort of ministry of law and justice, something like that of the English lord chancellor of the later middle ages. During the progress of the work of the commission there broke out in Constantinople (532) the Nika insurrection. Tribonian

was accused of having prostituted his office for the purposes of gain, and the mob searched for him to put him to death (Procop *Pers.* i. 24–26). Justinian, yielding for the moment, removed him from office, and appointed a certain Basilides in his place After the suppression of the insurrection the work of codification was resumed. A little earlier than the publication of the *Digest*, or *Pandects*, there had been published another but much smaller law-book, the *Institutes*, prepared under Justinian's orders by Tribonian, with Theophilus and Dorotheus, professors of law (see Preface to *Institutes*). About the same time the emperor placed Tribonian at the head of a fourth commission, consisting of himself as chief and four others—Dorotheus, professor at Beyrut, and three practising advocates, who were directed to revise and re-edit the first *Codex* of imperial constitutions The new *Codex* was published in November 534 With it Tribonian's work of codification was completed. But he remained Justinian's chief legal minister He was reinstated as quaestor some time after 534 (Procop. *Pers.* i. 25; *Anecd.* 20) and seems to have held the office as long as he lived He was evidently the prime mover in the various changes effected in the law by the novels of Justinian (*Novellae constitutiones*). The date of his death has been variously assigned to 545, 546 and 547 *See* JUSTINIAN I.

The usual criticisms on Tribonian may be found in the *Anti-Tribonianus* (1567) of Francis Hotman, and an answer to them in J. P. von Ludewig, *Vita Justiniani M. atque Theodorae Augustorum, nec non Triboniani* (1731).

TRIBUNE [Lat. *tribunus*, connected with *tribus*, tribe], a name assigned to officers of different descriptions in ancient Rome

Military Tribunes.—The original tribunes were the commanders of the contingents of cavalry and infantry supplied to the Roman army by the early tribes: the Tities, the Ramnes, and the Luceres In the historical period, the infantry in each legion was commanded by six tribunes, and the number six is to be traced to the doubling of the three tribes by the incorporation of the new elements which received the names of *Tities secundi*, *Ramnes secundi*, *Luceres secundi* The *tribuni celerum*, or commanders of the horsemen, no longer existed in the later times of the republic, having died out with the decay of the genuine Roman cavalry. So long as the monarchy lasted these tribunes were nominated by the king as commander-in-chief; and the nomination passed over to his successors, the consuls From 362 B.C. six tribunes were annually nominated by popular vote, in 311 B.C the number was raised to 16, and in 207 B.C. to 24, at which figure it remained. The tribunes thus elected sufficed for four legions and ranked as magistrates of the Roman people, designated *tribuni militum a populo*, while those who owed their office to the consuls bore the title of *tribuni rufuli* The rights of the assembly passed to the emperors, and "the military tribunes of Augustus" were still contrasted with those nominated in the camp by the actual commanders. (For *Tribuni aerarii*, *see* AERARII) There was another important class of tribunes that owed its existence to the army. In the long struggle between the patrician and plebeian sections of the population, the first distinctions to which the plebeians forced their way were military, and the contest for admission to the consulate was, in part, a contest for admission to the supreme command of the national forces. In 445 B.C., power was given to the senate of determining from year to year whether consuls or military tribunes with consular authority (*tribuni militares consulari potestate*) should be appointed But no election was valid without the express sanction of the senate

Tribunes of the Plebs.—The most important tribunes were the tribunes of the *plebs* (*tribuni plebis*). These were the outcome of the struggle between the patrician and the plebeian orders. When in 494 B.C. the plebeian legionaries met on the Sacred Mount, it was determined that the plebeians should by themselves annually appoint executive officers, two tribunes (the very name commemorated the military nature of the revolt) to confront the two consuls, and two helpers, called *aediles*, to balance the *quaestors*, and that the persons of the tribunes and aediles should be regarded as inviolable. The ancient traditions concerning the revolution are extremely confused and contradictory. It must have ended in something which was deemed by both the contending bodies to be a binding compact, although the lapse of time has blotted out its terms. This is necessary to explain the "sacrosanct" character always attached to the tribunate. There must have been a formal acceptance by the patricians of the plebeian conditions, probably the oath which was first sworn by the insurgents was afterwards taken by the whole community, and the "sacrosanctity" of the plebeian officials became a part of the constitution There must also have been some constitutional definition of the powers of the tribunes These rested at first on an extension of the power of veto which the republic had introduced. Just as one consul could invalidate an order of a consul, or of any officer inferior to him. There was, no doubt, a vague understanding that only orders which sinned against the just and established practice of the constitution should be annulled, and then only in cases affecting definite individuals. This was technically called *auxilium*. The cases which arose most commonly concerned the administration of justice and the levying of troops

Development of the Tribunate.—Although the revolution of 494 B.C. gave the tribunes a foothold in the constitution, it left them with no very definite resources against breaches of compact by the patricians The traditional history of the tribunate from 494 to 451 B.C is obscure; but there is a thread running through it which may well be truth We hear of attacks by patricians on the newly won privileges, even of the assassination of a tribune, and of attempts on the part of the plebeians to bring patrician offenders to justice. The plebeians attempted to set up a criminal jurisdiction for their own assembly parallel to that practised by the older centuriate assembly. Furthermore, the *plebs* attempted something like legislation; it passed resolutions which it hoped to force the patrician body to accept as valid As to details, only a few are worth notice. In the first place, the number of tribunes was raised to ten; how we do not know, but apparently some constitutional recognition of the increase was obtained Then an alteration is made in the mode of election. As to the original mode, the authorities are hopelessly at variance. It was in accordance with the Roman spirit of order that the tribunes, in summoning their assemblies, should ask the plebeians to organize their supporters in bands The *curia* was certainly a territorial district, and the tribunes may have originally used it as the basis of their organization If tribunes were elected by plebeians massed *curiatim*, such a meeting would easily be mistaken in later times for the *comitia curiata*. A change was introduced in 471 B.C by the Publilian Law of Volero, which directed that the tribunes should be chosen in an assembly organized on the basis of the Servian tribe, instead of the *curia*. This assembly was the germ of the *comitia tributa*. The question by what authority the Law of Volero was sanctioned is difficult to answer. Possibly the law was a mere resolution of the plebeians with which the patricians did not interfere, because they did not consider that the mode of election was any concern of theirs. Whatever view may be taken of the movement which led to the decemvirate, an important element in it was the agitation carried on by the tribunes for the reduction of the law of Rome to a written code. Until they obtained this, it was impossible for them to protect those who appealed against harsh treatment by the consuls in their capacity of judges.

During the decemvirate the tribunate was in abeyance. It was called into life again by the revolution of 449 B.C., which gave the tribunes a considerably stronger position Their personal privileges and those of the aediles were renewed The road was opened up to legislation by the tribunes through an assembly summoned by them on the tribe-basis (*concilium plebis*), but subject to the control of the senate. The growth of the influence of this assembly over legislation belongs rather to the history of the *comitia* (*q.v.*) than to that of the tribunate. After the Hortensian Law of 287 B.C., down to the end of the republic, the legislation of Rome was mainly in the hands of the tribunes. The details of the history of the tribunate in its second period, from 449 to 367 B.C., are hardly less obscure than those which belong to the earlier time. There was, however, on the whole, undoubtedly an advance in dignity and importance. Gradually a right was acquired of watching and

interfering with the proceedings of the senate, and even with legislation. Whether the absolute right of veto had been achieved before 367 B.C. may well be doubted. But the original *auxilium*, or right of protecting individuals, was, during this period, undergoing a very remarkable expansion. From forbidding a single act of a magistrate in relation to a single person, the tribunes advanced to forbidding by anticipation all acts of a certain class, whoever the persons affected by these restrictions might prove to be. It therefore became useless for the senate or the *comitia* to pass ordinances if a tribune was ready to forbid the magistrates to carry them out. Ultimately, the mere announcement of such intention by a tribune was sufficient to cause the obnoxious project to drop; that is, the tribunes acquired a right to stop all business alike in the deliberative assembly, the senate, and in the legislative assemblies, or *comitia* The technical name for this right of veto is *intercessio*. The two main objects of the tribunes were the opening of the consulate to plebeians, and the regulation of the state domain in the interests of the whole community Both were attained by the Licinio-Sextian laws of 367 B.C.

Then a considerable change came over the tribunate. From being an opposition weapon it became an important wheel in the regular machine of state. As the senate became more and more plebeian, the old friction between senate and tribunes disappeared. It was found that the tribunate served to fill some gaps in the constitution, and its power was placed by common consent on a solid constitutional basis. From 367 to 134 B.C. (when Tiberius Gracchus became tribune) the tribunate was for the most part a mere organ of senatorial government.

Qualifications and Powers.—Even after the difference between patrician and plebeian birth had ceased to be of much consequence, the plebeian character was a necessity for the tribune. When the patricians P. Sulpicius Rufus and, later, P Clodius (the antagonist of Cicero) desired to enter on a demagogic course, they were compelled to divest themselves of their patrician quality by a peculiar legal process. The other necessary qualifications were such as attached to the other Roman magistracies: complete citizenship, absence of certain conditions regarded as disgraceful, and fulfilment of military duties. The election took place in a purely plebeian assembly, ranged by tribes, under the presidency of a tribune selected by lot. The tribune was bound by law to see a complete set of ten tribunes appointed. Technically, the tribunes were reckoned, not as magistrates of the Roman people, but as magistrates of the Roman *plebs;* they therefore had no special robe of office, no lictors, but only messengers (*viatores*), no official chair, like the curule seat, but only benches (*subsellia*). Their right to summon the *plebs* together, whether for the purpose of listening to a speech or for passing ordinances, was rendered absolute by the "laws under sacred sanction" (*leges sacratae*), which had been incorporated with the constitution on the abolition of the decemvirate. The right to summon the senate and to lay business before it was acquired soon after 367 B.C., but was seldom exercised, as the tribunes had abundant means of securing what they wanted by pressure applied to the ordinary presidents, the consuls or the praetor. When an *interregnum* came about and there were no "magistrates of the Roman people," the plebeian tribunes became the presidents of the senate and conductors of state business. At the end of the republic there were *interregna* of several months' duration, when the tribunes held a position of more than usual importance.

The Right of Veto.—The real kernel of the tribune's power consisted in his *intercessio*, or right of invalidating ordinances, whether framed by the senate or proposed by a magistrate to the *comitia*, or issued by a magistrate in pursuance of his office. From 367 B.C. down to the time of the Gracchi the power of veto in public matters was, on the whole, used in the interests of the governing families to check opposition arising in their own ranks. A recalcitrant consul was most readily brought to obedience by an exercise of tribunician power. The tribunes found a field for constant activity in watching the administration of justice, and in rendering assistance to those who had received harsh treatment from the magistrates. The tribunes were, in fact, primarily legal functionaries, and constituted in a way a court of appeal. It was to this end that they were forbidden to pass a whole night away from the city, except during the Latin festival on the Alban Mount, and that they were expected to keep their doors open to suppliants by night as well as by day. They held court by day in the Forum and frequently made elaborate legal inquiries into cases where their help was sought We hear of this not infrequently in Cicero's speeches, and in other writings which deal with legal matters According to the general principle of the constitution, magistrates could forbid the acts of magistrates equal to or inferior to themselves. For this purpose, the tribunes were deemed superior to all other officers. If a tribune exercised his veto no other tribune could annul it, for the veto could not be itself vetoed, but it was possible for another tribune to protect a definite individual from the consequences of disobedience. The number of the tribunes made it always possible that one might baulk the action of another, except at times when popular feeling was strongly roused The veto was not, however, absolute in all directions. In some it was limited by statute; thus, the law passed by Gaius Gracchus about the consular provinces did not permit a tribune to veto the annual decree of the senate concerning them. When there was a dictator at the head of the state, the veto was of no avail against him. One of the important political functions of the tribunes was to conduct prosecutions of state offenders, particularly ex-magistrates. These prosecutions began with a sentence pronounced by the tribune upon the culprit; whereupon, exercising the right given him by the XII. Tables, the culprit appealed. If the tribune sought to inflict punishment on the culprit's person, the appeal was to the assembly of the centuries; if he wished for a fine, the appeal was to the assembly of the tribes.

The Late Republic and Empire.—It is commonly stated that a great change passed over the tribunate at the time of the Gracchi, and that from their day to the end of the republic it was used as an instrument for setting on foot political agitation and for inducing revolutionary changes This view is an inversion of the facts. The tribunate did not create the agitation and the revolutions, but these found vent through the tribunate, which gave to the democratic leaders the hope that acknowledged evils might be cured by constitutional means, and in the desperate struggle to realize it the best democratic tribunes strained the powers of their office to their ruin For the bad tribunes did not hesitate to use for bad ends the powers which had been strained in the attempt to secure what was good But the tribunate only fared like all other parts of the republican constitution in its last period. The consuls and the senate were at least as guilty as the tribunes. After a severe restriction of its powers by Sulla and a restoration by Pompeius, which gave a twenty years' respite, the essential force of the tribunate was merged in the imperial constitution, of which indeed it became the principal constituent on the civil side The ten tribunes remained, with very restricted functions. The emperors did not become tribunes, but took up into their privileges the essence of the office, the "tribunician authority" (*tribunicia potestas*). This distinction between the principle of the office and the actual tenure of the office was a creation of the late republic Pompeius, for example, when he went to the east, was not made proconsul of all the eastern provinces, but he exercised in them a "proconsular authority," which was the germ of the imperial authority on its military side. Similarly the emperor, as civil governor, without being tribune, exercised powers of like quality with the powers of the tribune, though of superior force. By virtue of his tribunitian authority he acquired a veto on legislation, became the supreme court of appeal for the empire, and to his person was attached the ancient sacrosanctity. Augustus showed the highest statesmanship in founding his power upon a metamorphosed tribunate rather than upon a metamorphosed dictatorship, upon democratic rather than aristocratic traditions.

Rienzi.—The name "tribune" was once again illuminated by a passing glory when assumed by Cola di Rienzi (*q v.*) The movement which he headed was in many respects extremely like the early movements of the plebeians against the patricians, and his scheme for uniting Italy in one free republic was strangely parallel with the greatest dream of the Gracchi.

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TRICAMERON, BATTLE OF (A.D. 535). This battle is one of the landmarks in the emperor Justinian's (*see* JUSTINIAN I) series of campaigns by which Italy, Africa and southern Spain were temporarily recovered. In itself it was the decisive victory by which the army of the eastern Roman empire overthrew the Vandal power in Africa, and in military history it has special significance as an outstanding illustration of the predominant power of cavalry during the 1,000 years which succeeded the overthrow of the Roman (infantry) legions at Adrianople (*q.v.*). Belisarius' infantry was a day's march in rear of his cavalry when he encountered the Vandal army, under King Gelimer, assembled in order of battle. So great was Belisarius' faith in the combined fire power and mobility of his horse-archers that he accepted the risk of battle without waiting for his infantry. He took up a position behind a small stream, hoping that he might have the opportunity to launch his own stroke while the Vandals were entangled in the crossing, and to this end sent out small detachments to tease them into an advance. Finding that the enemy was too wary, or too doubtful of success, to be drawn across the river, Belisarius took a more audacious risk—advancing his own centre through the stream as a bait. Thereupon the Vandals, still holding their centre back, moved their wings forward to envelop and assail the Roman centre during the passage. While the leading lines were locked in this close-quarter struggle, and the rear lines waiting to engage, Belisarius launched his own wings at them. The charge, having the advantage of impetus, shattered the Vandal wings. The Roman centre, if hard pressed for a brief time, had admirably fulfilled its role of fixing the enemy. The rout of the Vandal wings uncovered their centre, which was then surrounded and almost annihilated by the Romans

TRICERATOPS, the best-known member of the horned dinosaur group (Ceratopsia) of the Upper Cretaceous This was a four-footed dinosaur about 20 ft long. Its head bore a pair of long brow horns and a smaller horn over the nose; a large bony frill protected the neck. (*See* DINOSAURIA.) (A. S. RR.)

TRICHINOPOLY, a city of India, in Madras state. The city is on the right bank of the river Cauvery, 250 mi. by rail S.W. from Madras. Pop. (1941) 159,566. The fort which forms the nucleus of the city measures about 1 mi. by ½ mi.; its defenses have been removed. Within it rises the isolated Rock of Trichinopoly, 273 ft. above the city, which is ascended by a covered stone staircase, entered by a carved gateway, and profusely ornamented. Trichinopoly is an important trading centre and railway junction Its industries are goldsmiths' work and modelling in pith, silk weaving, cigar and soap making Trichinopoly and its neighbourhood were the scene of much hard fighting between the English and the French during the Carnatic wars between 1749 and 1761.

TRICHINOSIS or TRICHINIASIS, a disease in man and other animals caused by infection with the parasite *Trichinella spiralis*. The parasite was named by Sir Richard Owen on the basis of encysted trichinae discovered in human muscle by Sir James Paget (*q.v.*) in 1835. The larvae were first found in the muscle tissue of swine by Joseph Leidy (1823–91) in 1846. The complete life cycle was elucidated in 1859 by Rudolf Leuckart (1822–98) and Rudolf Virchow (1821–1902), who, working independently, found the adult worms in the intestinal tract. The clinical character of the acute disease caused by the invasion of the parasite was demonstrated by Friedrich von Zenker (1825–98) in 1860. Following Zenker's discovery, severe outbreaks of the disease were recognized in Prussia and other parts of Germany.

The disease is acquired by eating uncooked or inadequately cooked flesh containing the encysted third-stage larvae, which are released from their cysts by the action of the gastric juice and migrate from the stomach to the small intestine. Here the sexes develop to maturity, usually within 72 hr, and mate promptly. Birth of living young begins as early as the fourth day after infection. Larval production may continue for a period of six weeks or longer. The young worms find their way to the lymph spaces and are carried to the heart and thence to the lungs, from whence they reach the general circulation Once in the voluntary muscles, the larvae come to rest within the substance of the muscle fibre. Here they undergo rapid growth Within 10 to 14 days after penetration, they reach a length of approximately ¼ in. and become spirally coiled. A cyst is gradually formed around the larva. In about eight to ten months, the cyst wall begins to calcify, in time the larvae die and are absorbed or become calcified

The parasite is widespread in many hosts Cats, dogs and rats are frequently infected In addition to infection from pork, clinical cases in man have resulted from the consumption of smoked dog meat, the flesh of the nutria and bear meat Infection in swine varies with methods of husbandry. In the United States, where the feeding of raw garbage is a common practice, approximately 6% of swine maintained on such food are infected. Undoubtedly, infection is carried through pork scraps in the garbage The incidence in grain-fed hogs is less than 1% In European countries for which data are available, only a fraction of 1% of swine are parasitized; many of these countries require the microscopic inspection of pork. Infection in hogs is equally low in England, which requires the cooking of garbage fed to swine.

Types of pork products customarily eaten without cooking are potent sources of infection unless processed for the destruction of the parasites. These so-called "summer sausages" include frankfurters, salami, mettwurst, cervelat, etc.

Trichinosis has occurred in many parts of the world Outbreaks have been reported from most European countries In England, trichinosis was a rare disease until 1941 when several hundred cases occurred. A number of small outbreaks were also reported from Wales at that time Between 1937 and 1951 inclusive, an average of about 400 clinical cases a year were reported in the United States, where the widespread distribution of the parasite was indicated by its recovery from 16.1% of 5,313 individuals succumbing to conditions other than trichinosis. These cases came to autopsy in 189 hospitals in 37 states and the District of Columbia between 1936 and 1942. The majority of these individuals had only light infections and probably never suffered ill health therefrom Surveys of similar scope were not carried out in England and other European countries. However, data indicate that the incidence of the parasite at mid-20th century was only a small fraction of that in the United States. Similar findings obtained in Canada and Australia

Trichinosis is characterized by an extremely varied chain of symptoms In severe infections, nausea, vomiting, diarrhoea and abdominal pain may appear within 24 to 48 hr In the absence of such symptoms, signs of illness usually begin about 5 to 14 days after the ingestion of infected pork; the incubation period may be as long as three weeks Early symptoms are weakness, fatigue, headache and fever; some patients have pharyngitis or laryngitis with cough Later the fever rises and there are chills and sweats Swelling around the eyes and face is a frequent symptom. A rash may be present on the trunk and upper extremities. When the larvae begin to reach the muscles, pronounced muscle pain and stiffness of the joints are experienced Symptoms of heart disease may be present and pneumonia is not an unusual complication. The larvae may invade the spinal cord and brain and give rise to symptoms simulating meningitis, encephalitis or poliomyelitis The acute phase of the disease lasts from two to three days in mild cases and up to three to four weeks in more severely infected individuals If complications ensue, the course may be prolonged After recovery, the muscle pain gradually disappears and in most cases there are no residual symptoms. The mortality rate of clinically recognized cases is fairly low; in the United States between 1930 and 1938, for example, it was approximately 6%

Diagnosis of sporadic cases is difficult because the symptoms simulate closely those of many other conditions A leucocytosis is usually associated with the disease, while an eosinophilia, or increase in the acid-staining white cells of the blood, is usually but not always present A biopsy of muscle tissue may disclose the larvae Skin tests and serological tests are of value but, like the biopsy, are usually not positive until after the larvae have reached the muscles Unfortunately, there is no drug of any specific value and treatment is mainly symptomatic.

Prevention lies in the thorough cooking of pork. As a general rule all pork should be cooked until the pink colour has entirely disappeared Microscopic inspection is carried out in some countries. In the United States, federal meat-inspection regulations require processing for the destruction of trichinae of all pork used in products customarily eaten without cooking by the consumer. However, only about 70% of the pork slaughtered comes under federal inspection. Protection extends only to such products since there is no inspection or treatment of fresh pork or other types of pork products. (*See* PARASITIC DISEASES.)

(W. H. WT.)

TRICHOPTERA, the term used in zoological classification for the order of insects commonly known as caddis flies. They are for the most part somberly coloured insects, many of them small, few exceeding an inch in length from head to wing tips Caddis flies are weakly flying insects of mothlike appearance, closely related to Lepidoptera Excepting a few species they are not often seen on the wing unless disturbed; they may, however, be conspicuous locally and at certain times because they are attracted to lights. They are found in the vicinity of ponds and streams in which the early stages are passed.

Caddis flies have four membranous, hair-covered wings with a predominantly longitudinal venation; the forewings are very hairy, the hindwings more transparent, usually broader and with

a plicated posterior lobe. The mouth parts are weakly formed; in some cases at least they are capable of ingesting liquid food, the mandibles are vestigial, the palpi alone are normally developed. The antennae are held porrect and are in some extreme cases three times the length of the wings.

Caddis flies have complete metamorphosis The eggs are laid in or near water, in masses, with a gelatinous covering. The larvae are aquatic, living in cases made of fragments of foreign materials such as leaves, twigs, gravel, sand and even the shells of small molluscs, held together by a salivary secretion. These cases are often characteristic of the species or genus; they may be made as soon as the larva hatches and enlarged as necessary, but in certain groups the cases are constructed shortly before pupation.

The larva has a well-developed head, biting mouth parts and rather long legs The last body segment has a pair of strong appendages whose terminal hooks serve to hold the case and to prevent eviction. Undulatory movements of the body keep water streaming through the case and respiration takes place through gills or through the body wall. The larvae are omnivorous, feeding on plant materials and on the smaller aquatic animals including insects.

At the approach of pupation the case is fastened down, the forward end is closed off with a sieve comparable to that of the rear end, and in one family a cocoon is spun within the pupal case The pupa has very well-developed mandibles which serve the single purpose of opening the case for emergence. The pupal skin is cast at the surface of the water or nearby



FROM H. W. ROSS, "THE TRICHOPTERA OF ILLINOIS" (STATE NATURAL HISTORY SURVEY OF ILLINOIS)

RHYACOPHILA FENESTRA (ABOUT FIVE TIMES NATURAL SIZE)

Caddis flies are found on all continents and more have been reported from boreal than from tropical areas. More than 3,500 species are described and they are commonly divided into from 13 to 17 families; more than 800 species are reported from North America and about 185 from the British Isles.

The larvae of caddis flies are of considerable importance as fish food.

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TRICONODONTA, a group of small, extinct, carnivorous mammals of the Jurassic Age, characterized by the condition of their molar teeth, which typically bore three cusps arranged in a line, the long axis fore-and-aft. They left no descendants *See* MAMMALIA; MULTITUBERCULATA; PALAEONTOLOGY.

TRIDYMITE, a rare mineral consisting of silicon oxide or silica, SiO_2, but differing from quartz in crystalline form. The crystals are small, thin hexagonal plates or scales, which are usually twinned together in groups of three; hence the name, from Greek, τρίδυμος, triplet. The apparent hexagonal plates are themselves pseudo-symmetric twins of optically biaxial material, but at a temperature of 117° C. these optical anomalies disappear and the plates are then truly hexagonal (β-tridymite). The specific gravity is 2.28 (that of quartz being 2.65). Unlike quartz, tridymite is soluble in a boiling solution of sodium carbonate; it occurs in the cavities of acid volcanic rocks (rhyolite, trachyte and andesite), but in most instances the crystals are replaced by a fine granular aggregate of quartz. At a temperature of 870° quartz passes over into β-tridymite with a considerable increase in volume; and this change has an important bearing on siliceous refractory materials used for furnace linings and silica bricks. At a still higher temperature (1,470°) tridymite itself passes over into another modification of silica known as cristobalite. (*See* SILICA.)

TRIER (French TRÈVES), an ancient city of Germany, formerly capital of an archbishopric and electorate of the empire, and now seat of a Roman Catholic bishop and chief town of a governmental department in the Prussian province of the Rhine Pop. (1939) 88,595 It is on the Moselle, about 6 mi. from the Luxembourg frontier and 69 mi. S W of Coblenz by rail on the Coblenz-Metz and Cologne-Saarbrucken lines. Some of the piers and buttresses of the bridge over the Moselle may date from about 28 B.C. The well-preserved amphitheatre just outside the modern town to the southeast was probably built in the reign of Trajan or Hadrian It accommodated about 8,000 spectators. The most remarkable Roman building is the Porta Nigra, the fortified north gate of the city, 115 ft. long, 75 to 93 ft. high and 29 ft. deep, built of sandstone blocks and held together with iron clamps This building may date from the 1st to the 4th century A.D. It is also called the Simeonstor, after a Greek hermit who inhabited it. In 1035 Archbishop Poppo converted the gate into two churches, one above the other, but all the additions except the apse have been removed. In the southeast of the city are ruins of the Roman imperial palace, and near the bridge substructures of the 4th-century Roman baths, 660 ft. long. On the Constantinsplatz stands the brick basilica, probably of the age of Constantine Converted into a palace for the Frankish kings and their deputies, it passed in 1197 to the archbishops, and was restored (1846–56) and turned into a Protestant church. Another Roman basilica forms the nucleus of the cathedral. Built under the emperors Valentinian I and Gratian as a quadrilateral hall, it was converted into a church about the close of the 4th century, and restored by Bishop Nicetius about 550. It is the most important pre-Carolingian church in Germany. Archbishop Poppo and his successors in the 11th and 12th centuries extended the cathedral and added an apse at each end. The vaulting of the nave and aisles and the cloisters were added in the 13th century. In the vaults are buried 26 archbishops and electors The most famous relic preserved is the "Holy Coat of Trier," believed by the devout to be the seamless robe of the Saviour, and said to have been discovered and presented to the city by the empress Helena. The cloisters connect the cathedral with the Church of Our Lady, a building in the form of a circle intersected by a cross, with a vault, built 1127–43 and said to be the oldest Gothic church in Germany. St Matthias in the south, now represented by a 12th-century building, has a Christian cemetery of the Roman age. A market cross dates from 958, and a beautiful Renaissance fountain, the Petersbrunnen, was erected in 1595. Close by are the Steipe or Rotes Haus, formerly the town hall, of the 15th century, and the Frankenturm or *propugnaculum*, of the 10th century. The provincial museum (1885–89) contains many Roman and mediaeval antiquities, and the town library has valuable examples of early printing. Among its most treasured manuscripts are the *codex aureus*, a copy of the gospels presented to the abbey of St. Maximin by Ada, a reputed sister of Charlemagne, and the *codex Egberti* of the 10th century. At Igel is a remarkable Roman column, 83 ft. high. It dates from the 2nd century, and was the family monument of the Secundini. At Nennig is a fine Roman mosaic pavement.

History.—The Treveri or Treviri, from whom the city derived its name, were among the most powerful tribes of the Belgae, and according to Julius Caesar, who conquered them in 56 B.C., possessed the best cavalry in Gaul. Attempts have been made to show that they were of German origin (*see* BELGAE), but although they were doubtless subject to Germanic influences they spoke a Celtic language. The Roman city, Augusta Treverorum, was probably fortified by Augustus about 14 B.C., and organized as a colony about A.D. 50, in the reign of Claudius, but is not mentioned before the war of Civilis in 69 (Tacitus, *Hist.*, iv). At first the Treveri resisted the appeal of Civilis and his Batavi to join the revolt, and built a defensive wall from Trier to Andernach, but soon after the two Treverans, Tutor and Classicus, led their fellow tribesmen, aided by the Lingones (Langres), in the attempt to set up a "Gallic empire." After a brief struggle the

rebels were overthrown at Trier by Cerealis, and 113 senators emigrated to Germany (70). Mainly on account of its strategic position, Diocletian, on his reorganization of the empire, made Trier the capital not only of *Belgica Prima*, but of the whole "diocese" of Gaul. Constantine the Great, who generally resided here from 306 to 331, and his successors, beautified the city with public works, and villas arose upon the hillsides.

The Franks, who had thrice previously sacked the city, gained permanent possession of it about 455. The city passed to Lorraine in 843, and to the East Frankish kingdom in 870. Hetti, who occupied the see from 814 to 847, is said to have been the first Archbishop of Trier, and Radbod acquired the temporal rights of the counts of Trier in 898. In the 10th century Archbishop Dietrich I. obtained the primacy over Gaul and Germany.

The temporal power of the archbishops was not gained without opposition. The German kings Otto IV. and Conrad IV. granted charters to the city, which, however, admitted the jurisdiction of its archbishop, Baldwin of Luxembourg, in 1308. This prince, a brother of the emperor Henry VII., ruled from 1307 to 1354 and was the real founder of the power of Trier. He raised it to great prosperity by his foresight, and chiefly as a result of the active support he rendered to the emperors Henry VII., Louis the Bavarian, and Charles IV, enlarged his dominions almost to their ultimate extent. He assumed the title of arch-chancellor of Gaul and Arles (or Burgundy), and thenceforward the elector of Trier held the third place in the electoral college. After Baldwin's death the prosperity of Trier was checked by wars and disputes between rival claimants to the see, and in 1456 the estates united for the purpose of restoring order and secured the right of electing their archbishops.

Throughout the middle ages the *sancta civitas Trevirorum* was a great seat of monastic learning. The university, founded in 1473, existed until 1797. The elector Richard von Greiffenklau (1467–1531) successfully opposed the Reformation and inaugurated the exhibitions of the holy coat, which called forth the denunciations of Luther but long after his time continued to bring wealth and celebrity to the city. In the latter half of the 16th century education fell into the hands of the Jesuits

The last elector and archbishop, Clemens Wenceslaus (1768–1802), granted toleration to the Protestants in 1782, established his residence at Coblenz in 1786, and fled from the French in 1794. In 1814 nearly the whole of the former electoral dominions were given to Prussia. A bishopric was again founded in 1821, but it was placed under Cologne. The area of the former electoral principality covered a broad strip of territory along the lower Saar and the Moselle from its confluence with that river to the Rhine, with a district on the right bank of the Rhine behind Ehrenbreitstein. The chief towns in addition to Trier were Coblenz, Cochem, Beilstein, Oberwesel, Lahnstein, and Sayn. The territory under the spiritual authority of the archbishop included the bishoprics of Metz, Toul, and Verdun, and after 1777 also those of Nancy and St. Dié.

Trier was occupied by the 3rd American army from 1918 to 1923 In World War II the town and its aerodrome were damaged by bombing.

See J. N von Wilmowsky, *Der Dom zu Trier in seinen drei Hauptperioden* (Trier, 1874); S. Beissel, *Geschichte der trierer Kirchen* (Trier, 1888); G Kentenich, *Geschichte der Stadt Trier* (Trier, 1915).

TRIESTE, formerly Austrian, but ceded to Italy under the treaty of St. Germain in 1919, a seaport in the district of Venezia Giulia, Italy. capital of the province of Trieste and an episcopal see, situated at the northeast angle of the Adriatic sea, on the Gulf of Trieste, is picturesquely built on terraces at the foot of the Carso. Pop. (1936) 237,717 (town), 248,379 (commune). It is divided into the old and the new town, which are connected by the broad and handsome Via del Corso, the busiest street in the town. The old town, nestling round the hill on which the castle stands, consists of narrow, steep and irregular streets. The new town, which lies on the flat expanse adjoining the crescent-shaped bay, partly on ground that has been reclaimed from the sea, has large and regularly-built streets.

The Austrian-Lloyd Steam Navigation company, which for many years has had its headquarters at Trieste, became the Lloyd-Triestino company, with control of several shipbuilding establishments; it later united with the Cosulich company. There is also a large yard at Muggia (3 mi to the S) with about 1,000 workmen; the other industries include petroleum refineries, iron-foundries, chemicals, soap boiling, silk and cotton spinning, jute works, the production of canned fish, soap, beer and preserves, distilleries, etc.; there are steel works at Servola (three smelters) Several marble quarries are worked in the neighbourhood, and there are some large cement factories. Good wine, fruit and olive oil are the most important natural products of the country round Trieste. Under Austria, Trieste owed its development to its geographical situation in the northeast angle of the Adriatic sea at the end of the deeply indented gulf, and to its harbour, which was more accessible to large vessels than that of Venice. Besides, it was declared a free imperial port in 1719, and was therefore released from the obstruction to trade contained in the hampering legislation of the period. It was deprived of this privilege in 1891, when only the harbour was declared to be outside the customs limit. With the 20th century an active policy was inaugurated. New and direct services were started to East Africa, Central America and Mexico; the service to India and the far east, as well as that to the Mediterranean ports, was much improved, and Trieste was made the centre of the large emigration from Austria to America by the inauguration of a direct emigrant service to New York. Railway communications were also improved, and Trieste, besides being the principal port of Austria, was the centre port for much of Germany's trade with the Mediterranean and the east. By 1924 Trieste had recovered 95% of her prewar trade, but this abnormal "boom" was not maintained, and the competition of Hamburg was felt.

Trieste has two ports, the Porto Emanuele Filiberto Duca d'Aosta and the Porto Vittorio Emanuele III, commonly called Porto Franco. The chief imports include coal, coffee, tobacco, mineral and vegetable oils, fats, flour and rice.

In the years 1930–34 an average of 34,350 ships entered and cleared the port annually, with a total tonnage of 10,400,000. In 1933, 145 ships with a gross tonnage of 587,000 tons were registered in the district (compartments) of Trieste, belonging to 16 companies.

Trieste is connected by rail with Monfalcone (branch for Gorizia and Udine), Treviso and Venice (another line to Gorizia runs across the Carso), with Postumia Grotte, the frontier station on the line to Ljubljana, with Parenzo and with Pola, and by electric railway with Villa Opicina.

About 4 mi. N.W. of Trieste on the very edge of the sea is the famous castle of Miramare, built in 1854–56 for the archduke Maximilian, the ill-fated emperor of Mexico.

History.—After the break-up of the Roman dominion Trieste shared the general fortunes of Istria. From the emperor Lothair II (in 948) it received an independent existence under its count-bishops, and it maintained this position down to its capture by Venice in 1202. For the next 180 years its history consists chiefly of a series of conflicts with this city, which were finally put an end to by Trieste placing itself in 1382 under the protection of Leopold III of Austria. The overlordship thus established insensibly developed into actual possession; and except in the Napoleonic period (1797–1805 and 1809–13) Trieste remained an integral part of the Austrian dominions until 1918, though always a centre of Italian irredentist feeling. It was an imperial free port from 1719 until 1891.

See Giulio Caprin, *Trieste* (Bergamo, 1906); A. Tamaro, *Storia di Trieste* (Trieste, 1924).

TRIFOLIUM, the generic name of the plants commonly called clover (*q.v.*), from the Latin *tres*, three and *folium*, a leaf

TRIFORIUM, in architecture, a longitudinal passage or gallery of a church, or other high ceiled interior, the triforium floor being usually above a side aisle vault or ceiling. The usage of the term is loose; by some it is applied to any second floor gallery opening on to a higher nave by means of arcades or colonnades, like the galleries occurring in some pagan Roman basilicas, or similar galleries in Byzantine churches. In other cases its usage is limited to an arcaded gallery above the side aisle of a mediaeval church and below the clerestory windows, thus occupying the height of the side aisle lean-to roof. The triforium became an integral part of interior church design during the Romanesque

period, sometimes merely as a series of openings to light and ventilate the roof space, and sometimes as a complete open gallery, often vaulted with a quarter circle vault, which transmitted the thrust of the main nave vault to the outside walls, as in the church of S Cernin at Toulouse (begun 1096). With the development of articulated Gothic vaulting in France the usage became confused. At times there was a complete vaulted gallery over the side aisle, which created a lower triforium; in the height of the *lean-to roof* over this a second, minor triforium was developed, as in Laon cathedral (1160–1205), and in Noyon (1150–1200).

In Notre Dame at Paris (1163–96) the upper triforium was originally represented by a series of simple, round openings with rudimentary tracery opening to the roof space. The change in Notre Dame, in the rebuilding (between 1240–58), by which the aisle roofs were flattened, the clerestorey windows heightened and the circular openings eliminated, shows the 13th century dissatisfaction with the old four stage composition, and the upper vaulted gallery is found in few churches of the developed Rayonnant period. Chartres cathedral (1194–1212), Reims cathedral (begun 1220) and Amiens (1220–47) all show triforia of little relative height, but of rich arcading and, in the last, the central mullion of the clerestorey tracery is carried down through the triforium arcading, so as to bind clerestorey and triforium into one composition. In the apse of Amiens, moreover, the flatness of the side aisle roofs allows windows to be placed behind the triforium arcading, which thus becomes, as it were, merely a decorated base to the slim clerestorey above This development reaches its climax in the church of S Urbain at Troyes (1262–80), in which the triforium gallery completely disappears as a separate motif, although it is faintly recalled by the tracery of the clerestorey windows.

In the Flamboyant period the entire omission of the triforium becomes the rule. The English love of horizontal lines shows in a great development of the triforium gallery as an important decorative element in church interiors. In both Norman and Gothic work it is relatively much higher than in similar work in France, often almost equalling the pier arcades. It frequently receives the richest possible treatment, by the use of both tracery and sculpture. The richest and most characteristic example is the angel choir at Lincoln (completed 1282) In the 15th century the tendency toward height of pier arcade and clerestorey window, so clearly shown in Perpendicular work generally, leads to the marked reduction in importance and the final disappearance of the triforium. (*See* BYZANTINE AND ROMANESQUE ARCHITECTURE; GOTHIC ARCHITECTURE.) (T. F. H.)

TRIGONOMETRY. To compute numerical results for which geometry would require diagrams plotted to scale is the first function of trigonometry. Such problems as relate to a figure lying wholly in one plane constitute *plane trigonometry;* principally the calculations of certain unknown distances and angles from other known or measured distances and angles. Problems whose diagrams lie in two or more different planes of three-dimensional space are comprised in *spherical trigonometry.* Their relation to a sphere will be shown below. Algebraical discussion of such computations or calculations forms what is called *theoretical trigonometry,* while the numerical work is called concrete or *practical trigonometry.*

PLANE TRIGONOMETRY

All solutions of problems of distance and direction in a plane depend upon finding unknown parts of a triangle when three parts are known (or "given") Most simply, these may be sides and angles, at least one being the length of one side. For calculations involving the size of an angle, the ratios of sides in a right triangle are employed, a right triangle having one angle equal to the given angle, or differing from it by some even number of right angles; or the *supplement* of such an angle. For convenience of measurement and uniformity of language a technical system is adopted, as follows:

The angle to be measured is depicted in a vertical plane, facing the observer. The angle is defined by one straight segment *OA,* called its *initial side,* and a second segment *OB,* its *terminal side.* It is often said to be *generated* by the continuous rotation of a straight segment about the point *O,* from the position *OA* to the position *OB* Since this rotation has two conceivable directions or senses, one is called the negative sense, namely, that performed by the hands of a clock as seen by an observer standing before its face; the opposite sense of rotation is called positive If one could stand at the position of the north pole-star and face toward the sun, the planets of our solar system would appear in their orbits to revolve in the positive sense about the sun.

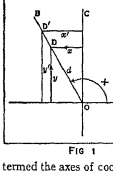


FIG 1

Fix arbitrarily a point *D* on the terminal segment (fig 1), and let *d* denote the distance *OD* Draw a line *OC* perpendicular to *OA* and measure the Cartesian coordinates *x* and *y* of *D,* taking as *x* the distance of *D* from the line *OC* (right or left), and *y* its distance above or below the initial line or that line produced in the direction *AO.* The indefinitely extended lines *OA* and *OC* are termed the axes of coordinates (*see* COORDINATES) in this diagram, *OA* being the *x* axis and *OC* the *y* axis, so that *x* coordinates are parallel to the *x* axis, *y* coordinates parallel to the *y* axis. Coordinates are measured from an axis, to the point *D,* and are positive for an acute angle. Hence on the diagram which is used here, a positive *x* extends from the *y* axis toward the observer's right, a negative *x* toward his left; a positive *y* upward from the *x* axis, a negative *y* downward. These conventional definitions enable us to characterize the picture of any real angle by three real numbers, *d, x* and *y* But any new selection of the point *D* on the terminal line, as *D',* would give a second set of numbers, *d', x', y',* which are proportional to *d, x* and *y.* Accordingly not these numbers, but their ratios, are chosen to describe or measure the angle.

Trigonometric Functions or Ratios, of an Angle.—Six names are assigned to the six ratios of the numbers, *x, y, d.* Some symbol, as *K,* is used for the angle. Then

y/d	is called	the	sine of K,	or $\sin K = y/d$
x/d	"	"	cosine of K,	or $\cos K = x/d$
y/x	"	"	tangent of K,	or $\tan K = y/x$
x/y	"	"	cotangent of K,	or $\cot K = x/y$
d/x	"	"	secant of K,	or $\sec K = d/x$
d/y	"	"	cosecant of K,	or $\operatorname{cosec} K = d/y$

By definition three of these six are reciprocals of three others;

$$\cot K = 1/\tan K,\ \sec K = 1/\cos K,\ \operatorname{cosec} K = 1/\sin K.$$

The sine is also the product of two others; $\sin K = \cos K \cdot \tan K$. Since also the Pythagorean relation connects *x, y* and *d*,—viz., $x^2+y^2=d^2$,—there are quadratic relations or identities among the six ratios. One of these is $\sin^2 K + \cos^2 K = 1$. By the use of these five relations or any equivalent set, when the numerical value of any one ratio or function is known the five others can be found numerically, but not always their plus or minus sign. If however the *sign* of a second ratio is given, a ratio not the reciprocal of the first, then the rest can be found completely.

Limits of Values of the Six Functions.—From the fact that *d* is numerically greater than either *x* or *y,* and that either one of the latter may become equal to zero for some angle which is a whole number of right angles, it is seen that two functions of real angles have outer boundaries, two have inner boundaries, and two are unbounded.

$$-1 \leqq \sin K \leqq (+1), \qquad \sec K \geqq (+1) \text{ or } \sec K \leqq (-1),$$

$$-1 \leqq \cos K \leqq (+1), \qquad \operatorname{cosec} K \geqq (+1) \text{ or } \operatorname{cosec} K \leqq (-1),$$

$\tan K$ and $\cot K$ are unlimited in value.

Unit of Real and Imaginary Angles.—In geometry the unit of angle, a *degree,* was defined as one ninetieth part of a right angle, a *degree* is divided into sixty equal parts called *minutes,* and each minute into sixty equal parts called *seconds.* In terms of these units an angle can be described by three whole numbers if it

does not demand more precise measurement, or it may be described by the aid of a decimal fraction of a unit. Astronomers use degrees, minutes, seconds, and often tenths and hundredths of a second. Land surveyors use degrees and minutes, and sometimes tenths of a minute. For purely theoretical discussions a larger unit is usually employed. This is the *radian* and is best described by saying that π radians are the same as 180 degrees. Using the symbols °, ′, ″ for degrees, minutes, seconds, we may say that

$$1 \text{ radian} = 57°.2957796 = 57°17'44''.81$$
$$1 \text{ degree} = 0.01745329 \text{ radians}$$

Glaisher has calculated the value of the radian to 41 places of decimals.

In calculations regarding angles it may happen that data are used which do not admit the construction of a *real* triangle (or other figure that is sought); then the impossibility will come to light when either: (*a*) the value of some function is given by an equation whose roots are imaginary, or (*b*) the numerical value of some function is excluded by the above statement of boundary values. In either case, (*a*) or (*b*), the angle is said to be *imaginary*.

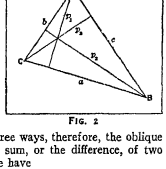


FIG. 2

Dissection of an Oblique Triangle into Right Triangles.—From any vertex of an oblique triangle a perpendicular may be drawn to the opposite side. In three ways, therefore, the oblique triangle may be looked at as the sum, or the difference, of two right triangles. Then, in fig. 2, we have

$$p_1 = b \sin C = c \sin B$$
$$p_2 = a \sin C = c \sin A$$
$$p_3 = a \sin B = b \sin A$$

These equalities give first the

Law of Sines: $$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C};$$

and secondly the three equivalent expressions for the area T of this triangle:

$$T = \tfrac{1}{2}ap_1 = \tfrac{1}{2}bp_2 = \tfrac{1}{2}cp_3$$
$$= \tfrac{1}{2}ab \sin C = \tfrac{1}{2}bc \sin A = \tfrac{1}{2}ca \sin B.$$

In this diagram each side is the algebraic sum of two bases of right triangles, and each base is the product of one side of the triangle multiplied by the cosine of an angle. The three equations from this source are

$$a = b \cos C + c \cos B,$$
$$b = c \cos A + a \cos C,$$
$$c = a \cos B + b \cos A.$$

Two cosines can be eliminated from these equations, leaving a relation among three sides and one angle:

$$b^2 + c^2 - a^2 = 2bc \cos A,$$

or

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}.$$

By this formula the angles can be computed when the three sides are known, if a table of cosines is available. Or, in terms purely geometric, this formula, and the two similar ones for cos B and cos C, reduce the problem from that of constructing the angles of an oblique triangle whose sides are given to that of constructing the angles of a right triangle when the ratio of two sides is given.

Addition of Angles.—The addition theorem, the most comprehensive formula in theoretical trigonometry, results easily from these cosine-equations and the rule of proportionality of sides and sines in a triangle. Since $A+B+C = 180°$, $\sin C = \sin(A+B)$. Also if in a given triangle the ratio $a/\sin A = m$, then $a = m \sin A$, $b = m \sin B$, and $c = m \sin(A+B)$. By these substitutions the third cosine-equation above becomes:

$$m \sin(A+B) = m \sin A \cos B + m \sin B \cos A.$$

This gives the following relation, identically true when A and B are positive real angles with a sum less than 180°.

$$\sin(A+B) = \sin A \cos B + \sin B \cos A.$$

Similar substitutions are made in the formula for cos C,

$$-\cos C = \frac{c^2 - a^2 - b^2}{2ab} = \frac{m^2(\sin^2 C - \sin^2 A - \sin^2 B)}{2m^2 \sin A \sin B}$$
$$= \frac{\sin^2(A+B) - \sin^2 A - \sin^2 B}{2 \sin A \sin B}$$
$$= \frac{\sin^2 A(\cos^2 B - 1) + \sin^2 B(\cos^2 A - 1) + 2 \sin A \sin B \cos A \cos B}{2 \sin A \sin B}$$
$$\therefore -\cos C = \cos(A+B) = \cos A \cos B - \sin A \sin B.$$

The two formulae for sin $(A+B)$ and cos $(A+B)$ are termed the *addition theorem* for the sine and cosine. Either may be derived from the other, together with the statements that supplementary angles have equal sines and that their cosines are numerically equal but unlike in sign. They are valid not only within the limits already stated for A and B, but for real angles of any magnitude, positive or negative. Demonstration of this universal validity is conveniently made by adding 90° to one angle (as A) at a time and observing that sin $(A+90°) = \cos A$, cos $(A+90°) = -\sin A$, and the same for $(A+B+90°)$ and $(A+B)$. Such increase of $A+B$ and A is found to exchange the formulae for sin $(A+B)$ and cos $(A+B)$, whence it is inferred that they are true for angles differing by entire multiples of 90° from acute angles. Further, for imaginary angles the definitions of sine and cosine are taken subject to the postulate that these addition theorems shall remain true.

Functions of Multiples of 90°.—When an angle becomes an exact multiple of 90°, the prescribed rules for constructing x, y, and d will give either $d = x$, $y = 0$ or $d = y$, $x = 0$. This gives for sine and cosine the values in this table:

	0°	90°	180°	270°
sine	0	1	0	−1
cosine	1	0	−1	0

Tangent and cotangent become, for such angles, either zero or infinitely great (0 or ∞).

Functions of Double Angles and Half Angles.—Equal angles, $A=B$, give for sin $(A+B)$ and cos $(A+B)$ the two formulae:

$$\sin 2A = \sin(A+A) = 2 \sin A \cos A,$$
$$\cos 2A = \cos(A+A) = \cos^2 A - \sin^2 A$$
$$= 2\cos^2 A - 1$$
$$= 1 - 2\sin^2 A.$$

The latter gives both the following relations:

$$\sin A = \sqrt{\left(\frac{1 - \cos 2A}{2}\right)}, \quad \cos A = \sqrt{\left(\frac{1 + \cos 2A}{2}\right)},$$

which relations are commonly quoted in the form:

$$\sin \tfrac{1}{2}A = \sqrt{\left(\frac{1 - \cos A}{2}\right)}, \quad \cos \tfrac{1}{2}A = \sqrt{\left(\frac{1 + \cos A}{2}\right)},$$
$$\tan \tfrac{1}{2}A = \sqrt{\left(\frac{1 - \cos A}{1 + \cos A}\right)}.$$

This permits a more convenient solution for the angles of a triangle when the three sides are given. The substitution of $\frac{b^2 + c^2 - a^2}{2bc}$ for cos A, with easy factoring, gives

$$\tan \tfrac{1}{2}A = \sqrt{\left[\frac{(b+a-c)(c+a-b)}{(b+c-a)(a+b+c)}\right]},$$

and this allows the use of logarithms in multiplication and the extraction of a square root.

Factorizing Formulae.—For a more expeditious calculation when logarithms are used, the sum or difference of two sines or of two cosines can be factored. To factor the sum, $\sin P+\sin Q$, one angle is taken as the sum of two auxiliary angles, and the other as their difference, thus:

$$P=A+B,\ Q=A-B,\ A=\tfrac{1}{2}(P+Q),\ B=\tfrac{1}{2}(P-Q).$$

The addition theorem is then applied for $A+B$ and $A-B$, as follows:

$$\begin{aligned}\sin P+\sin Q&=\sin(A+B)+\sin(A-B)\\&=2\sin A\cos B\\&=2\sin\tfrac{1}{2}(P+Q)\cos\tfrac{1}{2}(P-Q).\end{aligned}$$

Similarly,
$$\sin P-\sin Q=2\cos\tfrac{1}{2}(P+Q)\sin\tfrac{1}{2}(P-Q),$$
$$\cos P+\cos Q=2\cos\tfrac{1}{2}(P+Q)\cos\tfrac{1}{2}(P-Q),$$
$$\cos P-\cos Q=-2\sin\tfrac{1}{2}(P+Q)\sin\tfrac{1}{2}(P-Q),$$
$$\sin P+\cos P=2\sin(45^\circ+P)\cos 45^\circ,$$
$$\cos P-\sin P=2\cos(45^\circ+P)\sin_{45}{}^\circ.$$

The first two of these give a useful rule when two sides of a triangle and the included angle are known. Since $\sin A/\sin B=a/b$,

$$\frac{a-b}{a+b}=\frac{\sin A-\sin B}{\sin A+\sin B}=\frac{2\cos\frac{1}{2}(A+B)\sin\frac{1}{2}(A-B)}{2\sin\frac{1}{2}(A+B)\cos\frac{1}{2}(A-B)}$$
$$=\frac{\tan\frac{1}{2}(A-B)}{\tan\frac{1}{2}(A+B)}=\tan\tfrac{1}{2}(A-B)\tan\tfrac{1}{2}C.$$

Other formulae for transformation purposes are derived from the addition theorem and the primitive reciprocities and Pythagorean relations, together with the premise that, in a plane triangle, $A+B+C=180^\circ$. Of frequent use are the formulae for radii of the circles inscribed and circumscribed respectively to a triangle:

$$r=\sqrt{\left[\frac{(a+b-c)(a-b+c)(-a+b+c)}{4(a+b+c)}\right]},$$
$$R=\frac{abc}{\sqrt{[(a+b+c)(a+b-c)(a-b+c)(-a+b+c)]}}.$$

Calculation of Tables.—When the radian is used as unit, small angles like 1° or 5° are represented by decimal fractions less than 0·1. The sine and cosine of x radians are represented by convergent series in ascending powers of x:

$$\sin x=x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}+\cdots,$$
$$\cos x=1-\frac{x^2}{2!}+\frac{x^4}{4!}-\frac{x^6}{6!}+\cdots.$$

For $x\leqq\frac{1}{10}\pi$, these functions can be computed with no error in the 10th decimal place by using five terms of the series. For larger angles, more terms can be used, or the addition theorem can be employed. From 1° up to 45° it saves labour to apply the relations

$$\sin(30^\circ\pm x)=\tfrac{1}{2}\cos x\pm\frac{\sqrt{3}}{2}\sin x,$$
$$\cos(30^\circ\pm x)=\frac{\sqrt{3}}{2}\cos x\mp\tfrac{1}{2}\sin x.$$

Beyond 45° of course no further calculation is necessary, since

$$\sin(45^\circ+x)=\cos(45^\circ-x),$$
and
$$\cos(45^\circ+x)=\sin(45^\circ-x).$$

Most sets of trigonometric tables therefore give values of the various functions for angles from 0° to 45°, and apply a system of double titles for completing the first quadrant.

Multiples of an Angle. De Moivre's Formula.—The inscription of regular polygons in a circle is parallel to the solution of an algebraic equation for $\sin x$ or $\cos x$ when $\sin(nx)$ or $\cos(nx)$ is a known quantity, n denoting any integer. To express $\sin(nx)$ in terms of $\sin x$ is a problem for the addition theorem of sines. It is shortened by De Moivre's (or Euler's) formula, itself a direct consequence of that addition theorem. Denote by i the imaginary unit $\sqrt{-1}$. The formula is this:

$$\cos(nx)+i\sin(nx)=(\cos x+i\sin x)^n.$$

The binomial theorem gives the expansion of the second member, terms in odd powers of $\sin x$ being imaginary, while the first and alternate terms are real. The sum of real terms is then the desired expression for $\cos(nx)$; the others, divided by i, give $\sin(nx)$. Compare the treatment of hyperbolic functions, below.

Trigonometric or Fourier Series.—Many functions, especially periodic functions, can be calculated most easily by convergent series proceeding by sines, or cosines (or both), of integral multiples of a variable angle. This topic is best treated in differential calculus (*see* CALCULUS). An interesting example, of little value, however, is this:

$$\frac{x}{2}=\sin x-\frac{\sin 2x}{2}+\frac{\sin 3x}{3}-\frac{\sin 4x}{4}+\cdots.$$

SPHERICAL TRIGONOMETRY

Figures composed of lines and points in a plane are accessible to computation through triangles, and these in turn through right triangles. In the totality of lines and planes radiating from a point in ordinary space of three dimensions the useful instrument for computation is that consisting of three lines or rays—half lines starting from a common point—and the three plane angles which are bounded each by two of these three lines. It is usually agreed to restrict these angles to be not over 180° each, and to fix the same limit for the dihedral angles whose edges are the three lines first mentioned. The plane angles are called *face-angles*, angles formed by two planes at any edge are *dihedral angles*, and the complete figure of six parts is a *trihedral* or *solid angle*. If the point (or vertex) lies at the centre of a sphere, the edges and faces cut the spherical surface in points and arcs of great circles that constitute a spherical triangle. The sides and angles of this spherical triangle have the same measures (in degrees or radians) as the plane and dihedral angles of the trihedral angle. The capitals A, B, C may be used for the positions and for the measures of the angles at the vertices, and a, b, c for the measures of the three plane angles (face angles) of the arcs of the triangle.

Right Trihedral Angles or Spherical Triangles.—If two planes of the trihedral angle are perpendicular, *e.g.*, if the angle C of the intercepted spherical triangle is 90°, the latter is a *right spherical triangle* and subtends a right trihedral angle. If a side (a face angle) is 90°, the triangle and its trihedral angle are called a *quadrantal triangle*. In contrast to the plane triangle, two or even three angles of the triangle may be right angles; in the one case two and in the other case three of the sides will then be quadrants or quarter-circles of the sphere, and the triangles will be biquadrantal, or else equilateral (trirectangular or triquandrantal).

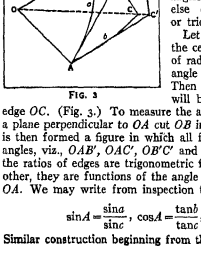


FIG. 3

Let a trihedral angle at O, the centre, intercept on a sphere of radius R a right spherical triangle ABC, right angled at C. Then the planes AOC and BOC will be perpendicular along the edge OC. (Fig. 3.) To measure the angle whose edge is OA, let a plane perpendicular to OA cut OB in B', and OC in C'. There is then formed a figure in which all four triangles are right triangles, viz., OAB', OAC', $OB'C'$ and $AB'C'$. In three of these, the ratios of edges are trigonometric functions of c, b, a; in the other, they are functions of the angle A or of the dihedral angle OA. We may write from inspection these three relations:

$$\sin A=\frac{\sin a}{\sin c},\ \cos A=\frac{\tan b}{\tan c},\ \tan A=\frac{\tan a}{\sin b}.$$

Similar construction beginning from the edge OB gives the three

formulae:

$$\sin B = \frac{\sin b}{\sin c},\quad \cos B = \frac{\tan a}{\tan c},\quad \tan B = \frac{\tan b}{\sin a}.$$

By proper elimination, four more relations, each among three parts of the spherical right triangle, can be derived algebraically from these six, as follows:

$$\cos c = \cos a \cos b, \qquad \cos c = \cot an A \cot an B,$$

$$\cos A = \cos a \sin B, \qquad \cos B = \cos b \sin A.$$

The ten formulae suffice for computing any desired part when two parts beside the right angle are given. The last three of these ten determine the sides when two angles are given, a case having no parallel in plane triangles.

Napier's Rules.—Two "Napier's Rules" form a mnemonic for these ten relations. They relate not to the actual parts (viz., a, B, c, A, b, C), but to a set of so-called "Napier's Parts," amongst which the right angle C does not appear. These are thought of as follows:

$$a,\ 90°-B,\ 90°-c,\ 90°-A,\ b,\ a,\ 90°-B, \text{ etc.},$$

in cycle. Each Napier's part is *adjacent* to two in the cycle, the one next preceding and the one immediately following it in the cycle. The rules read:

1) The *sine* of any middle part is the product of the *tangents* of the *adjacent* parts,

2) The *sine* of any middle part is the product of the *cosines* of the *opposite* parts.

Here *opposite* means *non-adjacent*. When any three Napier's parts are specified, of the five excluding the right angle C, either they are consecutive in the cycle, and then the first and third are called *adjacent* to the second; or only two are consecutive, in which case they are both called opposite to the third. These formulae solve most of the problems arising in geodetic navigation, and the problems of celestial astronomy concerning an altitude and an azimuth.

Polar Triangles: Quadrantal Triangles.—There is a unique relation between two trihedral angles, each *polar* to the other. The interior and exterior spaces of a trihedral angle must be defined. Given three half-lines OA, OB, OC, and the plane angles, each less than 180°, which they bound, produce indefinitely AO, BO, and CO, to A_1, B_1, and C_1. Through O draw any other line ODD_1, not in any face plane (fig. 4). If from D_1, but not from D, a point can move continuously to A_1 without crossing the interior of any face angle or any edge, then D is an interior point and D_1 is an exterior point. If both D_1 and D can be so moved, then both are exterior to the trihedral angle O—ABC. Take D an interior point, and from it draw three half-lines intersecting perpendicularly the three faces of the first trihedral angle. On the half-line perpendicular to AOB mark any point C_2, and similarly mark two other points A_2, B_2. The edges DA_2, DB_2, DC_2, define a second trihedral angle called *polar* to the first. The relations of perpendicularity among lines and planes show that also the first is polar to the second trihedral angle. In solid geometry it is shown, as is visible if one will construct a model, that each dihedral angle in either is the supplement of a face-angle in the other. If the first is a right-trihedral angle (spherical triangle), the second is quadrantal, and vice versa. There is no need of new formulae for a quadrantal triangle, since the ten given already for a right triangle can be altered by merely exchanging small letters for capitals and reciprocally, and changing the sign prefixed to every *cosine*.

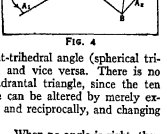


FIG. 4

Oblique Spherical Triangles.—When no angle is right, then from any point in an edge OC two planes can be passed, each perpendicular to one other edge, both therefore containing a line CX, of length p, perpendicular to the plane AOB (fig. 5). From such a figure it is seen that

$$\frac{\sin A}{\sin B} = \frac{\sin a}{\sin b}, \text{ since } \frac{p/l_1}{p/l_2} = \frac{l_2/r}{l_1/r}.$$

From this, since A and B were any two angles of the triangle, there follows the *sine theorem* for every trihedral angle or spherical triangle,

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c}.$$

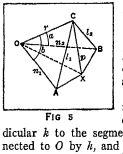


FIG 5

From a slightly different diagram (fig. 6), come formulae connecting three faces and a dihedral angle, or three angles and a face

At a point C on one edge, perpendiculars to OC are erected, terminating in A and B on the two other edges; also a perpendicular k to the segment AB at P. This point P is now connected to O by k, and other parts of the six right triangles are lettered as in the accompanying sketch. We then have the face angle $C = \alpha+\beta$; now call the corresponding parts of angle C,

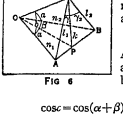


FIG 6

γ_1 and γ_2, and we have $C = \gamma_1+\gamma_2$.

Applying the addition theorem for cosines and referring the segments involved to r by ratios in right triangles, we have

$$\cos c = \cos(\alpha+\beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta = \frac{h^2 - m_1 m_2}{n_1 n_2},$$

$$\cos C = \cos(\gamma_1+\gamma_2) = \cos\gamma_1\cos\gamma_2 - \sin\gamma_1\sin\gamma_2 = \frac{k^2 - m_1 m_2}{l_1 l_2}.$$

Hence $$r^2 = h^2 - k^2 = n_1 n_2 \cos c - l_1 l_2 \cos C,$$

$$1 = \frac{n_1}{r}\cdot\frac{n_2}{r}\cos c - \frac{l_1}{r}\cdot\frac{l_2}{r}\cos C = \frac{\cos c}{\cos a \cos b} - \tan a \tan b \cos C,$$

or $$\cos c = \cos a \cos b + \sin a \sin b \cos C,$$

whence also $$\cos a = \cos b \cos c + \sin b \sin c \cos A, \tag{1}$$

and $$\cos b = \cos c \cos a + \sin c \sin a \cos B.$$

But this trihedral angle is the polar of another, for which those same three cosine formulae are true. In them we may substitute for face-angles and dihedrals the *supplements* of the dihedrals and of the face-angles respectively, cosines and tangents reversing sign. The results are, for this first trihedral angle,

$$\cos A = -\cos B \cos C + \sin B \sin C \cos a,$$

$$\cos B = -\cos C \cos A + \sin C \sin A \cos b, \tag{2}$$

and $$\cos C = -\cos A \cos B + \sin A \sin B \cos C.$$

From set (1), dihedral angles may be calculated in terms of the face-angles; but derived formulae for halves of the dihedrals are more convenient for logarithmic computation, as when in plane triangles the angles are to be found from the sides. Since

$$\cos A = \frac{\cos a - \cos b \cos c}{\sin b \sin c},$$

it follows that

$$\sin^2 \tfrac{1}{2} A = \frac{1 - \cos A}{2} = \frac{\cos(b-c) - \cos a}{2 \sin b \sin c} = \frac{2 \sin \tfrac{1}{2}(b-c+a) \sin \tfrac{1}{2}(a-b+c)}{2 \sin b \sin c},$$

or, if $a+b+c = 2s$,

$$\sin^2 \tfrac{1}{2} A = \frac{\sin(s-b)\sin(s-c)}{\sin b \sin c}; \tag{3}$$

and similarly $$\cos^2 \tfrac{1}{2} A = \frac{\sin s \cdot \sin(s-a)}{\sin b \cdot \sin c}; \tag{4}$$

and $$\tan \tfrac{1}{2} A = \sqrt{\left[\frac{\sin(s-b)\cdot\sin(s-c)}{\sin s \cdot \sin(s-a)}\right]}. \tag{5}$$

The polar triangle converts these formulae into expressions for half-sides in terms of the three dihedral angles; or they may be derived in the same way from set (2) above. They are, when S denotes $\frac{1}{2}(A+B+C)$,

$$\sin^2\frac{a}{2} = \frac{-\cos S\cos(S-A)}{\sin B\sin C}, \tag{6}$$

$$\cos^2\frac{a}{2} = \frac{\cos(S-B)\cos(S-C)}{\sin B\sin C}, \tag{7}$$

$$\tan\frac{a}{2} = \sqrt{\left[-\frac{\cos S\cos(S-A)}{\cos(S-B)\cos(S-C)}\right]}. \tag{8}$$

Gauss's Equations.—The *Gauss equations* are four relations deducible from (3), (4), (6), and (7). Restrict the trihedrals to having positive face-angles less than 180°, and dihedral angles with the same limitations; then the right-hand members of equations (3), (4), (6) and (7) are all positive, and their positive square roots must be taken. From the set represented by (3) and (4), substitute in the addition formula

$$\sin\tfrac{1}{2}(A+B) = \sin\frac{A}{2}\cos\frac{B}{2} + \cos\frac{A}{2}\sin\frac{B}{2},$$

and thus find

$$\cos\frac{c}{2}\sin\tfrac{1}{2}(A+B) = \cos\frac{c}{2}\sqrt{\left[\frac{\sin s\sin(s-c)}{\sin a\sin b\sin^2 c}\right]}\cdot[\sin(s-b)+\sin(s-a)]$$
$$= \cos\frac{C}{2}\cos\frac{a-b}{2}.$$

Not very different are three other proofs. The set of four is this:

$$\begin{aligned}
\cos\frac{a}{2}\sin\tfrac{1}{2}(B+C) &= \cos\frac{A}{2}\cos\tfrac{1}{2}(b-c),\\
\cos\frac{a}{2}\cos\tfrac{1}{2}(B+C) &= \sin\frac{A}{2}\cos\tfrac{1}{2}(b+c),\\
\sin\frac{a}{2}\sin\tfrac{1}{2}(B-C) &= \cos\frac{A}{2}\sin\tfrac{1}{2}(b-c),\\
\sin\frac{a}{2}\cos\tfrac{1}{2}(B-C) &= \sin\frac{A}{2}\sin\tfrac{1}{2}(b+c).
\end{aligned} \tag{9}$$

Professor Simon Newcomb is authority for the statement that these equations were first published anonymously by Delambre, although Gauss was the first to use them in spherical astronomy. It is evident that they solve directly any triangle in which three consecutive parts are known, either two sides and the included angle, or two angles and the side adjacent to both. Where all parts are less than 180°, so that the tangent is a sufficient index of the quadrant in which a part lies, Napier's analogies are the better statement of the solution.

Napier's Analogies.—These analogies are found by division from pairs in set (9), as follows:

$$\frac{\sin\frac{1}{2}(B+C)}{\sin\frac{1}{2}(B-C)} = \frac{\tan\frac{a}{2}}{\tan\frac{1}{2}(b-c)}, \quad \frac{\sin\frac{1}{2}(b+c)}{\sin\frac{1}{2}(b-c)} = \frac{\operatorname{cotan}\frac{A}{2}}{\tan\frac{1}{2}(B-C)},$$

$$\frac{\cos\frac{1}{2}(B+C)}{\cos\frac{1}{2}(B-C)} = \frac{\tan\frac{a}{2}}{\tan\frac{1}{2}(b+c)}, \quad \frac{\cos\frac{1}{2}(b+c)}{\cos\frac{1}{2}(b-c)} = \frac{\operatorname{cotan}\frac{A}{2}}{\tan\frac{1}{2}(B+C)}.$$

By the use of the polar triangle (or trihedral angle), the analogies are exchanged reciprocally two and two; while of the Gauss equations, two are exchanged, the others being self-reciprocal.

Equations of set (1) or (2), have been used here as fundamental, and that asserting proportionality of four sines, as derivative. A different selection is of course possible. While those given above suffice for the logarithmic solution of spherical triangles from any three given parts, and for checks, there is a great variety of other relations adapted to special sets of data, either saving labour or admitting of greater accuracy from the same set of tables.

Hyperbolic Functions.—Trigonometric functions are algebraically related to the sine or cosine. Sine and cosine of a real variable quantity, represented as rectangular coordinates in a plane, define a point whose locus is a circle of unit radius about the origin as centre. They may be defined either by this geometric property; or better, by two absolutely convergent series:

$$\sin\theta = \theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \frac{\theta^7}{7!} + \cdots,$$

$$\cos\theta = 1 - \frac{\theta^2}{2!} + \frac{\theta^4}{4!} - \frac{\theta^6}{6!} + \cdots.$$

Both converge for all values of θ, and are periodic with the common modulus 2π. Their relation to the circle is expressed by the identity: $\sin^2\theta+\cos^2\theta\equiv 1$. Further, it is shown in the theory of limits (*see* LIMITS) usually given in treatises on differential calculus, that the relation of these two functions and their derivatives is nearly reciprocal, viz., in radian units,

$$\frac{d(\sin\theta)}{d\theta} = \cos\theta, \quad \frac{d(\cos\theta)}{d\theta} = -\sin\theta;$$

in other words, each is an integral of the differential equation

$$\frac{d^2u}{d\theta^2} = -u.$$

Two functions resembling these in the features mentioned are the *hyperbolic sine* and *hyperbolic cosine*, abbreviated to $\sinh\theta$ and $\cosh\theta$. They are defined by absolutely convergent series:

$$\sinh\theta = \theta + \frac{\theta^3}{3!} + \frac{\theta^5}{5!} + \frac{\theta^7}{7!} + \cdots,$$

$$\cosh\theta = 1 + \frac{\theta^2}{2!} + \frac{\theta^4}{4!} + \frac{\theta^6}{6!} + \cdots.$$

So far however as a real variable θ is concerned, these functions are not periodic. Their modulus of periodicity is imaginary. The identity connecting them is geometrically the equation of an equilateral (or rectangular) hyperbola,

$$\cosh^2\theta - \sinh^2\theta \equiv 1.$$

Their interest for the physicist or engineer arises from their completely symmetrical or reciprocal differential relations:

$$\frac{d(\sinh\theta)}{d\theta} = \cosh\theta, \quad \frac{d(\cosh\theta)}{d\theta} = \sinh\theta.$$

Both are solutions of the differential equation of the second order

$$\frac{d^2u}{d\theta^2} = +u.$$

Analogous to the trigonometric functions the hyperbolic tangent, cotangent, secant, and cosecant are defined as follows:

$$\tanh\theta = \frac{\sinh\theta}{\cosh\theta}, \ \coth\theta = \frac{\cosh\theta}{\sinh\theta}, \ \operatorname{sech}\theta = \frac{1}{\cosh\theta}, \ \operatorname{cosech}\theta = \frac{1}{\sinh\theta}.$$

The first two are mutually reciprocals: $\tanh\theta\cdot\coth\theta\equiv 1$, and are related to the latter two by the equations: $\operatorname{sech}^2\theta \equiv 1-\tanh^2\theta$, $\operatorname{cosech}^2\theta \equiv \coth^2\theta - 1$.

Like the inverse trigonometric, or circular functions, the inverse hyperbolic functions are usefully represented as integrals. Some writers indeed prefer to define them by integration, as follows:

$$\sinh^{-1}y = \int_0^y \frac{dy}{\sqrt{(y^2+1)}}, \quad \cosh^{-1}x = \int_1^x \frac{dx}{\sqrt{(x^2-1)}}.$$

It follows then that

$$\sinh u = \frac{e^u - e^{-u}}{2}, \ \cosh u = \frac{e^u + e^{-u}}{2},$$

as at first defined, while

$\sinh^{-1}y=\log[y+\sqrt{(y^2+1)}]$, $\cosh^{-1}x=+\log[x\pm\sqrt{(x^2-1)}]$.

The addition theorem is evidently

$$\sinh(u+v)=\sinh u\cosh v+\cosh u\sinh v,$$
$$\cosh(u+v)=\cosh u\cdot\cosh v+\sinh u\sinh v.$$

Misled by apparent implication in the names, some suppose that the Jacobian elliptic functions sin *am u*, cos *am u*, etc., resemble the trigonometric and hyperbolic functions as closely as these sets resemble one another. That this is far from correct may be seen at once by consulting the article on ELLIPTIC FUNCTIONS.

HISTORY

The beginnings of trigonometry in explicit form may perhaps be traced to the lost work of a Greek, Hipparchus of Nicaea (*c.* 140 B.C.), which is said to have comprised twelve books with tables *On Chords of Circles*. Apparently Egyptian builders of the pyramids knew of fixed ratios in similar triangles, and they had a name *seqt* for the cosine of an angle, but there is no known record of tables or of further theory. Three books of Menelaus of Alexandria show that interest in astronomy had induced more progress in spherical than in plane trigonometry. To advance toward its modern form, the science needed more named ratios or functions, tabulated, being like a language scantily supplied with nouns. In India, six centuries later, chords were halved, and became what we now call *sines*, appearing in the writings of Aryabhaṭa (*c.* A.D. 500) and Brahmagupta (*c.* A.D. 620). The knowledge of India passed into the keeping of the Arabs, and Al Battani (*c.* A.D. 900) gave names to functions now called cotangent and secant. Still later (*c.* A.D. 1250), there came a systematizer, the Persian Nasīr ed-dīn al-Tūsī, who collected and supplemented older knowledge into a coherent whole. The sine theorem was employed wherever possible; but, lacking the cosine theorem, he resorted when necessary to auxiliary right triangles to solve problems in oblique triangles.

Among modern writers, the first to exhibit trigonometry as a science was the German Johann Muller, better known as Regiomontanus (*c.* 1460). He seems to have invented the tangent, traces of which have been suspected, however, in the ancient Egyptian Ahmes ms. (*c.* 1650 B.C.) while the secant was reintroduced *c.* 1500 by Copernicus. Vieta, in Paris in the latter part of the sixteenth century, brought algebra and particularly algebraic transformations into the service of trigonometry. Euler, in the mid-eighteenth century, recast, simplified, and gave elegance to the body of rules and technique, by this time so necessary for navigation and the physical sciences. The name, trigonometry, probably originated with Pitiscus (Heidelberg, 1593).

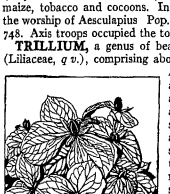
The first discoverers of leading theorems and formulae must of course be named with an implied proviso. For plane triangles the sine theorem narrowly missed by Al Battānī and the Spanish Moor Jabir Ibn Aflah (*c.* 1140), was enunciated by Nasīr ed-dīn al-Tūsī (*c.* 1250). The cosine theorem in complete form is first found in Vieta's work of 1593, *Variorum de rebus mathematicis responsorum liber octavus*. The same author restated the tangent theorem in the accepted form of today, in 1593. It stands however unmistakable in the work of a Dane, Thomas Fincke, ten years earlier, save that the angle $\frac{1}{2}(A+B)$ is expressed as $\frac{1}{2}(180-C)$, a form immediately applicable to the usual data. Formulae for finding angles directly from the sides, without auxiliary right triangles, appear first with Rhaeticus of Wittenberg in a work written in 1568, published in 1596. He gives the rule for $\tan\frac{1}{2}A$. Rules for the sine and cosine of the half-angle are certainly as old as Oughtred's *Trigonometrie* of 1657. Proportions for sines and cosines, of $\frac{1}{2}(A+B)$ and of $\frac{1}{2}(A-B)$ are found, the sines in Newton's writings, 1707, and both functions appear in F. W. Oppel's *Analysis Triangulorum*, 1746.

The six triadic relations in spherical right triangles evolved during long centuries, first of course in words stating proportions, later in the short-hand of equations. Menelaus of Alexandria (*c.* A.D. 100) and Ptolemaeus (*c.* A.D. 140) give most of them, and all were known to Nasīr ed-dīn al-Tūsī (*c.* 1250). For oblique spherical triangles, the sine theorem was found by the early Arabians. It was known to Abū'l-Wafā (*c.* 980), and possibly to his contemporaries Abū Nāṣr or al-Khojendī (al-Chodschendi), in the tenth century of our era. The cosine theorem was implied in what is known to the early Indians, but was exhibited more fully by Regiomontanus (*c.* 1460), and ultimately by Tycho Brahe (before 1590). Gauss's formulae of 1809 were found earlier by Delambre (1807) and Mollweide (1808). Napier's analogies, curiously enough, arrived much earlier, 1619, in Napier's work, and were practically exhibited by Briggs in 1620.

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TRIKKALA (anc. *Trikka*), a town of Thessaly, Greece, capital of department of Trikkala, and see of an archbishop, 38 mi. W. of Larissa. In winter, when great numbers of Vlach herdsmen settle in the town, its population exceeds that of Larissa. It has the appearance of a Mussulman town on account of its mosques (only two of which are in use) and is a centre of trade in wheat, maize, tobacco and cocoons. In ancient times it was a seat of the worship of Aesculapius. Pop. 23,470, of the department, 214,748. Axis troops occupied the town in April 1941.

TRILLIUM, a genus of beautiful plants of the lily family (Liliaceae, *q.v.*), comprising about 30 species, natives of North America and eastern Asia. They are smooth low perennials, with a simple stem bearing at the top a whorl of three leaves and a single conspicuous flower. There are three green sepals, three showy petals, six stamens and a three-celled ovary; the fruit is a many-seeded berry. Some 18 species occur in the United States and Canada; these include many handsome spring wild flowers, known as wake-robin and birthroot. Well-known eastern species are the great white trillium (*T. grandiflorum*), the bethroot (*T erectum*), the painted wake-robin (*T. undulatum*) and the mountain wake-robin (*T. stylosum*).



BY COURTESY OF THE WILD FLOWER PRESERVATION SOCIETY

TRILLIUM OR WAKE ROBIN (TRILIUM SESSILE), ONE OF THE LILY FAMILY HAVING BROWNISH PURPLE FLOWERS

TRILOBITA, a group of extinct Arthropoda of which the fossil remains are found in the rocks of the Palaeozoic era. Many species are found in the Lower Cambrian, among the earliest known fossils. They are abundant in the Ordovician and Silurian when they begin to decline and only three genera survive in the Permian.

A typical trilobite has a segmented body roughly resembling that of a wood-louse, with the dorsal surface marked by two longitudinal furrows which divide it into the three lobes alluded to in the name of the group. In the head-region the middle lobe is the glabella and usually shows transverse grooves marking the five segments of which the head is composed. On either side of the head are plates, the "free cheeks," divided from the central part of the head by the "facial sutures" and bearing the compound eyes. In some trilobites, however, the eyes are reduced or absent. Behind the head a number of the body-segments, from two to 44, are freely movable, and they are followed by a tail-shield or "pygidium" which often shows, by transverse furrows, that it is composed of a number, sometimes a large number, of segments. Most

trilobites, after the Cambrian, could roll up into a ball like many wood-lice and are often found in this condition.

For long no definite traces of the limbs of trilobites could be discovered and their nature was the subject of much speculation. They have now been described in several genera by C. D. Walcott, C. E. Beecher and P. E. Raymond. The structure is most fully known in *Triarthrus*, investigated by Beecher and by Raymond. The appendages of the first pair, placed at the sides of the forelip (hypostoma) which underbangs the mouth, are long, slender, many-jointed antennae. The remaining appendages are all similar in structure and are attached, four pairs to the head and one pair each to the somites of the body whether free or coalesced into the pygidium. They are two-branched, the inner branch (endopodite) being a jointed leg, while the outer (exopodite) bears a fringe of what seem to be stiff flattened bristles. The two branches spring from a single basal segment drawn out on the inner side as a jaw-lobe (gnathobase) which served, no doubt, to seize food and pass it forward to the mouth. Towards the hinder end of the body the appendages become smaller and the inner edge of the endopodite is lobed in a way recalling the appendages of the Branchiopod Crustacea. In *Neolenus* another point of resemblance to certain Branchiopoda is provided by a pair of long thread-like tail-filaments. Walcott believed the structure of the limbs to be more complex, certain genera possessing, in addition to the parts mentioned, two or three "epipodites," but the presence of these awaits confirmation. Still less probable is Walcott's conclusion that *Calymmene* and *Ceraurus* possessed corkscrew-like gills.

The development of various species has been traced. Starting with a minute larva with only indications of head and pygidium, segments appear between these regions in order from behind forwards, the new segments being set free in succession from the front edge of the pygidium. The relationships of trilobites to the various groups of Arthropoda now living have been the subject of much discussion but the elucidation of their appendages leaves no doubt that their main affinities are with the Crustacea (*q.v.*). The five pairs of appendages on the head-region are directly comparable with those of Crustacea, since the second pair or antennae of Crustacea are still postoral and biramous and carry a masticatory process or gnathobase in the nauplius larva as in the trilobites. The biramous form of all the postoral limbs is also a weighty argument in favour of crustacean affinity. On the other hand, there is no trace of the characteristic crustacean shell-fold or carapace. In the uniformity of the postoral appendages, however, the trilobites are more primitive than any living crustacean. The view that trilobites are phylogenetically connected with Arachnida (*q.v.*) has less to support it, but it is possible that connecting links may yet be proved to exist in the imperfectly known Cambrian *Limulava* of Walcott.

The trilobites were all marine and lived, some on sandy or muddy bottoms, some on coral reefs, and some, perhaps, in the deep sea. They were distributed all over the world and in some localities were in such abundance that rock strata are crowded with their remains. A very large number of genera and species are known. Their range of size is from a quarter of an inch to 27 in. in length, but most species are between one and three inches long.

(W. T. C.)

TRIM, a market town and the county town of Co. Meath, Ireland, on the upper waters of the Boyne, 30 mi. N.W. by W. from Dublin on a branch of the Great Southern railway. Pop. (1951) 1,309. Monthly fairs are held, and there is considerable trade in corn and flour. The town was the seat of a very early bishopric. A Norman tower, called the Yellow Steeple, is supposed to mark the site of St. Patrick's Abbey of St. Mary. Two gates remain from the old town walls. King John's castle was originally founded by Hugh de Lacy in 1173, but a later date is assignable to the greater part of the building. Other castles are Talbot's and Scurlogstown castles; the former erected by Sir John Talbot, lord lieutenant of Ireland in 1415, the latter dating from 1180. About a mile east of the town, the ruins of the abbey of St. Peter and St. Paul occupy both banks of the river. These include the Transitional-Norman cathedral on the north bank, and a castle guarding the crossing of the river on the south, together with a chapel and other remains. North of the town ruins may be seen of a 13th century Dominican friary. The tower of the old parish church dates from 1449. Several Irish parliaments met at the castle until the middle of the 15th century, and a mint was established in 1469. The town was incorporated by Edward III.

TRIMONTIUM, according to Ptolemy (ii. 3, 6) a "city" in the territory of the Selgovae, was probably the name of the Roman fort at Newstead, near Melrose, Scotland, close under the three Eildon Hills (whence the name *trium montium*). It was an advanced post of the Romans towards Scotland from about A.D. 80 onwards, and again (after an interval of evacuation) from about A.D. 140–180. Excavations carried out between 1907 and 1911 yielded finds of almost unique importance. These included the foundations of several successive forts, one above the other, which throw much light on the character of the Roman military post, an unparalleled collection of Roman armour, notably ornate helmets, and a good series of coins and datable pottery. The whole illustrate the history of the Roman army and that of Roman Scotland very remarkably and to an extent equalled by no other Scottish site as yet explored.

See James Curle, *A Roman Frontier Post and its People* (Glasgow, 1911).

TRINCOMALEE, a town and former naval station on the northeast coast of Ceylon, 100 m. N.E. by N. of Kandy. Pop. (1931) 10,160. It is built on the north side of the bay of Trincomalee, on the neck of a bold peninsula separating the inner from the outer harbour. The annual average rainfall is 64.8 inches and the average temperature 81.2° F.

The town was one of the first Tamil settlements in Ceylon. The great temple, dedicated to Konatha, or Konasir, on a height at the extremity of the peninsula, was known as the "temple of a thousand columns." The building was destroyed in 1622 by the Portuguese. The town was successively held by the Dutch (1639), the French (1673), the Dutch (1674), the French (1782), and the Dutch (1783). It surrendered to the British fleet in 1795, and with other Dutch possessions in Ceylon was ceded to Great Britain by the Treaty of Amiens in 1802

With its magnificent harbour—one of the five or six greatest natural harbours in the world—it used to be the headquarters of the admiral commanding on the East Indian station and had a military garrison. Pearl oysters are found in the lagoon of Tambalagam to the west of the bay. Some tobacco, rice, and coco-nuts are grown in the district.

Rice and general merchandise are imported while paddy, timber, dried fish, tobacco, deer horns and skins are exported. The merchant anchorage in the harbour is in 4 to 8 fathoms about 4 cable lengths from the wharf. The harbour can accommodate the largest vessels.

TRING, an urban district in Hertfordshire, England, 31½ mi. N.W. of London on the London Midland Region railway. Pop. (1951) 5,018. Area 6.9 sq mi. It lies on the western slope of the Chiltern hills, close to the entrance to a narrow valley which pierces them and forms one of the highways through them to London. The Rothschild museum contains an extensive natural history collection. The road which passes through Tring follows the ancient Icknield way, and there may have been a Romano-British village on the site of the present town

TRINIDAD, a town near the southern coast of Cuba, in Las Villas province, about 45 mi. southeast of Cienfuegos, and 3 mi. from its seaport, Casilda, which lies due south. Pop. (1943) 15,453. There is a local railway, connected with the central trunk line of the island. The city lies on the slope of La Vigia hill (900 ft.) amid higher mountains, and on the banks of the Jayoba (San Juan) river. Casilda has a land-locked, shallow harbour; but Masio bay, a trifle farther distant, accommodates larger craft; and there are excellent deep-water anchorages among the quays off the coast. The Manatí river is navigable for about 7 mi. inland and is used as an outlet for sugar and molasses crops. These and honey are the chief exports; tobacco and various vegetables and fruits are of minor importance. Trinidad is one of the seven original cities of Cuba established by Diego Velásquez. It was founded in 1514 on the coast, but after being attacked by pirates

was removed inland. It was thrice sacked by English buccaneers—in 1642, 1654 and 1702. The late 18th century witnessed the development of sugar in this area on a scale that led Trinidad to become by the middle of the 19th century Cuba's fifth city, with more than 14,000 inhabitants. But it did not recover from the civil war and the shift of the sugar industry to other areas Its traditional architecture makes it one of the most interesting tourist centres in Cuba.

TRINIDAD, a city of southern Colorado, U S., on Purgatory river, at an altitude of 5,963 ft., 14 mi from the New Mexico line; the county seat of Las Animas county. It is on federal highways 85, 87 and 350, and is served by the Colorado Southern, the Colorado and Wyoming, the Denver and Rio Grande Western and the Santa Fe railways The population was 12 206 in 1950 and 13,223 in 1940. It is in the midst of beautiful mountain scenery and picturesque canyons, with Fisher's peak (9,586 ft.), the highest in the Raton range, 5 mi to the south The city is a shipping point for livestock and for the large quantities of coal (1,500,000 tons annually) mined in the vicinity.

Trinidad was incorporated as a town in 1876 and as a city in 1879. In the early days it was a frequent resort of the scout "Kit" Carson.

TRINIDAD, the most southerly and, next to Jamaica, the largest of the British West Indian islands Politically, Trinidad and Tobago (*q.v.*) constitute a single colony. Trinidad is 16 mi. E of the coast of Venezuela, between 10° 3′ and 10° 50′ N and 60° 55′ and 61° 56′ W. Average length, 50 mi ; breadth, 37 mi.; area, 1,863 sq.mi Geographically and biologically it is a part of South America, from which it is separated by the Gulf of Paria. Off the northwest coast of Trinidad lie several islands, of which Chacachacare, Huevos, Monos and Gaspar Grande are the most important; Patos, westernmost of the islands, was ceded to Venezuela in 1942 Under its "destroyer bases" agreement with Great Britain in 1940, the United States acquired 99-year lease rights for naval and air bases in Trinidad Several areas were taken over and occupied beginning in 1941, but by 1950 all of these had been relinquished except the naval base at Chaguaramas, although the United States retained full rights to re-establish bases in the event of war or grave emergency.

Both in the north and south of Trinidad there are ranges of hills running east and west, prolongations of the Venezuelan coast ranges Of these, the northern is the more elevated, its highest point being Mt. Aripo (3,085 ft.). A small ridge runs through the centre of the island, from Manzanilla point to San Fernando, with the isolated Mt. Tamana (1,010 ft). All hills are densely wooded There are four mineral springs and several mud volcanoes, but the two most striking natural features are the Maracas falls and the Pitch lake. The Maracas falls, 312 ft high, are situated at the head of a valley of the same name, to the northeast of Port-of-Spain. The Pitch lake lies some 38 mi. S E. of the capital, by water, in the ward of La Brea. It is circular in form, about 3 mi in circumference, and 104 ac. in extent. The asphalt wells up in low bulging masses, separated from one another by narrow channels, in which the rain forms pools Near the centre of the lake the pitch is always liquid and can be observed bubbling up When the sun is hot the lightest footfall leaves an impression, and the pitch emits a strong odour. The soil of the surrounding district is charged with asphalt, but is very fertile, while the road to the neighbouring port of La Brea, running over a bed of asphalt, moves slowly toward the sea like a glacier. The lake is worked by a company which exports the asphalt to the United States, paying royalty to the local government. Asphalt ordinarily accounts for around 3% of all exports.

The mountain range which runs along the north coast is formed of clay slates, micaceous and talcose schists and crystalline and compact limestones, constituting the group of unknown age called the Caribbean series. The rest of the island is composed of Cretaceous, Tertiary and Quaternary strata. The Cretaceous beds rise to the surface in the centre and are flanked to north and south by later deposits. The relations of the various divisions of the Tertiary formation are still somewhat obscure, but they are grouped by J. B. Harrison into (1) Nariva and San Fernando beds = Eocene and Oligocene; (2) Naparima marls = Miocene; and (3) Moruga series = Pliocene and Pleistocene. The Naparima marls consist of a lower division containing *Globigerina* and an upper division with Radiolaria and diatoms and are clearly of deep-sea origin The bitumen of the Pliocene and Pleistocene deposits appears to have been formed by the decomposition of vegetable matter. Salses or mud volcanoes occur upon the island

Trinidad is the third largest producer of petroleum in the British Commonwealth. The first well was drilled at Aripero in 1867, but no shipments were made until 1911. In 1950 production was 20,600,000 bbl. Most of this oil was refined by the island's two refineries, which were also refining an increasing volume of crude oil from Colombia and Venezuela.

Trinidad has a rich soil well adapted to the cultivation of tropical products. For many years cacao was the most important crop, but sugar eventually supplanted it. In 1949 production rose to a new high of 159,135 tons, the previous peak having been 154,569 tons in 1936 It declined slightly to 146,508 tons in 1950 Around 23,000 tons annually is consumed locally, the remainder being exported.

Sugar and its by-products have an annual value of more than B W I $20,000,000 In 1950 the industry gave employment to 21,434 persons at season's peak, with a minimum of 15,617, compared with an average of 16,300 employed by the oil industry Coconuts are third in agricultural importance Coffee, tonka beans, citrus fruits and bananas are raised The manufacture of Angostura bitters is important

Petroleum accounts for around 75% of all export values, with sugar and sugar products following In 1950 imports reached a total of B W I $160,250,000 in value Exports were B.W.I $167,500,000, not including approximately B W I $10,000,000 of re-exports. An important ship supply trade (B.W I $19,000,000 in 1949) usually accounts for more than 15% of export values The heaviest trade is with the United Kingdom, with Canada, the United States and Brazil also important. Trinidad has a large carrying trade with neighbouring republics and is an important distributing centre for much of the West Indies.

Government accounts were kept in sterling until 1935, when the decimal system replaced it. British currency is legal tender but the official monetary unit is the British West Indian (B.W.I.) dollar, valued at B W I. $4 80 to the pound sterling.

The 1946 census showed the entire colony's population to be 557,970, a 35.2% increase in 15 years, with Trinidad itself having 530,809. In 1950 the population of Trinidad was 635,843 (official estimate). Nearly one-third of the inhabitants are of East Indian extraction, constituting the largest unit of that racial element in the western hemisphere Of the rest, the upper classes are of British, French and Spanish blood, while the lower are of Negro and mixed Negro origin, with a few Chinese. English is spoken generally, though in the north a French patois prevails and in several districts Spanish is still in use. Port-of-Spain (1950 pop., 105,744), the capital, is on the west coast. It is the leading port of the British West Indies and handles virtually all the island's external trade. Formerly, large ships had to anchor in an open roadstead because of the shallowness of the harbour proper, but in 1941 a deep-water project was completed, including a 3,700-ft. wharf wall, a 13,000-ft. entrance channel and a basin 4,000 ft. by 500 ft. A new 1,800-ton slipway was opened in 1946 In addition to the city of Port-of-Spain there are two other municipalities, both of them rated as boroughs: San Fernando (pop. 32,867), on the Gulf of Paria about 30 mi. from Port-of-Spain, and Arima (pop. 9,194), 16 mi. inland and east of Port-of-Spain.

Trinidad's seasons are regular, wet from May to January except for a short break in October, and dry from late January to mid-May. The temperature varies only slightly, with a daylight average of 84° F. and a night average of 64° F. Annual rainfall averages 64 in. at Port-of-Spain and from 50 in. to 120 in. at other points.

A government railway system of 118 mi. links Port-of-Spain with other parts of the island. There are 1,091 mi of main roads and 781 mi. of local roads. The island is served by British, Canadian, United States, Venezuelan, Dutch, Brazilian, Argen-

tine, Colombian and Spanish air lines. Between 4,000 and 5,000 ships (with a total net registered tonnage of 10,859,396 in 1950) touch annually.

The colony underwent several changes in governmental structure during the first half of the 20th century, all designed to permit greater popular participation in government affairs. Under the constitution of 1950, there is a governor (appointed by the crown) and a legislative body consisting of an executive council of 9 (5 chosen by elected members of the legislative council from among their own number) and a legislative council of 5 members appointed by the governor, 3 ex officio and 18 elected by universal suffrage.

The colony's revenues exceeded expenditures in all the post-World War II years through 1950, but in 1951 they were estimated at B.W I $52,056,050 and B W.I. $54,882,725, respectively. The public debt was B.W.I. $42,124,085 in 1950.

In 1950 a five-year economic program, calling for B.W I. $38,885,275 expenditure on public works, was launched. The largest single outlay was $14,000,000 toward completion of an island-wide water scheme which it was estimated would eventually cost $23,724,000. Other projects included highway development, slum clearance and erection of school buildings. The program's costs were to be met in part by advances from the Colonial Welfare and Development fund.

Elementary education is free, but is compulsory only in Port-of-Spain, San Fernando and San Juan. In 1950 there were 306 primary schools, 12 of them being new in the course of the year. Their total enrolment was 115,309. Most of these schools (about two-thirds) are denominational, including Moslem and Hindu, receiving government subsidies. The remainder are government operated. Fees are charged at the intermediate and secondary schools. Colleges for training teachers for elementary schools comprised government and Roman Catholic institutions at Port-of-Spain and the Naparima Training college at San Fernando. Several high schools in Trinidad, and one in Tobago, were affiliated with the Queen's Royal college at Port-of-Spain. The government awarded annually three four-year scholarships for students to proceed to universities overseas.

In 1921 the Imperial College of Tropical Agriculture was established in Trinidad, at St. Augustine, about 8 mi. E of Port-of-Spain; it was incorporated by royal charter in 1926. Its purposes are to provide training in the science and practice of tropical agriculture for students intending to become tropical planters, agricultural administrators or specialists in agricultural science and technology; it also conducts research relating to a wide range of tropical crops, and advises other British possessions in the Caribbean area with respect to agricultural problems.

Trinidad was discovered by Columbus in 1498. A Spanish governor was appointed in 1532, and before the end of the 16th century San José de Oruna (site of the modern town of St. Joseph), 7 mi. inland from Port-of-Spain, became the capital. San José de Oruna was burned by Sir Walter Raleigh in 1595, and the island was raided by the Dutch in 1640 and by the French in 1677 and 1690. Foreigners of all nations were encouraged to settle in Trinidad by advantages offered in 1783, and a large influx of people included many French families driven from Haiti and elsewhere by events of the French Revolution. In 1797, during war between Great Britain and Spain, a British expedition under Sir Ralph Abercromby sailed from Martinique to reduce the island Trinidad capitulated without a fight on Feb 18, 1797, and it was formally ceded to Great Britain by the treaty of Amiens in 1802

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(L. W. Bz.)

TRINIDAD, an uninhabited island in the South Atlantic, 680 mi. E. of the coast of Espiritо Santo, Braz., in 20° 30′ S, 29° 20′ W., 4 mi long by 2 mi. broad.

TRINITARIANS, a religious order founded in 1198 by St. John of Matha and St. Felix of Valois, for the liberation of Christian prisoners and slaves from captivity under the Moors and Saracens The two founders went to Rome and there obtained the approbation of Innocent III, 1198. The rule was the Augustinian, supplemented by regulations of an austere character. The habit was white, with a red and blue cross on the breast. The Trinitarians are canons regular, but in England they were often spoken of as friars. The first to go on the special mission of the order were two Englishmen, who in 1200 went to Morocco and returned thence to France with 186 liberated Christian captives. Vast sums of money were collected by the Trinitarians; but they were called upon, if other means failed, to offer themselves in exchange for Christian captives. Many thousands were liberated by their efforts. In the 17th century a reform called the Barefooted Trinitarians was initiated, which became a distinct order and is the only one that survives. There are now less than 500 members. Their headquarters are at San Crisogono in Rome. They devote themselves to the ransoming of negro slaves, especially children, and a great district in Somaliland has been since 1904 entrusted to them as a field for missionary work.

Bibliography.—The chief modern book on the Trinitarians is Deslandres, *L'Ordre français des Trinitaires* (2 vols., 1903). Sufficient information will be found in Max Heimbucher, *Orden u. Kongregationen* (1907), ii. §57; and in the *Catholic Encyclopaedia*, article "Trinitarians."

TRINITY. The Christian doctrine of the Trinity can be best expressed in the words "The Father is God, the Son is God, and the Holy Ghost is God, and yet they are not three Gods but one God . . . for like as we are compelled by the Christian verity to acknowledge every Person by himself (*singillatim*) to be God and Lord, so we are forbidden by the Catholic religion to say that there be three Gods or three Lords" (*Quicunque vult*). Though this doctrine was one of the first to be dealt with by modern methods of "comparative religion" (as long ago as when Gibbon wrote, "200 B.C, The Logos taught in Alexandria, A.D. 97, Revealed by St. John")—and though it is natural to ask its relation to certain triple arrangements of Pagan deities, to Jewish doctrines of "Wisdom" and the "Word," to the Hegelian triad "The Idea: Nature: Spirit"—it is probably less well adapted to this treatment than other Christian doctrines. At any rate the first step is to discover what, in using this *prima facie* paradoxical language, the Christian Church believed itself to be asserting.

Here a common misunderstanding must be cleared away. "The Creed"—it has been suggested (see *Hibbert Journal*, xxiv. No. 1) —"means that there is only one being that can, with strict theological correctness, be called 'God,' viz., the Trinity as a whole; but each of the three persons can be called 'God' in a looser sense." This suggestion is offered as a short method of "rendering consistent" the statements of the Creed But the paradox is not thus lightly to be got rid of. Plainly the Church did not regard itself as lowering the conception of the Father, so that He should become merely one Component of a Divine Whole. "The Father," says St. Thomas Aquinas, "is as great as the whole Trinity," and explains that in such matters "greatness signifies perfection of nature and pertains to essence" (*Summa Theol.* i., xxx. 1, xlii 4).

Fundamental Conceptions.—This conception of the Trinity is systematically developed by theologians, Greek, Latin and Protestant. "The whole perfection of the Divine nature is in each of the persons. The essence and dignity of the Father and the Son is the same, but is in the Father according to the relation of Giver, in the Son according to the relation of Receiver" (*S.T.* i., xlii 4). Writers in the 4th and 5th centuries had compared the relation of the Father to the Son with the relation of the "flame to its light," of the "spring to the stream," of the "seal" to its "impress." "Think," says St. Augustine (*Sermo ad Catechumenos*, sec. 8) "of fire as a father, light as a son. See: we have found coevals: and it is easy to see which begets which." The meaning of these comparisons is plain. They teach that the whole Divine nature or essence is in each of the Three Persons. The impress, for example, is a *full* reproduction of the character of the seal. They teach also that the Divine persons are inseparable. We are dealing both with a "generical" and a "numerical" unity (*cf.* Aug., *F. and S*, sec. 4; *Modern Churchman*, vol. xv. 12, 675–7; Webb, *God and Personality*, 69n).

Thus, side by side with language declaring that Father and Son are each in the full sense God, there is other language—not *intended* to be inconsistent with the former—which implies that the Son is "necessary to the completeness of the Godhead." The Son, we are told, is not "external" to the Father (Athan., *Discourse I.*, ch. v.), does not "accrue" to the Father from without, but is "of the Substance of the Father." If the Son, it is argued,

were not eternal, the Father would not always be Father, and this absence of fatherhood, it is implied, would be a defect (*cf.* the words *consortium, solitarius, S.T* i, xxxi., 2 and 3). What is the value of these speculations? They cannot be understood apart from a knowledge of the context in which they grew up. This context may be summed up in a sentence Christians, who were willing to die for Monotheism, deliberately held Jesus to be worthy of full Divine worship; and offered the phrase *Consubstantialem patri* as the intellectual justification of this attitude. In contact with the "Spirit" (who was held to speak in the heart of the individual Christian) they believed themselves to be in contact with God. In contact with Jesus as Master, they likewise found themselves in contact with God; but with no divided allegiance, since they conceived the Universe—in spite of its manifest evils—as the work of the Father of Jesus Christ, and so the embodiment of the same Holy Will which expressed itself most clearly in Jesus and in the Holy Spirit

The doctrine, then, is primarily religious; and if we define God—as in practice religion does—as "That which has an absolute claim upon our obedience" or as "the Supreme Object of our reverence," the paradoxical element in the doctrine is at least diminished. The ultimate Object of the Christian's reverence is—as reflection will show—the Christian ideal of holiness. A being who fell short of this standard, however omnipotent or self-existent he might be, would not receive the Christian's worship. Conversely, this standard would have an equal claim upon our reverence—since its claim to our obedience is conceived as being absolute—whether or not it were embodied in a person. Jesus is worshipped because the Christian "identifies" Him with His Call—His Law. Reverence and subjection to Him are reverence and subjection to it (John xiv. 21, etc) Is there, then, any insuperable difficulty in the notion of a threefold personal embodiment of the one Divine Will and Character, an embodiment so complete in each case that contact with the Divine Person is contact with God?

Claims of Unity.—The answer to the foregoing question turns upon the claims of unity. The unity of the world is sometimes represented as based upon its presence to, and its existence in, a single Divine Mind. Religion, however, is interested primarily in the unity of the moral ideal, of the ideal of perfection generally. "The Monotheism of Israel," it has been well said, "was primarily moral seriousness" Religion is concerned also with a faith—which is the basis of its trust and hope—in the necessity of the complete realization of the good in the universe as seen in God; with a faith in that "perfection of the Universe" which St. Thomas regarded as God's chief purpose in creation (i. 50, 3). A Universe which has unity as the complete realization of this single ideal, has the unity which chiefly concerns religion. This ultimate unity of subordination to a single principle is not necessarily identical with the unity which comes from being included within the mind of a single Divine Beng. Nor is it obviously identical with the theologian's "numerical unity of substance" (*see e.g.*, Tanqueray, *Syn. Theol. Dog.*, ii. 575–576). The Unity, then, of the Object of our supreme reverence and trust is not plainly inconsistent with the existence of personal distinctions (in the modern sense of the word) within the Godhead. It was probably an afterthought to regard the doctrine of the Trinity as providing a more satisfactory conception of "personality in God" than could grow up under a "unipersonal" theology. Yet Trinitarianism has some points of superiority over a theory which may compel us to conceive God as waking up at the Creation from "an eternity of idleness" (Shelley, *Queen Mab*, vii. *cf. Journal of Theol Studies*, iv. 376). Love—it may be argued—can only be at its highest perfection in the "love of God for God"—in a love in which the that loves and He that is loved are wholly adequate to one another. A faith in God's perfection would thus tend to a belief in the "plurality of persons in the Godhead"

Amplifying Conceptions.—It has been similarly argued that in conceiving the "not-self with which God contrasts Himself" as "wholly internal to His essence" while the unity (the Holy Spirit) "within which the relation of the two falls is not, as in us, a dark mystery at the back of our life but something which 'proceeds from both' " we have "the best notion that we can frame of Being at its highest" (Webb, *J T.S.*, Oct 1900) Such an argument leads not merely to a plurality but to a trinity of Divine persons, and supports the Western doctrine of the procession of the Spirit from the Father and the Son, *tanquam ab uno principio et unica spiratione* (Council of 1274) It agrees also with the conception of the mutual indwelling of the Three Persons (Tanqueray, *S.T.D.*, ii., 664–665). Again, the argument—if joined with the belief that "whatever we conceive the Divine life to be, our life cannot be outside it"—is in accordance with the Scriptural conception that mankind is within the Eternal Son, that the Church is His "body" or His "fulness." Such a conception would lead us beyond any mere "trinity of manifestation"; since it implies that, though in knowing each Person of the Trinity we are knowing God, yet to know God as Trinity is a real addition to our knowledge, and further, that the personal relations within the Trinity are necessary to His full glory, since they make possible to God something better than mere self-contemplation.

The doctrine, then, we may conclude, arose primarily from the conviction that worship of Jesus is consistent with Monotheism. But if, secondarily, the doctrine when formed is defended as offering the best attainable conception of the Divine perfection, it follows that our sense of what is good and fitting, our aesthetic and religious instinct for perfection, and likewise those qualities in the doctrine which moved Dante (*Parad.*, x. 1–6) to give it poetic expression, are all relevant to its discussion. (*See* PANTHEISM, ATHEISM)

(C. J. SH.)

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TRINITY HOUSE, CORPORATION OF. A fraternity of seamen connected from early times with the river Thames and described in the charter of incorporation granted in the name of the Holy Trinity by King Henry VIII on May 20, 1514, as the Shipmen of Mariners of England. Its present charter, granted by King James II on July 8, 1685, describes it as the "Guild, Fraternity, or Brotherhood of the Most Glorious and Undivided Trinity and of St. Clement in the Parish of Deptford Stronde in the County of Kent." The first master appointed was the founder of the corporation, Sir Thomas Spert, Controller of the Navy to King Henry VIII. Deptford having been made a royal dockyard by Henry VIII, and being the station where outgoing ships were supplied with pilots, the corporation rapidly developed By an Act of Parliament, 8. Queen Elizabeth, the corporation was granted power to erect seamarks at its own costs, and in 1594 it received the very valuable grants of ballastage in the river Thames, and the rights to erect and place beacons and buoys up to that time held by the Great Admiral of England. The charter was regranted by successive sovereigns, King James I made considerable changes and added a number of "Elder Brethren" as distinct from the remaining brethren who were designated "Younger Brethren", whose sole rights consisted of having a vote in the election of the master and wardens.

During the Commonwealth the constitution of the corporation was suspended and the work was conducted by nominees of Parliament, but on the restoration the charter was given back but subsequently surrendered to King Charles II towards the end of his reign, and a new charter was granted by King James II under which the corporation now functions.

The original home of the corporation was at Deptford, but in the seventeenth century it was moved to Water Lane, London, where it remained until 1795 when it was transferred to its House on Tower Hill where it still remains. The corporation by virtue of letters patent granted by the Crown from time to time had

erected lighthouses and established light vessels and buoys, for the maintenance of which it was empowered to collect tolls, and in 1836 Parliament passed an Act giving the corporation power to purchase from the Crown, as well as from sundry private proprietors, all their interests in certain principal coast lights. From the earliest days the maintenance of the lights, buoys, etc., was met out of the tolls levied on shipping, any surplus being devoted to the relief of old and indigent mariners and their families, but in 1853 the control of the light dues or tolls was transferred to the Board of Trade, and the corporation was left with only its private and charitable income.

The corporation is now the general lighthouse authority for England and Wales, the Channel Islands and Gibraltar; it is also the principal pilotage authority for England and Wales, and its functions in both these respects are controlled by statute. The Elder Brethren act as nautical assessors in the House of Lords, the Admiralty Division of the High Court of Justice, and the Court of Session in Scotland. Other Trinity Houses established under ancient charters exist at Hull, Newcastle and Leith.

See W. H. Mayo, *Trinity House, London, Past and Present* (1905); C. R. B. Barrett, *The Trinity House of Deptford Strond* (1893).

TRINITY SUNDAY, the Sunday next after Whitsunday. A festival in honour of the Trinity had been celebrated locally at various dates for many centuries before Pope John XXII (1316–1334) ordered its general observance on the octave of Whitsunday. From Trinity Sunday onward all Sundays until the close of the ecclesiastical year are reckoned in the Church of England as "after Trinity," in the Roman Church as "after Pentecost."

TRINOVANTES, commonly *Trinobantes*, a powerful British tribe about 50 B.C.–A.D. 50 dwelling north and northeast of London, rivals and neighbours of the Catuvellauni. When Gaius Julius Caesar invaded Britain 54 B.C. they joined him against their domestic rivals. They were conquered by Rome in A.D. 43 and joined in Boadicea's revolt in 61. In the tribal division of Roman Britain given by Ptolemy their land included Camulodunum (Colchester), but nothing more is known of them. Their name plays a part in mediaeval legends and romances. There it was interpreted as Troy Novant, the "new Troy," and connected with the names of the Trojans Brutus and Corineus who were reputed to have given their names to Britain and Cornwall.

(F. J. H)

TRIOLET, one of the fixed forms of verse invented in mediaeval France, and preserved in the practice of many modern literatures. It consists of eight short lines on two rhymes, arranged a b a a a b a b, and in French usually begins on the masculine rhyme. The first line reappears as the fourth line, and the seventh and eighth lines repeat the opening couplet; the first line, therefore, is repeated three times, and hence the name. No more typical specimen of the triolet could be found than the following, by Jacques Ranchin (*c.* 1690):—

"Le premier jour du mois de mai
Fut le plus heureux de ma vie:
Le beau dessein que je formais,
Le premier jour du mois de mai!
Je vous vis et je vous aimais.
Si ce dessein vous plut, Sylvie,
Le premier jour du mois de mai
Fut le plus heureux de ma vie."

This poem was styled by Ménage "the king of triolets." The great art of the triolet consists in using the refrain-line with such naturalness and ease that it should seem inevitable, and yet in each repetition slightly altering its meaning, or at least its relation to the rest of the poem. The triolet seems to have been invented in the 13th century. The earliest example known occurs in the *Cléomadès* of Adenès-le-Roi (1258–97). The mediaeval triolet was usually written in lines of ten syllables, and the lightness of touch in the modern specimens was unknown to these perfectly serious examples. One of the best-known is that of Jean Froissart, "Mon coeur s'ébât en odorant la rose." The rules are laid down in the *Art et Science de Rhethorique* (1493) of Henry de Croi, who quotes a triolet written in words of one syllable. According to Jean Sarasin, who introduces the triolet as a mourner in his *Pompe funèbre de Voiture*, it was Froissart who "remit en vogue" the ancient precise forms of verse, "par ses balades, ses triolets et ses rondeaux, qui par sa mort (1648) retournaient dans leur ancien décri." N. Boileau-Despreaux threw scorn upon the delicate art of these pieces, but they continued to be written in France, though not by poets of much pretension, until the middle of the 19th century, when there was a great revival of their use. There are delightful examples by Theodore de Banville.

The earliest triolets in English are those of a devotional nature composed in 1651 by Patrick Carey, a Benedictine monk at Douai, where he probably had become acquainted with what Voiture had made a fashionable French pastime. The triolet was re-introduced into English by Robert Bridges, in 1873, with his—

"When first we met, we did not guess
That Love would prove so hard a master;
Of more than common friendliness
When first we met we did not guess.
Who could foretell this sore distress,
This irretrievable disaster,
When first we met?—we did not guess
That Love would prove so hard a master."

Since then the triolet has been cultivated very widely in English, most successfully by Austin Dobson, whose "Rose kissed me today," "I intended an Ode" and "In the School of Coquettes" are masterpieces of ingenuity and easy grace.

In French literature, triolets are innumerable; perhaps the most graceful cycle of them is "Les Prunes," attached by Alphonse Daudet to his *Les Amoureuses* in 1858. In Germany the triolet has attracted much attention. Those which had been written before his day were collected by Friedrich Rassmann in 1815 and 1817. But as early as 1795 an anthology of triolets had been published at Halberstadt and another at Brunswick in 1796 Rassmann distinguished three species of triolet: the legitimate form (which has been described above), the loose triolet, which only approximately abides by the rules as to number of rhymes and lines and single-strophe poems which more or less accidentally approach the true triolet in character. The true triolet was employed by W. Schlegel, F. Hagedorn, F. Ruckert, A. Platen and other romantic poets of the early 19th century. In many languages the triolet has come into frequent use to give point and brightness to a brief stroke of satire; the French newspapers are full of examples of this. The triolet has laboured under a suspicion of frivolity, but in the hands of a genuine poet the form possesses a delicate charm.

TRIPHENYLMETHANE, a hydrocarbon, $(C_6H_5)_3CH$, which gives its name to an important group of synthetic colouring matters which includes magenta, paramagenta (rosanilines), malachite green, brilliant green, patent blue, aurin and rosolic acid. (*See* Dyes, Synthetic.) It is a white crystalline solid melting at 92° C. and boiling at 358° C./760 mm. Its preparation is best effected by adding anhydrous aluminum chloride to a mixture of dry benzene and dry carbon tetrachloride; after 24 hours anhydrous ether is slowly added; and, after a further 24 hours, the mixture is treated with acidified ice water. The hydrocarbon is extracted with benzene and obtained from this extract by a distillation under reduced pressure, being purified by crystallization from ethyl alcohol (O. Kamm and J. F. Norris, *Organic Syntheses*, vol. iv, J. Wiley and Sons, 1925). Other modes of formation are as follows: (1) condensation of benzal (benzylidene) chloride, $C_6H_5CHCl_2$, with mercury diphenyl; (2) condensation of benzene with chloroform in presence of aluminum chloride; (3) from paramagenta (pararosaniline chloride) by successive reduction, diazotization and replacement of diazo-groups by hydrogen. The third process is of historical interest as it served to establish the connection between the hydrocarbon and the rosaniline colouring matters (O. and E. Fischer, 1881). Conversely, triphenylmethane can be nitrated and its trinitro-compound can be reduced to paraleucaniline, $CH(C_6H_4.NH_2)_3$, which on oxidation in acid solution yields pararosaniline chloride or paramagenta, $(NH_2.C_6H_4)_2C:C_6H_4:NH_2Cl$. Triphenylmethane on oxidation is found to give triphenylcarbinol, $(C_6H_5)_3C.OH$, a feebly basic hydroxide which on treatment with hydrogen chloride is converted into colourless triphenylmethyl chloride, $(C_6H_5)_3C.Cl$,

melting at 111° C. This chloride is the primary product of the foregoing condensation of benzene and carbon tetrachloride (*v. supra*). (G. T. M.)

TRIPOD, in classical antiquities, any "three-footed" utensil or article of furniture. The name is specially applied to: (1) a seat or table with three legs; (2) a stand for a cauldron in cooking, or for a camera, compass, theodolite, etc; (3) a sacrificial tripod or altar, the most famous of which was the Delphic tripod, on which the Pythian priestess took her seat to deliver the oracles of the god, the seat being formed by a circular slab on the top, on which a branch of laurel was deposited when it was unoccupied by the priestess. Another well-known tripod was the "Plataean," made from a tenth part of the spoils taken from the Persian army after the battle of Plataea. This consisted of a golden basin, supported by a bronze serpent with three heads (or three serpents intertwined), with a list of the states that had taken part in the war inscribed on the coils of the serpent. The golden bowl was carried off by the Phocians during the Sacred War; the stand was removed by the emperor Constantine to Constantinople, where it is still to be seen in the Atmeidan (hippodrome), but in a damaged condition, the heads of the serpents having disappeared. Tripods are frequently mentioned in Homer as prizes in athletic games and as complimentary gifts, and in later times, highly decorated and bearing inscriptions, they served the same purpose.



ROMAN BRONZE TRIPOD IN MUSEUM AT NAPLES

TRIPOLI, a city in Lebanon and the seat of administration of the sanjak of North Lebanon in French mandated territory until 1941, mod. *Tarabulus*. It is situated about 2 mi. inland from its port, El-Mina, to which it is joined by a tramway. Pop. (1943) 70,800. The city is the terminal of railroads connecting with Turkey and Egypt, has a modern port for seaplanes and is the terminal of one of the two pipe lines of Mosul oil. The chief industries are soap manufacture, sponge fishing, tobacco cultivation and fruitgrowing. It has an export trade in fruit (especially oranges), eggs and cotton.

History.—Tripoli is known only by its Greek name. Founded after 700 B.C, it became in the Persian period the capital for the Phoenician triple federation—Sidon, Tyre and Aradus. Each of the three had its own district in the "triple town," which at that time stood on the El-Mina peninsula. The Seleucids and Romans extended and embellished the city. The Moslems took possession in A.D. 638. In 1109 it surrendered to Raymund of St. Gilles, after a five-year siege. A great library founded by 'Ammar, the ruling family, and consisting, it is said, of 100,000 volumes, was consigned to the flames. When Sultan Kala'un of Egypt took the town in 1289 it was destroyed, and a new city arose on the present site. Tripoli was often a disputed possession of the rival princes of Aleppo and Acre. In 1834, during the Egyptian conquest of Syria, it was made a centre of administration. The British occupied it Oct. 13, 1918. It was incorporated in the state of Grand Liban on Aug. 31, 1920. In 1941 it was occupied by the British and Fighting French and became part of the independent republic of Lebanon on Nov. 26 of that year. (E. Ro.; X.)

TRIPOLI, the ancient Oea, capital and major urban settlement of Tripolitania, Libya. Prior to the establishment of an independent Libya it was under British military administration (from 1942), and before that served as capital of the Italian colony (1911) and province (1939) of Tripolitania, and the Turkish vilayet (1835) of Tripoli. It is situated on the North African coast at 32° 53′ 40″ N. and 13° 11′ 32″ E. on a promontory stretching out into the Mediterranean and forming a small crescent-shaped bay which shelters the harbour from the north winds. Including the 35,000 natives of the adjacent oasis, the population was about 108,000 (40,000 Italians) in 1938; 119,000 (est.), 1951. The crenellated enceinte walls by which the city was surrounded had the form of an irregular pentagon, but have now been, to a considerable extent, demolished They dated from Roman times, but the earliest portions actually preserved belonged to the Byzantine period, and the greater part to the 16th century. The citadel, dating from the time of the Spanish occupation, now serves as the residence of the governor, and there also is the archaeological museum The desert almost touches the western side of the city, while on the east is the verdant oasis of Mechia, where are still to be seen the tombs of the Karamanlian sultanas. The aspect of the city is picturesque, the houses (many possessing beautiful gardens) rise in terraces from the seashore. The Turkish quarter contains numerous mosques whose minarets and cupolas break the monotony of the flat-roofed and whitewashed houses. The Pasha mosque (originally a church built by the Spaniards) has an octagonal minaret, but the most beautiful is the Gurgi mosque (1833). Many of the streets are arcaded. Near the port stands a Roman triumphal arch, quadrifrontal in form, made entirely of white marble and richly embellished with sculpture. It was erected in A.D. 163.

The modern part of the city, to the southwest of the old town, contains a number of official buildings, a cathedral, the Victory monument, theatres, hotels, etc., most of them along the fine sea front called Lungomare Conte Volpi, in honour of the former governor (1921–25). There is also a large tobacco factory, productive salt works and breweries using barley grown locally and in Cyrenaica. In the 1920s harbour works of considerable magnitude were undertaken and Tripoli was made one of the most modern ports on the Mediterranean. Regular communications with Italy by sea and air were established as well as colonial coastwise shipping routes both west and east. Tripoli also became the focus of the few rail lines and the growing road system, planned to unite more completely the parts of Libya. Military buildings, artillery factories, supply bases, hangars and a hospital were also constructed at the port. Tripoli thus became the major base for German-Italian operations in the North African campaign of World War II. On Jan. 23, 1943, the city fell to the British.

The oasis of Tripoli is very fertile and beautiful; its total surface is about 25 sq.mi., and it contains about 4,000 houses, 8,500 wells and 1,000,000 trees At Sidi Mezri there is an important governmental agricultural experimental station.

The ancient Oea (one of the cemeteries of which has been discovered) was probably founded by Phoenicians from Sicily. It became a Roman colony after the fall of Carthage. It owed its importance in the middle ages and subsequently to the destruction of Sabratha and Leptis by the Arab invasion in the 11th century. In 1510 Tripoli was taken by Pedro Navarro; in 1530 it was granted to the Knights of St. John; but in 1551 it was lost again, and attempts to retake it, organized by Philip II of Spain and led by Andrea Doria, came to nothing, the expedition being defeated at Jerba. It subsequently became a nest of pirates, stamped out by U.S. naval action in 1801–05. (H. M. Kt.; H. V. B. K.)

TRIPOLI is a porous, friable, microcrystalline silica rock of sedimentary origin comprised chiefly of chalcedony and microcrystalline quartz. It does not include diatomite, although the name was chosen because of its superficial resemblance to tripolite, a diatomite from Tripolitania in North Africa. Some tripoli is a coherent residuum from leached limestone, dolomite or chert; other is probably leached, flocculated colloidal silica which has partly recrystallized. The friable variety is more typical. The chemical composition is usually more than 95% SiO_2, but the impurities may impart beneficial, desirable physical properties instead of being deleterious. Tripoli is used mainly as a polishing or buffing abrasive, wherein it excels because of its physical properties (particle shape and porosity), and also as a parting powder between moulding sand Commercial tripoli powder is finely pulverized, much of it being reduced below ten microns in diameter. Production in the U.S. is chiefly from Missouri and Illinois, less from Arkansas, Georgia and the Tennessee valley. Besides domestic consumption, large exports go to England chiefly and to other European, Asiatic and South American countries.

(W. D. Kr.)

TRIPOLITANIA, the western part of the kingdom of Libya, has an area of about 348,000 sq.mi. (only 96,472 if the desert

hinterland of the Fezzan be excluded) and is bounded on the east by Cyrenaica, on the north by the Mediterranean sea, on the west by Tunisia and, beyond the Fezzan, by Algeria and on the south, likewise beyond the Fezzan, by French West Africa and by French Equatorial Africa The population in 1951 was estimated as follows. Moslems 753,240; Italians 46,838; Jews 8,000; others, mainly Maltese and Greeks, 3,800; total 811,878. The chief towns, both coastal, are Tripoli (*q v.*; pop., 1951 est., 119,000) and Misurata (pop, 1951 est., 48,000).

Physical Features.—Tripolitania is essentially an undulating plateau, forming a northern part of the central Sahara desert. The surface rises generally southward, where, at the extreme southern frontier, it merges into the Ahaggar, Timmu and Tibesti uplands of the central Sahara. In the northeast, between Misurata and the Gulf of Sirte, the land rises gradually from sea level without much discontinuity; but westward there is first a coastal plain, known as the Jefara, that is backed to the south by a line of northward-facing scarps, successively from east to west the Jabal Misurata, Jabal Tahuna, Jabal Garian and Jabal Nefusa. This latter feature, formed by subsidence along fracture lines trending from east to west with downthrow to the north, is often referred to simply as the Jabal It does not run parallel to the coast but strikes inland from the coast due westward between Misurata and Homs (Khums), giving the Jefara a triangular shape, with its broadest part in the west.

The Jabal reaches a general elevation of 2,000 ft. and is marked in places by outpourings of lava (*e.g.*, at Takut, due south of Tripoli). Beyond the crest of the Jabal lies the Hammada al-Hamra (Red desert), a stony plateau about 1,700 ft. above sea level, that covers 40,000 sq.mi. The Hammada is uninhabited, but the presence of numerous well-developed and now dry river valleys indicates that climatic conditions were once very different. There are a few ridges running east-west, the most imposing being the Jabal as-Suda (Black mountain), about 1,000 ft. higher than the plateau. About 400 mi. S. of the Mediterranean coast, the Hammada gives place abruptly to a series of depressions aligned east-west, which form the basin of the Fezzan. There water can be tapped at three distinct levels below ground—at 20 ft., 70 ft. and 700 ft.—and settlements occur in three main districts, Murzuk (the capital), Gatrun (south) and Sebha-Ubari (north). Away from these oases, there is the same alternation of seas of soft sand, gravel desert and volcanic masses. Two isolated oases lie in the extreme west of Tripolitania. Ghadames, an ancient centre 350 mi. S W. of Tripoli; and Ghat, a much newer settlement 250 mi S.W. of Murzuk. Both centres command trade routes skirting the main Hammada on the west and continuing southward between the Ahaggar and Timmu ranges toward the Niger and Lake Chad. For several decades previous to 1920 the only caravan routes from the Niger to Tripoli used the track via Ghat, disturbances in Bornu and the Tuareg country farther east having closed all others. The importance of both places has greatly declined.

Because of its open topography, with few screening hills, Tripolitania is affected by unmodified influences alternately from the Mediterranean and from the Sahara. Hence the climate is somewhat unstable, with rapid changes in temperature and unreliable, sporadic rainfall. Temperatures are generally high, with modification caused by the sea near the coast and by altitude in the Jabal. Day maxima in summer frequently exceed 100° F. or even 110° inland. Typical mean conditions for the different regions are: coldest month 54° F. (coast), 52° (Jefara), 47° (Jabal) and 51° (Hammada); warmest month 80° F. (coast), 86° (Jefara), 81° (Jabal) and 84° (Hammada). In summer, the whole of Tripolitania falls under the influence of the Azores anticyclone, and there is no appreciable rainfall. In winter, the northern half of the country is affected from time to time by small depressions that move eastward over the Mediterranean sea; but the northward-jutting promontory of Tunisia shelters Tripolitania from the main rain-bearing northwesterly winds, so that most of the country has only eight inches or less of annual rainfall. The Tripoli area and the Jabal lying to the south and east may receive 10 in. to 15 in. Figures of average rainfall can, however, be misleading, as rain may be entirely restricted to a few weeks, or even days, in each year. Severe droughts occur roughly at ten-year intervals, with, at times, successive seasons of drought. A special feature is the *ghibli*, a violent dusty wind from the south that can suddenly raise temperatures to more than 105° F. and cause enormous damage to growing crops.

The flora of Tripolitania is mainly Saharan, with the date palm and tamarisk highly characteristic. Acacia, asphodel, sapanwood and mastic are found in the wadies, and wormwood forms clusters in the Hammada. Near the coast laurel, myrtle, oak and other evergreens are common, with rarer patches of cypress, pine and carob. Among the commoner animals are the hare, rabbit, hyena, fox, jackal and marmot, while reptiles include the horned viper and gecko. Birds include the vulture, hoopoe, wood pigeon and dove. (W. B. Fr.)

History.—Tripolitania, also commonly called Tripoli simply, was originally a Phoenician colony. The wars between the Libyans and the ancient Egyptians do not come properly into its history. (*See* EGYPT.) Before the colonization of the neighbouring territory to the east by the Greeks (*see* CYRENAICA) the Phoenicians appear to have founded the cities of Sabratha, Oea and Leptis Oea, which stood between the other cities, became the capital of the country and was named Tripolis (the "Three Cities"). These towns commanded the trade of the central Sudan, and caravans regularly crossed the Sahara, there at its narrowest. The early history of Tripolitania was similar to that of Cyrenaica: Cyrenaica passed from the Greeks to the Ptolemies and from them to the Romans; Tripolitania, adjoining Carthaginian territory on its west, fell under the sway of Carthage and, following its fortunes, became eventually a Roman province.

In the 5th century A.D. both Tripolitania and Cyrenaica were conquered by the Vandals, whose power was destroyed in the 6th century by the Byzantine general Belisarius. In the middle of the 7th century North Africa was overrun by the Arabs, and Christianity gave place to Islam. From this period dates the decay of a civilization which had lasted about 1,000 years. Tripolitania became subject to the successive rulers of Tunisia. It was pillaged in 1146 by the Normans of Sicily. In 1321 the Beni Ammar established an independent dynasty, which lasted, with an interval during which two sovereigns of the Beni Mekki reigned (1354–69), until 1551, when Tripolitania was reconquered by the Tunisians. In 1510 Ferdinand the Catholic of Spain took the city of Tripoli, and in 1530 it was given to the Knights of St. John, who were expelled in 1551 by the Turkish corsairs Dragut and Sinan. Thus the country fell to the Turks, though after the death of Dragut the connection with Constantinople seems to have weakened. The Tripolitan pirates soon became the scourge of the Mediterranean; half the states of Europe seem at one time or other to have sent fleets to bombard the capital of the country, nor was piracy stopped until after the French occupation of Algiers in 1830. In 1714 Ahmed Pasha Karamanli achieved practical independence. He and his descendants governed the country as a regency, the claims of the Porte being recognized by the payment of tribute, or "presents."

In the early part of the 19th century the regency was twice involved in war with the United States. In May 1801 the pasha demanded from the U.S. an increase in the tribute ($83,000) which the government had paid since 1796 for the protection of its commerce from piracy. The demand was refused and a naval force was sent from the U.S. to blockade Tripoli. The war dragged on for four years, and the Americans in 1803 lost the frigate "Philadelphia," Capt. William Bainbridge and the whole crew being made prisoners. The expedition undertaken by William Eaton (*q.v.*) had the object of enthroning an exiled pasha, elder brother of the reigning sovereign, who had promised to accede to all the wishes of the United States. Eaton, at the head of a motley assembly of 500 men, marched across the desert from Alexandria and with the aid of U.S. ships took Derna. Soon afterward (June 3, 1805) peace was concluded, the reigning pasha relinquishing his demands but receiving $60,000 (about £12,000) as ransom for the "Philadelphia" prisoners. In 1815, in consequence of further outrages, Captains Bainbridge and Stephen Decatur again visited Tripoli with a squadron and forced the pasha to

comply with the U.S. demands.

In 1835 the Turks took advantage of a civil war to reassert their direct authority. They administered the country as an ordinary vilayet (province) under a pasha. Turkish rule was marked by occasional, spasmodic and mainly ineffective efforts to develop the country. When in 1881 the French seized Tunisia the Turks were alarmed and greatly strengthened their garrison in Tripolitania. Disputes followed as to the extent of the Tripolitanian hinterland, which the French endeavoured to circumscribe. It was not only the French that the Turks had to fear: Italy had looked upon Tunisia as its heritage and, baulked in that direction, now fixed its eyes upon Tripolitania and Cyrenaica; and understandings were reached with other European powers interested. For another generation, however, the Turks remained undisturbed and under the impetus of the pan-Islamic movement penetrated farther south, a Turkish garrison even occupying the oasis of Bilma in 1910. Meanwhile Germany was making endeavours to secure economic and, as a result, political predominance in both Tripolitania and Cyrenaica. This led to action by Italy; war was declared upon Turkey in Nov. 1911 and both Tripolitania and Cyrenaica were declared to be under the full sovereignty of Italy. (For the war *see* ITALO-TURKISH WAR.) However, when the first treaty of Lausanne was signed in Oct. 1912 the Italians held only the coastal region and they met with considerable opposition from the natives (Berbers and Arabs) in their occupation of the interior. But by Aug. 1914 every place of importance in the vilayet, including Fezzan, was in Italian hands. Meanwhile in the coastal districts the Italians had with great energy begun a big program of public works, while toward the Arabs and Berbers they adopted a policy of confidence and trust.

In Cyrenaica the war continued, the Turks having incited the Senussites to continue the struggle. (*See* SENUSSI.) In Sept. 1914 the Fezzani, many of whom adhered to the Senussite sect, rose in revolt. Turkish, German and Senussi propaganda was very active throughout Tripolitania, and the declaration of war by Italy upon Austria (May 28, 1915) was the signal for a general rising. After some hesitation the Italians, in view of the situation in Europe, abandoned the whole country, with the exception of the seaports of Tripoli and Homs. Another seaport, Zuwara, was reoccupied in Aug. 1916. Meanwhile a brother of the Senussi chief ruled in Fezzan; Sulaiman al-Baruni, a Berber chieftain who had given much trouble in 1912–13, reappeared (Sept. 1916) with a firman from the sultan of Turkey appointing him governor general of the vilayets of Tripoli, Tunis and Algiers; and Ramadan ash-Shitawi, another powerful chieftain, established a so-called republic of Tripoli and ruled at Misurata, which place became a German submarine base. There was, however, little cohesion and much jealousy among the opponents of Italy.

A campaign under the direction of the governor, Count Giuseppe Volpi, during 1922–23 restored Italian authority as far east as Misurata. It was extended southward to the Hammada al-Hamra in 1924, eastward over the Sirte desert in 1928 and southward again over the Fezzan in 1929–30. In Jan. 1935 the French government under Pierre Laval ceded to Italy a strip of territory 700 m. long and 40–90 mi. broad along the northern margin of the Tibesti massif. On Jan. 1, 1934, Tripolitania and Cyrenaica had been united to form the colony of Libya, and this was incorporated into the metropolitan kingdom of Italy on Jan. 9, 1939.

The Italian population of Tripolitania rose from 18,000 in 1921 to 90,000 in 1940, nearly half of these living in the capital while large agricultural colonies were settled in the comparatively fertile coastal area.

With the expulsion of the axis forces from North Africa in the spring of 1943, Tripolitania came under British military administration with local Arab and Italian councils, while the southern Fezzan oases had been occupied by the Free French and remained under French administration. The political situation was more complex than in Cyrenaica because of the large Italian minority and also because the Moslem population was less united in its views, since only a minority of Tripolitanian Moslems belonged to the Senussite sect. However, on Nov. 21, 1949, the United Nations general assembly decided that Tripolitania should form part of an independent and sovereign state of Libya. Accordingly, the British and French, who had progressively transferred authority to the embryo state, completed the transfer on Dec. 24, 1951, when the emir Mohammed Idris el-Mahdi es-Senussi became King Idris I of Libya. (*See* LIBYA.)

See Gordon Casserly, *Tripolitana* (London, 1943); Lord Rennell of Rodd, *British Military Administration in Africa, 1941–47* (London, 1948) (F. R. C., G. E. K.)

Economic Conditions.—Agriculture occupies at least 80% of the population, but, because of severe environmental limitations, production is low. It is estimated that only 11% of the land is potentially productive. Four-fifths of this productive land is fit only for grazing, and of the remaining fifth only 960,000 ac are used for static agriculture, 3,950,000 ac. being partly unused, partly occupied by shifting agriculture. Barley is the chief crop, being best suited to the severe conditions (average annual production under British administration, 66,000 metric tons), and there is some wheat (7,000 tons annually) and millet. There are 3,500,000 olive trees (yielding 9,000 tons of oil in 1951), of which 2,500,000 were planted by the Italians. Dates are important, forming a staple food in the southern oases, but quality is much inferior to that of Tunisian dates. There would seem to be about 1,500,000 palms in the north and as many as 10,000,000 in the Fezzan, giving an annual production of at least 30,000 metric tons. The Italians planted 300,000 citrus trees, and 80% more were planted after 1945; quality is high, and the export of oranges and tangerines had met with some success by the end of 1951. Other crops are almonds (1,800,000 trees and 2,000 tons in 1951), figs, peaches, apricots, peanuts, castor beans, henna, tobacco, vegetables and vines. There were 20,000,000 vines (mostly Italian-owned) in 1951, yielding more than 660,000 gal of wine annually. Animal husbandry is of great importance, and in 1950 livestock numbers were sheep 305,000, goats 324,000, camels 63,000, donkeys 33,000, cattle 31,000, horses 5,400. Industrial activities are small, many being carried on as local crafts. The main activity consists in the processing of agricultural and fishing products; olive- and castor-oil pressing, the canning of tunny and sardines, brewing and macaroni making. Textiles are mainly produced at home, but there are a few carpet and weaving factories in Tripoli and Misurata. Other activities are the collection of esparto grass, which grows wild in the Jabal and Jefara (18,000 tons in 1950; value £120,000), and fishing for tunny, sardines and sponges (1,500 tons of fish and 25 tons of sponges in 1950). Total exports in 1950 amounted to £2,350,000, imports to £4,600,000. An annual budgetary deficit was met by grants-in-aid from the British government during the period of British administration.

Development under the Italians.—The Fascist government (*see History*, above) spent about £20,000,000 in developing Tripolitanian agriculture. Two main types of farming grew up, concessions, which were moderately large farms financed by private firms; and demographic settlements organized on a communal basis. The concessions were a kind of small plantation, employing much Arab labour, the communal settlements were planned and subsidized by the state, and occupants (Italian immigrants) worked first as semilabourers and then as part owners and were finally to become full owners (after about 20 years) on liquidation of debt charges. No Arabs were employed. In 1949 there were still 7,400 Italians living in private concessions (covering an area of 314,000 ac.) and 11,000 in public settlements (240,000 ac.). Thus 60% of the land under static farming was in Italian hands when Tripolitania was incorporated into the predominantly Arab-Berber kingdom of Libya. The concessions were approximately self-supporting, but the settlements had depended on state subsidies.

Railways comprise 122 mi. of narrow-gauge line centred on Tripoli.

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TRIPOLITSA, officially TRIPOLIS, a town of Greece, capital of the nomarchy of Arcadia, 22 mi. S.W. of Argos. The name refers to the three ancient cities of Mantineia, Pallantium and Tegea, of which Tripolitsa is the modern representative. It does not stand on any ancient site. Before the War of Independence it was the capital of the Morea and the seat of a pasha, with about 20,000 inhabitants; but in 1821 it was sacked by the insurgents, and in 1825 its ruin was completed by Ibrahim Pasha. The town was later rebuilt; German troops captured it in April 1941. Pop. (1951 census) 17,585.

TRIPOLYE (KOMSOMOLYE), a town of the Ukrainian Soviet Socialist Republic, U.S.S.R., on the Dnieper river, 35 mi. south of Kiev, with which it has steamer communication. It is famous for its painted pottery of late Neolithic date; its site and others near by were explored by Chwojka and the name

Tripolye was given to the culture there represented This highly developed civilization probably dates from about 2750 B.C. Two types of pottery have been discovered, Tripolye A the grooved type, being the more common. Tripolye B, or painted pottery, is thought to be an imported product and both are considered to be contemporary Tripolye is mentioned in 1093 and later was inhabited by refugees from Kiev, after the capture of that city by the Mongols In the 17th century Tripolye was a fortress, and the remains of its walls still stand, as do two old churches built in the Ukrainian style. During the 1917–20 civil war it was the headquarters of the bandit chief Zeleny, who drowned 100 victims in the Dnieper. A battle ensued between the Communist Youth party (Komsomol) and the bandits and the town was re-named Komsomolye in memory of the Communist victims.

See M. Rostovtzeff, *Iranians and Greeks in South Russia*, 1922. H. J. E. Peake, and H. J. Fleure, *Priests and Kings*, 1927. V. G Childe, *The Dawn of European Civilization*, 1925. E. H. Minns, *Scythians and Greek*, 1913 *In Russian*: V. Chwojka, Article in vol I. p 736 of the Report of the XI. Russian Arch. Congress at Kiev, 1899, published in Moscow in 2 vols, 1901 and 1902. V. Chwojka, *The Ancient Dwellers in the Middle Dnieper*, Kiev, 1913. Gorodtsov, *Bytovaya Arkheologia*, Moscow, 1910. *Report of the Historical Museum of Moscow*, 1916.

TRIPTOLEMUS, an agricultural hero of Eleusis, first priest of Demeter, and founder of the Eleusinian mysteries. His name is of doubtful meaning ("he who ploughs or toils thrice"; *i.e.*, diligently?); in some legends he is the inventor of the plough. In the best known legend (Apollodorus, i.) Triptolemus was the son of Celeus, king of Eleusis, and Metaneira. Demeter, during her search for her daughter Persephone, arrived at Eleusis in the form of an old woman. Here she was hospitably received by Celeus, and out of gratitude would have made his son Demophon immortal by anointing him with ambrosia and destroying his mortal parts by fire; but Metaneira, happening to see what was going on, screamed out and disturbed the goddess. Demophon was burnt to death, and Demeter, to console his parents, took upon herself the care of Triptolemus, instructed him in everything connected with agriculture, and presented him with a wonderful chariot, drawn by dragons, in which he travelled all over the world, spreading the knowledge of her gifts. In another account (Hyginus, *Fab.* 147) Triptolemus is the son of Eleusinus, and takes the place of Demophon in the above narrative, but does not die. In the Homeric hymn to Demeter, Triptolemus is simply one of the nobles of Eleusis, who was instructed by the goddess in her rites and ceremonies. The Attic legend represented him as one of the judges of the underworld. He is often represented in art, and formed the subject of a play (now lost) of Sophocles. His altar and threshing-floor were shown on the Rarian plain near Eleusis; hence he is sometimes called the son of Rarus.

See Preller-Robert, i., 767, and the classical dictionaries.

TRIPTYCH, a painting, carving or other decorative design, executed on three compartments or panels, so constructed that the two wings may fold on hinges over the centre-piece (Gr. τριπτυχος, three-fold). The backs of the wing-pieces are often also painted, carved or otherwise decorated. The subject of the side-pieces are usually appropriate and subsidiary to that of the centre. The triptych is most frequently designed as an altar-piece. An earlier use of the term is for a set of three wooden or ivory writing-tablets, hinged or otherwise fastened together, the central tablet being waxed on both sides for the impression of the *stilus* or writing implement, the outer tablets only on the inside. The three tablets thus formed a small book.

TRIPURA (formerly called *Hill Tippera*), a feudatory State of India, adjoining the British district of Tippera, in Bengal. Area, 4,049 sq.mi.; pop. (1941) 513,010; estimated revenue Rs. 2,971,000 (including revenue from estates in British India). Tripura comprises six parallel ranges of hills running from north to south, at an average distance of 12 m. apart. The hills, of which the highest is 3,200 ft. above sea-level, are covered for the most part with forest and bamboo jungle, while the low ground abounds with trees of various kinds, canebrakes and swamps. The forests shelter wild elephants, bison, tigers, leopards and deer. The principal crop and food staple is rice. Half the population consists of Tiparas, a tribe of Mongolian origin. The capital is Agartala (pop 1941, 17,693), where there is an Arts college.

Tripura represents the remnant of an ancient kingdom which at various times extended in the north to Kamrup and in the east to Arakan Ralph Fitch, who travelled through the country in 1585, noted that "the king of Tippara had almost continual wars with the Arakanese." The country now included in the Tippera district was conquered by the Mughals and annexed in 1733, but Tripura still remained under its own line of rulers. When the East India company obtained the *diwani* or financial administration of Bengal in 1765, they placed a Rajah on the throne, and, since 1808, each successive ruler has received investiture from the British government. The present ruler is H. H. Maharajah Manikya Bir Bikram Kishore Deb Barman Bahaden, who succeeded in 1923.

The District Magistrate of Tippera is ex-officio Political Agent for the State, and the governor of Bengal acts as Agent of the Governor-General for supervising the administration.

TRISECTRIX: *see* CURVES, SPECIAL.

TRISTAN or **TRISTRAM,** one of the most famous heroes of mediaeval romance. In the earlier versions of his story he is the son of Rivalin, a prince of north-west Britain, and Blanchefloir, sister to King Mark of Cornwall Rivalin is killed in battle, and Blanchefloir, after giving birth to a son, dies of grief. The boy is brought up as his own by Roald, or Rual, seneschal of the kingdom, who has him carefully trained in all chivalric and courtly arts. With the possible exception of Horn, Tristan is by far the most accomplished hero in the whole range of knightly romance; a finished musician, linguist and chess-player, no one can rival him in more knightly arts, in horsemanship or fencing. He has besides, the whole science of *vénerie* at his fingertips In fact, Tristan is the "Admirable Crichton" of mediaeval romance; there is nothing he cannot do, and that superlatively well—it must be regretfully admitted that he is also a most accomplished liar. Being kidnapped by pirates, Tristan is carried to Cornwall where he finds his way to the court of his uncle, King Mark, who is at first unaware of his identity, but, on learning it, joyfully accepts him as nephew and heir He defeats the Irish giant, Morholt, who comes to claim the tribute payable every third year by Cornwall, but is desperately wounded in the encounter. Set adrift in a boat, Tristan is carried by the waves to Ireland, where he is healed by the queen, sister to Morholt. Later on he returns to ask the hand of the princess Iseult for his uncle, King Mark, and, having slain a dragon which is devastating the country, succeeds in his quest. On the homeward journey Tristan and Iseult, by misadventure, drink of the love-potion prepared by the queen for her daughter and King Mark. Henceforward the two are bound to each other by an imperishable love which dares all dangers and makes light of hardships. The greater part of the romance is occupied by plot and counter-plot; Mark and the courtiers seeking to entrap the lovers, who by their wiles escape the snares laid for them. Finally, the two are discovered under circumstances which admit of no evasion, and Tristan is obliged to flee to Brittany. There, believing himself to be forgotten, he weds Iseult of the White Hand, daughter of the duke, but makes her his wife only in name. Wounded by a poisoned weapon he sends to Iseult of Ireland to come and heal him. If she accedes to his request the ship on which she embarks is to have a white sail, if she refuses, a black. Actuated by jealousy, his wife, who has discovered his secret, seeing the ship approach on which Iseult is hastening to her lover's aid, tells him that it carries a black sail. Tristan, turning his face to the wall, dies, and Iseult, arriving too late to save her lover, yields up her life in a final embrace.

Whether or not this beautiful story reposes upon a genuine historic tradition, the legend of Tristan and Iseult was one of the most popular themes of mediaeval romance; it was translated into many tongues, and the episodes are preserved in miniatures, carvings and embroideries. The earliest form of the story is still a matter of debate. Prof. Zimmer held that the main incidents were of historic origin, dating from the period of the Viking rule in Ireland. The name of Iseult's father, Gormond, is certainly Scandinavian, and she herself is noted for her golden hair; she is a northern, not a Celtic, princess The name of Tristan, on the

other hand, has been referred to the Pictish Drustan, and the story is now generally admitted to be of insular origin. Some think that the story was first told in the form of short episodic *lais*, which were later on woven into longer poems. On the other hand that distinguished scholar, M. Bédier, maintains that there was but one poem at the root of all the varying versions of the *Tristan* story, and that that work, composed in the 12th century by an unknown Anglo-Norman poet, was of such force that it determined for all time the form of the tradition. There certainly was an important *Tristan* poem, composed in the 12th century by an Anglo-Norman named Thomas, which was translated into German, English and Scandinavian. Only fragments now remain, but they are sufficient to show that the original was a work of outstanding merit. The German translation, by Gottfried von Strassburg, which seems to have followed the original closely, is a very beautiful poem and one of the classics of the middle ages.

Besides the version of Thomas we have a fragment by a certain Béroul, also an Anglo-Norman, and a German poem by Eilhart von Oberge, both of which derive from a common source. There also exists in two mss a short poem, *La Folie Tristan*, relating how Tristan, disguised as a fool, visits the court of King Mark. This poem is valuable, as, relying upon the sufficiency of his disguise, Tristan audaciously gives a *résumé* of his feats and of his relations with Iseult, in this agreeing with the version of Thomas. The "Gerbert" continuation of the *Perceval* contains the working over of a short *Tristan* poem, called by him the *Luite Tristan;* the latter part, probably a distinct poem, shows Tristan, in the disguise of a minstrel, visiting the court of Mark.

Finally, in consequence of the popularity of the cyclic version of the Arthurian romances, the original *Tristan* story was worked over in prose form, and incorporated with the final version of the Arthurian legend, where it served to swell the already unwieldy bulk of the romantic *corpus* to an impossible extent. Little of the primitive story is here preserved, and its original tragic beauty is obscured by an interminable series of "banal" adventures. It was in this form that Malory knew it. Fortunately for the present generation the genius of Richard Wagner, inspired by the text of Gottfried von Strassburg, has restored the story to its earlier form, and enshrined it in imperishable music.

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TRISTAN DA CUNHA, the general name for a group of three small volcanic islands belonging to Great Britain, situated in the south Atlantic, the summit of the largest being in 37° 5′ 50″ S., 12° 16′ 40″ W. They are midway between the Cape of Good Hope province of the Union of South Africa and South America. The islands rise from the submarine elevation which runs down the middle of the Atlantic.

Tristan, the largest and northernmost island, has an area of 16 sq.mi., is nearly circular in form, about 9 mi in diameter, and has a volcanic cone (6,760 ft.), usually capped with snow, in the centre. Precipitous cliffs, 1,000 to 2,000 ft., rise from the ocean on all sides, except the north-west, where there is an irregular plateau of about 12 sq.m., 100 ft above the sea. A stream crosses the northern end of the plateau, falling over the cliff edge in a fine cascade. The crater of the central cone contains a fresh-water lake about 150 yd. in diameter. This and other crater lakes are said never to be frozen over.

Inaccessible island, the westernmost of the group, is about 20 m. from Tristan. It is quadrilateral in form, the sides being about 2 m long, with cliffs about 1,000 ft., its highest point (1,840) is on the west. At the base of the cliffs in some places are narrow fringes of beach.

Nightingale island, the smallest and most southern of the group, is 10 m from Inaccessible island. Its area is not more than 1 sq. m. Its coasts are surrounded by low cliffs, from which there is a gentle slope up to two peaks (1,100 ft. and 960 ft. high). There are two small islets—Stoltenhoff (325 ft.) and Middle (150 ft.)—and several rocks adjacent to the coast.

The rocks of Tristan da Cunha are basalt, porphyritic basalt, dolerite, augite-andesite, palagonite, volcanic tuff and ashes. A block of gneiss in the crater indicates a continental foundation of the island. The caves in Nightingale island indicate that it has been elevated several feet. On almost all sides the islands are surrounded by a broad belt of kelp, the gigantic southern seaweed (*Macrocystis pyrifera*), through which a boat may approach the rocky shores even in stormy weather. There is no good anchorage in rough weather.

The prevailing winds are westerly. December to March is the fine season. The climate is mild and on the whole healthy, the temperature averaging 68° Fahr in summer, 55° in winter—sometimes falling to 40°. Rain is frequent; hail and snow fall occasionally on the lower grounds. The sky is usually cloudy. The islands have a cold and barren appearance. The tide rises and falls about 4 ft.

History.—The islands were discovered in 1506 by the Portuguese admiral Tristão da Cunha. Thereafter the islands (which were uninhabited) were occasionally visited by outward bound ships to the Indies. Attempts to form settlements were made by the Dutch in 1656, and by the English East India company a few years later, but the first permanent inhabitant was one Thomas Currie, who landed on the island in 1810. At this time American whalers frequented the neighbouring waters and, in the same year, an American named Lambert and a man named Williams made Tristan their home, but they were drowned while out fishing in May 1812. Currie was joined by two other men and they busied themselves in growing vegetables, wheat and oats, and in breeding pigs. Because of the fear that the islands might become a base for rescuing Napoleon from St. Helena, a temporary garrison was placed on Tristan, the group being formally annexed to Britain on Aug. 14, 1816. The following year the troops were withdrawn, and when they left, William Glass, his wife and two children and two masons were left behind, and shipwrecked mariners, coloured women from Cape Colony, and British, Dutch, Italian and Asiatic settlers have since made their home there. The settlers grew wheat (since made impossible owing to the ravages of rats), raised cattle, sheep and pigs, grew apples and peaches, and engaged in seal fishing. They had of necessity to make their settlement on the plain on the north-west of Tristan; here a number of substantial stone cottages and a church were built. It is named Edinburgh in memory of a visit in 1867 by the duke of Edinburgh. Several scientific expeditions have visited Tristan, the first being that of the "Challenger" in 1873, and the last one before outbreak of World War II being that of the Norwegian, Erling Christophersen, in 1938. In 1880 the population was 109; by 1897 the figure had fallen to 64, but by 1939 the inhabitants numbered 180. The inhabitants have declined repeated invitations to leave the island. They manage their own affairs under the direction of a headman (first appointed in 1933), who is chairman of the island council. The inhabitants are moral, without intoxicating liquors, religious, hospitable to strangers, well mannered and industrious, healthy and long-lived. The spiritual and educational welfare of the islanders is the responsibility of successive chaplains who have volunteered for the work. Life on Tristan is a hard one; the potato is the chief food, and fuel is very scarce. The men are daring sailors, and in small canvas boats of their own building voyage to Nightingale and Inaccessible islands. In 1938 the islands of Tristan da Cunha, Inaccessible, Nightingale and Gough were made dependencies of the colony of St. Helena.

Gough Island.—Gough island or Diego Alvarez lies in 40° 20′ S., 9° 44′ W., and is 220 mi. S.S.E. of Tristan da Cunha. It is of volcanic origin, is rugged and mountainous, the highest peak rising to 4,380 ft. The island is about 8 mi. long by 4 mi. broad. Pre-

cipitous cliffs, from 200 to 1,000 ft. high, characterize the coast They are divided by picturesque valleys. Streams fall over the cliffs into the sea in fine cascades. Three species of plants are found only on Gough, one of them named *Callitriche Christensens* for its finder, Lars Christensen. The island also has unique animals; it is the breeding place of the giant wandering albatross; and it is the most northerly point at which the giant petrel of the Antarctic is found. There are vast numbers of penguins and crayfish, and valuable guano deposits. It is also the home of numerous seals. Originally called Diego Alvarez, it derives its other name from a Captain Gough who visited it in 1731. It has been claimed as a British possession since the annexation of Tristan da Cunha in 1816, and with the Tristan group became a dependency of the colony of St. Helena in 1938

The island has been visited by several scientific expeditions, and on a few occasions it has harboured the crews of shipwrecked vessels. It has no permanent population.

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TRITON, the Greek merman, son of Poseidon and Amphitrite. According to Hesiod (*Theog.* 930), he dwelt with his parents in a golden palace in the depths of the sea. The story of the Argonauts places his home on the coast of Libya. When the Argo was driven ashore on the Lesser Syrtes the crew carried the vessel to Lake Tritonis, whence Triton, the local deity, guided them across to the Mediterranean (Apollonius Rhodius iv. 1552). He was represented as human down to the waist, with the tail of a fish, but ancient artists portray other and more fantastic seacreatures as well. His special attribute was a twisted seashell, on which he blew to calm or raise the waves Various stories (as Virgil, *Aen.*, VI., 171, Pausanias, IX., 20, 4–5) represent him as jealous or violent.

See F. R. Dressler, *Triton und die Tritonen* (Wurzen, 1892); Preller, *Griechische Mythologie* (4th ed. 1894).

TRITUBERCULATA or **PANTOTHERIA,** a group of very small insect-eating mammals from the Jurassic rocks, characterized by the sharp-cusped lower molar teeth with a posterointernal heel (tuberculo-sectorial type). Some of them, such as *Amphitherium*, are, perhaps, the ancestors of all modern mammals except the platypus and echidna (Monotremata, *q.v.*). *See* MAMMALIA; MULTITUBERCULATA; PALAEONTOLOGY.

TRIUMPH, the highest honour bestowed in Rome upon a victorious general (Lat. *triumphus*). It was only granted on certain conditions, relaxed in special cases. Only those who held the office of dictator, consul, or praetor were entitled to the distinction; the war must have been brought to a definite conclusion, resulting in an extension of the boundaries of the state; the victory must have been gained over a foreign enemy. The power of granting a triumph rested with the senate Special legislation was necessary to keep the general in possession of the *imperium* on his entry into the city. Without this, his command would expire and he would have no right to a triumph. He remained outside the city limits until the ordinance was passed; Lucullus on his return from Asia waited outside Rome three years.

The triumph, a solemn procession, starting from the Campus Martius, passed through the city to the Capitol. The streets were adorned with garlands, and the procession was greeted with shouts of *Io triumphe* At its head were the magistrates and senate, followed by trumpeters and then by the spoils, (arms, standards, statues, etc., representations of battles, and of the towns, etc., of the conquered country). Next came the victims destined for sacrifice, especially white oxen with gilded horns. They were followed by the prisoners kept to grace the triumph. The chariot of the victorious general (*triumphator*) was crowned with laurel and drawn by four horses. The general was attired like the Capitoline Jupiter in robes of purple and gold; in his right hand he held a laurel branch, in his left an ivory sceptre surmounted by an eagle Above his head the golden crown of Jupiter was held by a slave, who reminded him in the midst of his glory that he was a mortal man. Last came the soldiers shouting *Io triumphe*. On reaching the temple of Jupiter on the Capitol, the general placed the laurel branch on the lap of the image of the god, and offered the thank-offerings. A feast of the magistrates and senate concluded the ceremony. Under the empire only the emperors celebrated a triumph, because the generals commanded under the auspices of the emperors as lieutenants (*legati*); the only honour they received was the right of wearing the triumphal insignia (the robes of purple and gold and the wreath of bay leaves) on holidays The last triumph recorded is that of Diocletian (A D 302) A naval triumph was sometimes allowed for victories at sea, the earliest being that celebrated by C. Duilius for his victory over the Carthaginians in 260 B.C.

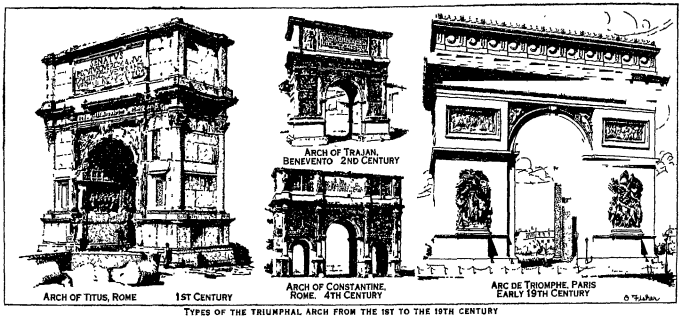
See Marquardt, *Römische Staatsverwaltung* (1884); Mommsen, *Römisches Staatsrecht* (1887); J. E Sandys, *Companion to Latin Studies* (1921).

TRIUMPHAL ARCH, originally an arch built to commemorate a victory of a Roman general, but more commonly used, in a broader sense, for any monumental arch built for purely commemorative or even decorative purposes. The term is also used for the great arch between the nave and apse or the nave and transepts of an early Christian basilica. It is probable that temporary structures spanning a road or street were built by many peoples of antiquity to celebrate the homecoming of a victorious army, but it was the Romans who first made such arches permanent monumental structures, broadened their use for general memorial purposes, and even applied them to the monumental gates of cities and towns. Obviously the building of such a structure as the developed Roman arch would occupy too much time to admit of its being used for the actual triumphal procession that it celebrated; it was, therefore, originally, probably a reconstruction in stone of an earlier, temporary archway.

Although no existing triumphal arches are earlier than the empire, it is known that there was, in the Forum, close to the regia, an arch commemorating the victory of Fabius Maximus Allobrogicus over the barbarians of Savoy in 121 B.C Augustus built a triumphal arch on the Via Sacra, commemorating the victory of Crassus over the Parthians. From that time on there was hardly an emperor who did not build a triumphal arch somewhere in Rome The greater number of these have perished, but those of Titus (completed under Domitian *c.* A.D. 80), of Septimius Severus (203–205) and that of Constantine (312), which incorporates much sculpture taken from the earlier arch of Trajan, still remain in good preservation. Many smaller monumental arches also exist in Rome. Both emperors and private citizens built them in all the important centres of the empire. Monumental gateways of triumphal arch type exist in many places in Syria, like that probably of the time of Hadrian at Palmyra, and certain city gates were given the importance of a triumphal arch, especially that of Autun, France (probably 3rd century A.D) and the Porta Nigra at Trier (4th century).

In the earlier arches, the arch is the most important element, usually with simple stretches of wall on either side. The orders appear only as minor decorative features, either under the arch impost, as at Saintes, or as flat pilasters, carrying a crowning entablature, and placed at the corners of the structure, as at S. Chamas. Only in the arches of Augustus, as at Susa and Aosta do engaged columns appear, and even then, still as minor decorative elements. It was in the arch of Titus, at Rome, that the later definite arrangement was worked out, in which the columns project boldly, on high pedestals, and carry an entablature that casts a strong shadow. Moreover, arch spandrils are sculptured, and the interior faces of the passage bear remarkable high relief panels, showing the seven branch candlestick and the other trophies of the capture of Jerusalem

In the triple arch of Septimius Severus, the attic projects out over the end columns, the inscription runs through from end to end, so that the central columns are left without apparent work to do. In the arch of Constantine, on the other hand, the free-standing columns have become, like the pilasters of the early examples, purely decorative features, and each supports a colossal statue, so that despite the crudity of much of the workmanship, this arch gives the most satisfactory effect of any



TYPES OF THE TRIUMPHAL ARCH FROM THE 1ST TO THE 19TH CENTURY

of the later arches in Rome. The Arch of Trajan at Timgad reveals another interesting attempt to relate free-standing columns to the body of an arch by connecting the two columns of each outer pair with a curved pediment, the attic over the central arch running up to a higher level. The triumphal arch of the early Christian basilica is chiefly remarkable as the position for some of the richest and most beautiful of the wall mosaics that were the chief form of interior decoration. (*See* BASILICA; BYZANTINE AND ROMANESQUE ARCHITECTURE; MOSAIC.)

There is an interesting early Renaissance triumphal arch at Naples (1453–70), to commemorate the entrance of Alphonso I into Aragon, designed by Pietro di Martino The most interesting Renaissance and modern triumphal arches are, however, of later date. The Porte Saint-Denis (1672–73), by Blondel and the Porte Saint-Martin (1674–75), by Bullet, both in Paris, depart from the Roman scheme and substitute trophies and reliefs for the orders which the Romans used. Of the more Roman type is the Arc de Triomphe du Carrousel, Paris (1805), by Percier and Fontaine, based on the arch of Septimius Severus. The Sieges Thor at Munich (1843–50), by Gaertner and Metzger, and the Marble arch in London, designed in 1828 by John Nash for an entrance to Buckingham palace and moved to its present position in 1851, are both closely imitated from the Arch of Constantine. The triple arch and screen at Hyde Park corner, London (1828), by Decimus Burton, is a freer design, but still in the Roman manner.

Another noteworthy modern arch is the Washington arch, New York city, by McKim, Mead and White, originally constructed in temporary materials in 1889 in celebration of the 100th anniversary of Washington's inauguration, later reconstructed in marble and completed 1895. By far the largest of all triumphal arches and the most beautiful of modern examples is the Arc de Triomphe de l'Étoile at Paris (begun 1805 from designs by Chalgrin, but not completed till 1836) It is remarkable for its architectural proportions and the great scale and almost stark grandeur of its sculpture, which emphasizes its great width of 147 ft. and height of 160 ft. Under the arch is the tomb of the "Unknown Warrior," over which burns the continuous "Flamme du Souvenir." (T. F. H.)

TRIVANDRUM, a city of southern India, capital of the state of Travancore-Cochin, 2 mi. from the seacoast. Pop. (1941) 128,365. It is the residence of the maharaja, and contains an observatory, a museum and zoological gardens Its chief fame centres upon an old temple in the fort, a great resort of pilgrims, round which the city grew up. The city contains the maharaja's law college, a Sanskrit college, a woman's college, technical and training schools and a hospital and medical school

TRIVIUM, in mediaeval educational systems, the curriculum which included grammar, rhetoric and logic (Lat for crossroad, *i.e.*, where three roads meet, from *tres*, three, and *via*, road). The trivium and the quadrivium (arithmetic, music, geometry and astronomy) together made up as the seven liberal arts

TRNAVA, a town in Slovakia, on the river Trnava, was transferred from Hungary to Czechoslovakia by the treaty of Trianon, 1920. It is a market town for a rich agricultural region. Manufactures include sugar refining, starch, beer, shoes and, oldest of all, cloth, fertilizers are also prepared. Pop (1930), 23,971

TRNOVO [TIRNOVO], a city and capital of a department in Bulgaria; 124 mi. E.N E of Sofia, on the Yantra river, on the Trans-Balkan railway, which joins the Sofia-Varna line at Gorna-Orehovitsa, 8 mi. N. of Trnovo. Pop. (1934) 14,100. The city is remarkably situated. The Yantra runs in a deep gorge, doubling first left, then right, round two promontories which stand like high fortresses, surrounded by water on three sides The first of these, the Tsarevitsa, is connected with the rest of the town by a high causeway, in part a bridge; the other, the Trapesitsa, is entirely isolated. The inhabited town covers the two sides of the rooflike ridge which terminates in the Tsarevitsa. On the latter are a ruined tower, known as Baldwin's tower, where the Frank emperor is supposed to have been imprisoned, and, behind it, the somewhat unimposing remains of the palace of the Asens (*q.v.*). Few of these ruins have been excavated The Trapesitsa contains the fragments of several mediaeval churches in the Byzantine style

Trnovo is believed to have been a Roman fortress, it was the birthplace of Tsar Sisman, and the home of the second Bulgar empire, proclaimed there in 1185 by the brothers Peter and Ivan Asen, who were boyars of the Tsarevitsa and Trapesitsa. It was capital of Bulgaria 1186–1394, when it was adorned with great splendour; most of the relics were destroyed in the earthquake of 1911. It was the seat of the Bulgarian patriarchate from 1232 to its abolition in 1767. Trnovo was taken by the Turks on July 17, 1394. It remained, however, a commercial centre It was captured by Russia in 1877. Prince Alexander of Battenberg was there proclaimed Bulgarian prince (1879). There the Bulgarian constituent assembly sat and the independent kingdom of Bulgaria was proclaimed in the Church of the Forty Martyrs (Oct. 5, 1908) (*see* BULGARIA: *History*). (C. A. M.)

TROAD: *see* TROY AND TROAD.

TROCHEE or CHOREE, literally the "running" or "dancing" foot (– ⏑) (Gr. τρέχειν, to run, and χορός, a band of dancers). Trochaic metre is of several kinds, usually described by the number of *metra*, or groups of two trochees, which they contain,

as the dimeter:

Rōma Rōma, | cernĕ quantă
Comrades, leave mĕ | here a little

consisting of two *metra* or four trochees. The commonest form, especially in ancient drama, is the *tetrameter catalectic* or *septenarius* (four *metra* or eight trochees, lacking the final syllable), as

Rōmă Rōma, | cernĕ quantă | sit dĕum benignĭtas
Comrades, leave mĕ | here a little, | while as yet 'tis | early morn.

TROCHOPHORE or **TROCHOSPHERE,** the names applied to the free-swimming larval form of the segmented worms or Annelida (*q.v.*) and to the very similar (first) larval stage of the Lamellibranchia (bivalves) and Gastropoda (univalves) (*qq.v.*) among the Mollusca (*q.v.*).

TROCHU, LOUIS JULES (1815–1896), French general, was born at Palais (Belle-Ile-en-Mer) on March 12, 1815. He served as a captain in Algeria and as a colonel throughout the Crimean campaign. He commanded a division in the Italian campaign of 1859. In 1866 he was employed at the ministry of war in the preparation of army reorganization schemes, and he published anonymously in the following year *L'Armée française en 1867*, a work inspired with Orleanist sentiment, which brought him into bad odour at court. He left the war office on half-pay, and was refused a command in the field at the outbreak of the Franco-German War. After the earlier disasters in 1870, he was appointed by the emperor first commandant of the troops of Châlons camp, and soon afterwards (Aug. 17) governor of Paris and commander-in-chief of all the forces destined for the defence of the capital, including some 120,000 regular troops, 80,000 mobiles, and 330,000 National Guards. He put Paris in a state of defence, and showed himself a master of the passive defensive. At the revolution of Sept. 4, he became president of the government of national defence. His "plan" for defending the city failed; the successive sorties were unsuccessful, and when capitulation became inevitable he resigned the governorship of Paris on Jan. 22, 1871 to General Vinoy, retaining the presidency of the government until after the armistice in February. He was elected to the National Assembly by eight departments, and sat for Morbihan. In July 1872 he retired from political life, and in 1873 from the army. He published in 1873 *Pour la vérité et pour la justice*, in justification of the government of national defence, and in 1879 *L'Armée française en 1879, par un officier en retraite.* He died at Tours on Oct. 7, 1896.

TROELSTRA, PIETER JELLES (1860–1930), Dutch Socialist leader, was born at Leeuwarden and educated for the legal profession at the University of Groningen, but early abandoned it for politics and journalism. He adopted Socialist opinions and becoming dissatisfied with the leadership of Domela Nieurenhuis, under whom Dutch Socialism had assumed an extremist complexion bordering on anarchism, he founded the Social Democratic Workers' Party in 1894 for the constitutional achievement of Socialism. In 1913, the Liberal party offered the Socialists three seats in a government which would include in its programme universal suffrage and old age pensions. This Troelstra refused, on the assumption that the entrance of the Socialists into the government would strengthen the opposition to universal suffrage. His point of view was approved by the conference of the party. At the elections of 1918, as a result of the introduction of universal suffrage, the Socialists scored important gains, and their parliamentary influence on the German revolution. There followed a remarkable speech in the Chamber, called upon the government to treat with a view to the formation of a new state. The leading members of his party regarded Troelstra's pressure as premature, but it was brought to bear upon the government which resulted in the eight-hour day and other reforms. Troelstra's influence with the proletariat increased rapidly, until in 1925, owing to failing health, he retired from politics.

TROGIR or **TRAU,** a seaport of Dalmatia, Yugoslavia. Pop. (1931) 23,525. The town is built upon an island connected with the mainland by a bridge. The Venetian loggia is a fine specimen of a 16th century court of justice; and the cathedral is one of the glories of Dalmatia. It is Hungarian Gothic, and founded in 1200, was only completed in 1450. Trau has some trade in fruit and wine, the fertile soil producing vines, figs, pomegranates and olives. The chief industries are the weaving of *rascia*, a coarse blue serge, and metal work.

Tragurium, by which name it was known to the Romans, was probably colonized about 380 B.C. by Syracusan Greeks from Lissa, and its name is sometimes derived from τράγηλος, a place near Syracuse. In 998 it submitted to Venice; but in 1105 it acknowledged the supremacy of Hungary, while retaining its municipal freedom, and receiving, in 1108, a charter which is quoted by Lucio. After being plundered by the Saracens in 1123, it was ruled for brief periods by Byzantium, Hungary and Venice. In 1242 the Tatars pursued Bela IV of Hungary to Trau, but were unable to storm the island city, which remained in the possession of Hungary till 1413. The Italians attempted to take possession of the town at the close of World War I, but were driven out by the inhabitants, 99% Slavs. After Germany's Balkan successes in World War II, Italy occupied the port (1941).

See T. G. Jackson, *Dalmatia, the Quarnero, and Istria* (Oxford, 1887); E. A. Freeman, *Sketches from the Subject and Neighbour Lands of Venice* (London, 1881); and G. Lucio, *Memorie istoriche in Trago, ora detto Trau* (Venice, 1673).

TROGLODYTES, "cave-dwellers," a name applied by ancient writers to different tribes in various parts of the world. Strabo speaks of them in Moesia, south of the Danube (vii. 318), in the Caucasus (xi. 506), but especially in various parts of Africa from Libya (xvii. 828) to the Red Sea. The troglodyte Ethiopians of Herodotus (iv. 183) in inner Africa, very swift of foot, living on lizards and creeping things, and with a speech like the screech of an owl, have been identified with the Tebus of Fezzan. According to Aristotle (*Hist. An* viii. 12) a dwarfish race of Troglodytes dwelt on the upper course of the Nile, who possessed horses and were in his opinion the Pygmies of fable. But the best known of these African cave-dwellers were the inhabitants of the "Troglodyte country" (Τρωγλοδυτική) on the coast of the Red Sea, as far north as the Greek port of Berenice, as recorded by Diodorus (iii. 32) and Photius (p. 454 Bekker) from Agatharchides of Cnidus, and by Artemidorus in Strabo (xvi. 776).

They were a pastoral people, living entirely on the flesh of their herds, or, in the season of fresh pasture, on mingled milk and blood. But they killed only old or sick cattle (as indeed they killed old men who could no longer follow the flock), and the butchers were called "unclean." They gave the name of parent to no man, but only to the cattle which provided their subsistence. They went almost naked; the women wore necklaces of shells as amulets. They practised circumcision or an operation of a more serious kind. The dead body, its neck and legs bound together with withies of the shrub called *paliurus*, was set up on a mound, and pelted with stones amidst the jeers of the onlookers, until its face was completely covered with them. A goat's horn was then placed above it, and the crowd dispersed with manifestations of joy.

TROGON, the name of birds forming the family Trogonidae. The trogons are birds of moderate size, the smallest hardly bigger than a thrush, the largest less bulky than a crow. The bill is wide at the gape, which is beset by recurved bristles. They seize most of their food on the wing. Their flight is short, rapid and spasmodic. Their feet are weak and of a unique structure, the second toe, which in most birds is the inner anterior one, being reverted; in all other birds that have two toes before and two behind, the outer toe is turned backward. The plumage is beautiful and characteristic, and the glory of the group culminates in the quezal (*q.v.*). The plumage is further remarkable for the absence of down and for the large size of its contour-feathers, which are extremely soft and so loosely seated as to come off in scores at a touch. The tail is a characteristic feature, the rectrices being often curiously squared at the tip. The nidification of these birds is in holes of trees, wherein are laid without any bedding two roundish eggs, generally white, but certainly in one species (quezal) tinted with bluish green.

The trogons form a very well-marked family of Coraciiform

birds placed near the colies (*see* COLY) and swifts (*q.v.*). The remains of one have been found in the Miocene of France. This discovery seems to account for the remarkable distribution of the trogons at the present day. While they chiefly abound in the tropics of the New World, they occur too in the tropical parts of the Old. About sixty species are recognized, which J. Gould in the second edition of his *Monograph* of the family (1875) divides into seven genera

TROGUS, GNAEUS POMPEIUS, Roman historian from the country of Vocontii in Gallia Narbonensis, nearly contemporary with Livy, flourished during the age of Augustus. The name Pompeius was adopted by his grandfather, who received the citizenship from Pompey. Trogus' books on natural history are frequently quoted by Pliny; his principal work, however, was *Historiae Philippicae* in 44 books, so called because the Macedonian empire founded by Philip is the central theme of the narrative. This was a general history of the world, or rather of those portions of it which came under the sway of Alexander and his successors. Of this great work, we possess only the epitome by Justin, the *prologi* or summaries of the 44 books, and fragments. But even in its present mutilated state it is often an important authority for the ancient history of the East. Ethnographical and geographical excursuses are a special feature of the work.

Fragments edit. by A. Bielowski (1853); *see* also, A. H. L. Heeren, *De Trogi P. fontibus et auctoritate* (prefixed to C. H. Frotscher's edition of Justin), A. Enmann on the authorities used by Trogus for Greek and Sicilian history (1880); A. von Gutschmid, *Über die Fragmente des Pompeius Trogus* (1857); M. Schanz, *Geschichte der römischen Litteratur* (2nd ed., 1899), ii., where all that is known of Trogus is given; and article *JUSTIN*.

TROIA, a town and episcopal see of Apulia, Italy, in province of Foggia, 1,440 ft. above sea level, 7 mi N.W. of the station of Giardinetto-Troia, which is 16 mi. S.W. of Foggia. Pop. (1936) 7,037 (town), 7,334 (commune). It is on the site of the ancient Aecae, 12 mi. S. of Luceria, on the Via Traiana. Troia was itself founded in 1017 by the Greek prefect Basilius Bugianus. The cathedral dates from 1107, but the upper part of the façade with its rich sculptures, fine rose-window and polychromatic decoration, the choir apse and the interior were restored early in the 13th century. The bronze doors, partly in relief and partly in niello (1119–1127) were cast in Benevento by Oderisus.

TROILUS, in Greek legend, son of Priam (or Apollo) and Hecuba. In the *Iliad* (xxiv., 257) he is already slain before the action of the poem commences. According to a non-Homeric tradition (*e.g.*, Virgil *Aen.* i. 474), when a mere boy he fell by the hand of Achilles. In another account he was dragged to death by his own horses. His death formed the subject of a lost tragedy by Sophocles. The story of Troilus and Cressida (Caxton, Chaucer, Shakespeare, etc.) is entirely mediaeval.

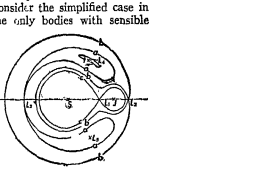
TROITSK, the name of several Russian settlements, the most important of which is the town of Troitsk in the Uralsk Area, in 54° 4′ N., 61° 35′ E., on the Ui, a tributary of the Tobol. Pop. (1926) 29,643. A fort was erected here in 1743, which became a centre for trade with the Kirghiz steppe and Turkestan. A branch railway now links the town with Chelyabinsk and Sverdlovsk, and it is on the great Siberian road It has tanneries and flour-mills, the latter supplying the Ural mining district.

TROITSKOSAVSK, a town of Asiatic Russia, in the Buriat-Mongol A S S R., in 51° 28′ N., 106° E., on the Kyakhta river near its junction with the navigable Selenga, which forms a waterway from Asiatic Russia to Mongolia. Two miles south of it is Russian Kyakhta, on the frontier, which adjoins Chinese Kiakhta or Mai-mai-Chên, a walled town with a large marketplace, and 10 mi. N., at the confluence of the Kyakhta and Selenga, is Ust-Kyakhta. It was formerly the great route by which Chinese tea entered Russia; and its December fair, when Russian leather, furs and wool were exchanged for tea, was very important. From 1689 to 1727 the trade was a government monopoly, but from then till 1860 trade was thrown open to private merchants and as all trade across the Chinese frontier was by law compelled to pass through it, the town increased greatly in importance. In 1860, however, the whole frontier was declared open, and Kyakhta declined; the Transbaikal railway further diminished its importance The combined population of Troitskosavsk and Kyakhta was only 12,000 in 1938. Gold and osmiridium are found in the district, and salt is worked. A railway is projected to link Verkhne-Udinsk with Kyakhta, and this might restore the prosperity of the town, as there is a great market for leather in Mongolia, which has no tanneries; raw hides are often sent via this route to be dressed and re-exported. The altitude is 2,600 ft., and the climate severe (average January temperature, −18·4° F, average July, 67·1° F, and of the annual rainfall of 11 in., 7·5 fall in July and August). The town was a storm centre in the post 1917 period, and was the scene of the massacre of 800 Bolshevik prisoners in 1920 by order of the Cossack ataman Semyonov.

TROJAN PLANETS, a group of asteroids revolving around the sun in the same period as Jupiter. Achilles, the first member of the group, was discovered on Feb. 22, 1906, by Prof Max Wolf in the course of a systematic search for new asteroids that was carried on by photography at the Königstuhl observatory, Heidelberg.

The orbit was calculated by Dr. Berberich at the Berlin Rechen-institut; he found that its period was almost exactly that of Jupiter. Thereupon Prof. C V. L. Charlier, of Lund observatory, noting that Achilles was about 55½° in front of Jupiter, as seen from the sun, suggested it was an example of one of the particular cases of planetary motion deduced by Joseph Louis Lagrange in 1772. Until 1906 these results had been of mathematical interest only.

Lagrange's work dealt with the general problem of three bodies. For the present purpose we may consider the simplified case in which the sun and Jupiter are the only bodies with sensible masses, the orbit of Jupiter being considered circular. The figure represents schematically a co-ordinate system rotating with Jupiter's period in which the sun, S, and Jupiter, J, will occupy fixed positions. A planet located in any of the three points L_1, L_2 or L_3 on the line joining S and J, or at either of the points L_4 or L_5, which form equilateral triangles with S and J, if started with an appropriate velocity, will then continue to occupy the same position relative to the sun and Jupiter. The straight-line solutions are unstable and of little practical importance, though it has been suggested that the *Gegenschein* or counterglow, may be due to particles in the neighbourhood of a point L_2 connected with the sun and the earth. The greater practical significance of the equilateral solutions is due to the fact that these solutions are stable in the sense that small oscillations about these positions exist provided that the ratio between the masses of S and J is greater than 25·96. This condition is certainly satisfied by the sun and Jupiter, where the mass ratio is approximately 1,047. The oscillations about the triangular points fall into two classes; (1) an oscillation, called the libration, with a period of about 148 years for small amplitudes, increasing with the amplitude; (2) oscillations with approximately the same period as that of Jupiter's revolution, about 11.86 years.



Libration path of a Trojan planet and limiting orbits related to this type of planetary motion. The sun, S, and Jupiter, J, occupy fixed positions. A planet located in any of the three points L_1, L_2, L_3, or at L_4 and L_5 (which form equilateral triangles with S and J), will then continue to occupy the same position relative to the sun and Jupiter. If started with an appropriate velocity. The sequence of orbits is shown schematically

Oscillations of this second type correspond to the eccentricity and inclination of the asteroid. In the case of Achilles these are approximately 0·15 and 11° respectively. If the oscillations of class (2) are ignored, the path of Achilles may be represented by the small elongated arc *s* about the equilateral point L_4.

Achilles did not long remain the sole example of this type of motion. Within a year two additional asteroids of this group were found. By subsequent discoveries the membership of the group stood at 12 in 1944, the latest addition having been made in 1937. All were discovered at the Königstuhl observatory. Of the 12 known members, 7 asteroids—588 Achilles, 624 Hector, 659

Nestor, 911 Agamemnon, 1,143 Odysseus, 1,404 Ajax, and 1,437 Diomedes—are in the neighbourhood of the triangular point L_4 which is 60° ahead of Jupiter (greater longitude). Five asteroids —617 Patroclus, 884 Priamus, 1,172 Aeneas, 1,173 Anchises and 1,208 Troilus—are about 60° behind Jupiter.

The name Trojan planets or Trojan asteroids is derived from the circumstance that the members of this group have received names taken from the *Iliad* of Homer. Unfortunately, the obvious plan of giving Greek names to those on one side, Trojan names to those on the other, was not followed, but it would cause confusion to change now. As a group they belong among the fainter known asteroids. A comparison in size with other equally faint asteroids requires making allowance for the greater distance of a Trojan planet from the sun and the earth. If equality of reflecting power is assumed it is found that a Trojan planet appears as faint as an asteroid having only one-fourth its diameter, but located within the principal ring between the orbits of Mars and Jupiter. Notwithstanding their faintness, therefore, the Trojans rank among larger asteroids.

The first investigations on the mathematical theory of the motions of the known Trojans were by L. J. Linders (1908). The most complete analysis of the problem yet made is by Prof. E W. Brown (1923) and later by E. W. Brown and C. A. Shook (1933). Of considerable interest is the effect of the attractions by Saturn upon the motion of a Trojan asteroid. Brown found that perturbations in the motion of Jupiter with a period which is long compared with the libration period are impressed upon the Trojan planet; and that the action of Jupiter prevents it from having very large direct perturbations of very long period due to other planets.

Sequence of Orbits.—The Trojan asteroids that have been discovered show amplitudes of the libration up to about 20°. Brown developed methods for dealing with such cases and those of still larger amplitude. He investigated the problem further in its simplified case in which it is assumed that Jupiter's orbit is circular. The orbits considered are those that lie in the same plane as the orbit of Jupiter, and that are free from the eccentricity type of oscillation. The sequence of orbits is illustrated schematically in the figure.

Beginning with a planet at either L_4 or L_5, one obtains orbits of moderate amplitudes, such as t in elongated paths surrounding L_4 or L_5. For greater amplitudes the path becomes less and less symmetrical, extending farther away from J than toward J. This type of orbit ends in an orbit a that has a cusp in the point L_3. Beyond this limiting type the orbits have the shape of a horseshoe, surrounding L_3, L_4, and L_5, and coming to a conclusion in the orbit b which has a cusp at L_2.

Extending the sequence, there are two continuations: (1) orbits that lie wholly outside b and which are therefore simple periodic orbits surrounding both masses S and J, and (2) orbits of an hourglass shape that lie between b and c. Again, c is a limiting type, with a cusp in L_1, beyond which the orbits separate into orbits surrounding S only or orbits surrounding J only.

All the orbits considered here are members of one single family of periodic orbits, namely, those that correspond to the circular solution in the problem of two bodies. It is interesting and significant that the curves show such great similarity with the "curves of zero velocity" in the restricted problem of three bodes (*see* Celestial Mechanics).

Unfortunately, the limiting cases that separate the different types of motion present great difficulties in analytical treatment. Therefore no certain information exists concerning the possibility that the action of other planets, and especially Saturn, may cause a Trojan to change into a non-Trojan or, conversely, change an orbit circling around the sun or Jupiter, or both, into a Trojan type.

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TROJAN WAR: *see* Troy and Troad.

TROLLE, HERLUF (1516–1565), Danish naval hero, was born on Jan. 14, 1516, at Lillo. At the age of nineteen Trolle went to *Vor Frue Skole* at Copenhagen, subsequently completing his studies at Wittenberg, where he adopted the views of Melanchthon, with whom he was in intimate correspondence for some years. His marriage with Brigitte, the daughter of Lord Treasurer Mogens Gjöe, brought him a rich inheritance, and in 1557 he took his seat in the senate. Both Christian III. and Frederick II. had a very high opinion of Trolle's trustworthiness and ability and employed him in various diplomatic missions. Trolle was, indeed, richly endowed by nature, and his handsome face and lively nature made him popular everywhere. His one enemy was his wife's nephew, Peder Oxe, the subsequently distinguished finance minister, whose narrow, grasping ways, especially as the two men were near neighbours, did not contribute towards family harmony. In 1559 Trolle was appointed admiral and inspector of the fleet, and in 1563 he superseded the aged Peder Skram as admiral in chief. On May 10 he put to sea with twenty-one ships of the line and five smaller vessels and, after uniting with a Lübeck squadron of six liners, encountered, off the isle of Öland, a superior Swedish fleet of thirty-eight ships under Jacob Bagge. Supported by two other Danish ships Trolle attacked the Swedish flagship "Makalös" (Matchless), then the largest flagship in northern waters, but was beaten off at nightfall. The fight was renewed at six o'clock the following morning, when the "Makalos" was again attacked and forced to surrender, but blew up immediately afterwards, no fewer than 300 Lubeck and Danish sailors perishing with her. The Swedish admiral was captured, and the remnant of the Swedish fleet took refuge at Stockholm. Despite the damage done to his own fleet and flagship "Fortuna" by this victory, Trolle, on Aug. 14, fought another but indecisive action with a second Swedish fleet under Klas Horn, and kept the sea till Oct. 13. Trolle spent the winter partly at his castle of Herlufsholm completing his long cherished plan of establishing a school for all classes, and partly at Copenhagen equipping a new fleet for the ensuing campaign. On June 1, 1565, he set sail with twenty-eight liners, which were reinforced off Femern by five Lubeck vessels. Klas Horn had put to sea still earlier with a superior fleet and the two admirals encountered off Fehmarn on June 4. The fight was severe but indecisive, and both commanders finally separated to repair their ships. Trolle was severely wounded in the thigh and shoulder, but he insisted on being the last to receive the surgeon's attention. He died of his wounds at Copenhagen on June 25.

TROLLHÄTTAN, a town of Sweden in the district (*län*) of Älfsborg, 45 mi. by rail N by E. of Gothenburg. Pop. (1943), 18,570. It lies on the left (east) bank of the Göta at the point where that river descends 108 ft. in the course of nearly a mile by the famous falls of Trollhättan (six in number) and several rapids. The scenic setting of the falls is not striking, but the great volume of water, nearly 18,000 cu.ft. per second, makes the falls imposing. The narrowed river here surrounds several islands, on either side of one of which (Toppö) are the first falls of the series, Toppó and Tjuf. These are 42 ft. in height. The water-power is used in rolling-mills, a cellulose factory and other works. The electric works supply power to Gothenburg and other Swedish towns. (*See* Göta.)

TROLLOPE, ANTHONY (1815–1882), English novelist, was born in London, April 24, 1815. He came of a family which engaged in literary pursuits. His father, Thomas Anthony Trollope (1774–1835) was a learned but unbusinesslike barrister, who spent much time on an *Encyclopedia Ecclesiastica* and gave up law for farming, with ruin as the result. His mother, Frances Milton Trollope (1780–1863) went with her husband to Cincinnati to retrieve their fortunes by running a fancy-goods shop, and coming back disappointed achieved notoriety and roused violent resentment by her caustic book, *Domestic Manners of the Americans* (1832). She afterwards wrote some fifty novels and books of travel, and maintained the family by her literary earnings, her best novel being *The Vicar of Wrexhill* (1837) and *The Widow Barnaby* (1839), a fair second. (See *Frances Trollope, her Life and Literary Work*, 1895, by her daughter-in-law.) Her

eldest son, THOMAS ADOLPHUS TROLLOPE (1810–92), was a popular writer of novels and miscellaneous works, largely on Italian subjects, his adopted home being in Florence. His second wife, FRANCES ELEANOR TROLLOPE, also a novelist, collaborated with him in *Homes and Haunts of Italian Poets* (1881)

Anthony, who was the third son, gave an unvarnished account of his unhappy youth in his *Autobiography* (which was edited by his son Henry M. Trollope in 1883), an extraordinarily candid book that had a disillusioning effect on too fervid admirers by giving away the secrets of his workshop It probably caused the long eclipse of his fame, which has recently been followed by a striking renewal. During the family impecuniosity, he was a day-boy at Winchester and Harrow, and suffered pangs through his shabby and dirty appearance, and the unpopularity and general discouragement which were the result. He reached the verge of manhood almost as ignorant as if he had had no schooling at all, yet he tried to start in life by taking the post of classical usher in a private school in Brussels. But he received the offer of a clerkship in the General Post Office, London, and after a farcical pretence at an examination was appointed (1834). For the seven years of his service here, his salary was small, he was in debt, troubled with awkward love-affairs, and often in hot water with his superiors. Then he was transferred to Ireland (1841) as a surveyor's clerk, with a moderate salary but liberal allowances and the duties of a sort of travelling inspector The change brought out a business capacity hitherto unsuspected He enjoyed a comfortable income, he had time in spite of a busy life to indulge freely in hunting, he consorted with people of all classes and began to stock his memory for the long-cherished purpose of trying his hand at fiction, and in 1844 he married an English lady, Rose Heseltine, whom he had met in Ireland, and established himself in a house at Clonmel.

Trollope's first two novels, *The Macdermots of Ballycloran* (1847) and *The Kellys and the O'Kellys* (1848), failures though they proved, are examples of his thoroughness in making himself acquainted with a given sphere of life, as he was afterwards to do with clerical society, political life, and legal affairs, and also of his aptitude for developing a good story casually heard. The first is dark and pathetic, the second has many sparkling scenes; neither is the work of a Carleton or Banim, but both steer clear of the mere stage Irishman of Lever and Lover. Trollope persevered, but a historical novel, *La Vendée* (1850) deservedly fell flat.

A chance visit to Salisbury Close gave him his idea for *The Warden* (1855), the simple, touching, but humorous story of a precentor in a cathedral town, who out of sensitiveness to public criticism resigns the well-paid office of warden to an ancient charity. Mr. Harding and his blustering son-in-law Archdeacon Grantly reappear, with other clerical dignitaries, their wives, families and friends, including the famous "Bishopess," Mrs Proudie, the unctuous and pushful Mr. Slope, and the epicurean Dr. Stanhope and his disreputable children, in *Barchester Towers* (1857). The "Barsetshire Chronicles" were thus launched, bringing their author praise and, in due time, substantial profit. Trollope was now inspector of rural deliveries for the south-west of Ireland, with a roving commission that suited his tastes, scope for improvements on which he prided himself, and plenty of time for hunting. He is said to have been the inventor of the pillar-box His ability and his experience of Post Office business led to his being sent on a mission to the West Indies (1858), which gave him material for a travel-book, *The West Indies and the Spanish Main* (1859). Other official journeys took him to Egypt (1858), the United States (1861), Australia and New Zealand (1871–72), and South Africa (1878), and resulted in further gossipy narratives and several tales He got himself transferred to England (1859), taking charge of the eastern postal district and settling in a house at Waltham Cross. He retired from the Post Office (1867), out of annoyance at being passed over for promotion. Trollope was instrumental in starting the *Fortnightly Review* (1865), edited the *St. Paul's Magazine* (1868), rather disastrously, and was a contributor to *Cornhill*, *Blackwood* and other periodicals. He stood for Beverley (1868), but only acquired useful experience for future novels of political life.

All this time he was steadily writing fiction. The first of his books to bring him remuneration was *The Three Clerks* (1858), a poor novel of the Civil Service which sold for £250. But before long, he tells us in the *Autobiography*, he was earning on the average £4,500 a year, and in one instance he received £3,525 for a single book. An enormous output—for, besides more than fifty novels he wrote much else, and believed that no writer had made a larger contribution to letters in an equal space of time—was rendered possible by a methodical apportionment of the 24 hours. He rose regularly at 5 30 A.M., wrote steadily for two hours and a half, at the rate of 250 words every quarter of an hour, and thus calculated each book as so many days' work, which was carefully checked off as it proceeded. Yet he found leisure to hunt three times a week during the season, played whist daily, and had plenty of time for social enjoyments. He lived in London for about eight years (1872–80), and then removed to the village of Harting, under the Sussex Downs. He was staying in town when he died of paralysis, Dec. 6, 1882.

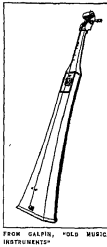
Trollope was a big, bluff, vociferous person, whose blustering and overbearing ways offended some, but whose John Bull philistinism did not conceal an essential honesty and good nature and a tender heart. He thought *Pride and Prejudice* the greatest novel in the language, and he idolized Thackeray; but he was as far from the exquisite art of the one writer as from the perfect mastery and irony of the other. With perhaps too much fidelity to the usual and commonplace, he depicted the great middle class as it was in mid-Victorian times. He was a "character-monger" of first-rate quality, who showed his personages moving in their own little spheres, and as he widened his circle of characters took in a larger sweep until he embraced almost as large and diversified a world as that surveyed by Thackeray. Among the characters that stand out, along with the two or three already mentioned, Mr. Crawley, the grimly pathetic hero of *The Last Chronicle of Barset*, the wicked but delightful Signora Neroni, Lucy Robarts, the best of many admirable heroines (unless Lady Glencora be preferred to that place), her husband, Mr. Plantagenet Palliser, afterwards Duke of Omnium, Lady Lufton, and that shrewd and downright person Miss Dunstable, with such different examples of the unattractive in life turned to artistic account as Mr. Sowerby and Mr. Chaffanbrass—these make a notable gallery and are only a selection from the catalogue Other characters show uncertainty of touch and a failure of motivation. Trollope was best at a sort of coarse or at any rate very broad comedy, but he also had a command of real pathos. Tragedy was outside his scope. He revelled in mankind's idiosyncrasies, but shirked the closer scrutiny into the byways of conscience, just as he was shy of the spiritual questions which must, surely, have played some part in the lives of his clerical personages. George Eliot, his contemporary, would have dealt with Mr. Harding and Mr. Crawley in a totally different way.

Besides *The Warden* and *Barchester Towers*, the Barchester series comprises:—*Dr. Thorne* (1858), *Framley Parsonage* (1864), *The Small House at Allington* (1864), and *The Last Chronicle of Barset* (1867). The best of Trollope outside that series, besides such as are named above, are probably *Orley Farm* (1862), *Can You Forgive Her* (1864), *Phineas Finn* (1869) and its sequel *Phineas Redux* (1874), *The Claverings* (1867), *The Belton Estate* (1866), *He Knew He was Right* (1869), *The Vicar of Bullhampton* (1870), *The Eustace Diamonds* (1873), *The Way We Live Now* (1875), *The American Senator* (1877), *The Duke's Children* (1880), *Ayala's Angel* (1881) and *Mr. Scarborough's Family* (1883). Trollope's *Autobiography* was edited by his son (1883). The best biography is T. H. S. Escott's *Anthony Trollope, His Work, Associates and Literary Originals* (1913) which may be supplemented by Michael Sadler's *Trollope, a Commentary* (1927), H Walpole's *Trollope* ("English Men of Letters," 1928), Leslie Stephen's *Studies of a Biographer*, IV. (1902), Henry James's *Partial Portraits* (1888), and Professor Saintsbury's "Trollope Revisited" (*Essays and Studies by members of the English Association*, VI., 1920).

(E. A. Ba)

TROMBA MARINA or **MARINE TRUMPET**, an obsolete bowed instrument about 6ft. in length, with an outline somewhat recalling that of an elongated cricket bat. It consisted of a body and neck in the shape of a truncated cone resting on a triangular base. In the days of Michael Praetorius (1618) its

length was 7ft. 3in. and the three sides at the base measured 7in., tapering to 2in. at the neck. These measurements varied considerably, as did also the shape of the body and the number of strings. The bridge had the curious feature that a portion of its foot was left loose so that it vibrated against the belly with every movement of the bow, producing a trumpet-like timbre. It is to this feature, in conjunction with its general resemblance in contour to the marine speaking-trumpet of the middle ages, that the name of the instrument is doubtless due, though other derivations have been suggested In Germany, at the time when the trumpet was extensively used in the churches, nuns often substituted the tromba marine, whence the name *Nonnengeige*. The instrument, whose tone was not beautiful, fell into disuse during the first half of the 18th century.

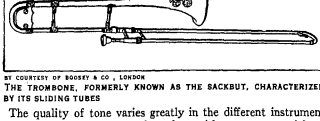


FROM GALPIN, "OLD MUSICAL INSTRUMENTS"

THE TROMBA MARINA, AN OBSOLETE STRING INSTRUMENT

TROMBONE, an important member of the brass wind family of musical instruments formerly known as sackbut (*q.v.*). The trombone is characterized by the slide, consisting of two parallel cylindrical tubes, over which two other cylindrical tubes, communicating at their lower extremities by means of a short semicircular pipe, slips without loss of air. The outer tube, therefore, slides upon the inner, thereby altering the total length of tube and so modifying the pitch. When the slide is closed the instrument is at its highest pitch To the upper end of one of the inner tubes is fastened the cup-shaped mouthpiece and to the end of the other tube is fixed the bell-joint, on the proper proportions of which depend the acoustic properties of the instrument.

Sound is produced on the trombone, as on the horn, by means of the lips stretched like a vibrating reed across the cup mouthpiece from rim to rim; the acoustic principles involved are the same for both instruments By overblowing, *i.e.*, by the varying tension of the lips and pressure of breath, the harmonic series is obtained, which is effective between the second and the tenth harmonics, the fundamental being but rarely of practical use There are seven positions of the slide on the trombone, each giving a theoretical fundamental tone and its upper partials a semitone lower than the last, and corresponding to the seven shifts on the violin and to the seven positions on valve instruments. These seven positions, which give a complete chromatic compass of two octaves and a sixth, are found by drawing out the slide a little more for each one



BY COURTESY OF BOOSEY & CO., LONDON

THE TROMBONE, FORMERLY KNOWN AS THE SACKBUT, CHARACTERIZED BY ITS SLIDING TUBES

The quality of tone varies greatly in the different instruments and registers. The alto trombone has neither power nor richness of tone, but sounds hard and has a timbre between that of a trumpet and a French horn. The tenor and bass have a full rich quality suitable for heroic, majestic music. The contra-bass trombone, formerly little in request in the concert hall, is required for some modern orchestral music.

Besides the slide trombone, which is most largely used, there are the valve trombones, and the double-slide trombones. The former in which the slide is replaced by three pistons permit more brilliant execution than the slide instruments, but their tone is inferior. In the double-slide trombone the sliding branches are doubled and their length accordingly halved, thereby making the instrument more compact and lessening the length of the shifts, though demanding greater nicety in the adjustment of the slide

The evolution of the trombone from the buccina is referred to in the article on the sackbut (*q.v.*), the name by which the earliest draw or slide trumpets, and subsequently the trombones, were known in England

Of all wind instruments the trombone has perhaps been least modified in form; changes have occasionally been attempted, but for the most part with only trifling success. The application of ventils or pistons was made for the first time in 1818, in Germany, but instruments of this kind, though extensively used, have never superseded the original sliding type

TROMP, the name of two famous Dutch admirals

1. MARTIN HARPERTZOON TROMP (1597–1653) was born at Brielle, South Holland At the age of eight he made a voyage to the East Indies in a merchantman, but was made prisoner and spent several years on board an English cruiser. On making his escape to Holland he entered the navy in 1624, and in 1637 was made lieutenant-admiral. In February 1639 he surprised, off the Flemish coast near Gravelines, a large Spanish fleet, which he completely destroyed, and in the following September he defeated the combined fleets of Spain and Portugal off the English coast—achievements which placed him in the first rank of Dutch naval commanders. On the outbreak of war with England Tromp appeared in the Downs in command of a large fleet and anchored off Dover. On the approach of Blake he weighed anchor and stood over towards France, but suddenly altered his course and bore down on the English fleet, which was much inferior to his in numbers In the engagement which followed (May 19, 1652) he had rather the worst of it and drew off with the loss of two ships. In November he again appeared in command of eighty ships of war, and a convoy of 300 merchantmen, which he had undertaken to guard past the English coast. Blake resolved to attack him, and, the two fleets coming to close quarters near Dungeness on Nov. 30, the English, after severe losses, drew off in the darkness and anchored off Dover, retiring next day to the Downs, while Tromp anchored off Boulogne till the Dutch merchantmen had all passed beyond danger. The statement that he sailed up the Channel with a broom at his masthead in token of his ability to sweep the seas is probably mythical. In the following February (1653), while in charge of a large convoy of merchantmen, he maintained a running fight with the combined English fleets under Blake, Penn and Monk off Portland to the sands of Calais, and, though baffling to some extent the purposes of the English, had the worst of the encounter, losing nine ships of war and 30 or 40 merchantmen. On June 3, he fought an indecisive battle with the English fleet under Richard Dean in the Channel, but the arrival of reinforcements under Blake on the following day enabled the English to turn the scale against him and he retired to the Texel with the loss of seventeen ships. Greatly discouraged by the results of the battle, the Dutch sent commissioners to Cromwell to treat for peace, but the proposal was so coldly received that war was immediately renewed, Tromp again appearing in the Channel towards the end of July 1653. In the hotly contested conflict which followed with the English under Monk on the 29th Tromp was shot by a musket bullet through the heart. He was buried with great pomp at Delft, where there is a monument to his memory

2 CORNELIUS VAN TROMP (1629–1691), the second son of the preceding, was born at Rotterdam on Sept. 9, 1629 At the age of 19 he commanded a small squadron charged to pursue the Barbary pirates. In 1652 and 1653 he served in Van Galen's fleet in the Mediterranean, and after the action with the English fleet off Leghorn on March 13, 1653, in which Van Galen was killed, Tromp was promoted to be rear-admiral. On July 13, 1665 his squadron was, by a hard stroke of ill-fortune, defeated by the English under the duke of York. In the following year Tromp served under De Ruyter, and on account of De Ruyter's complaints of his negligence in the action of Aug. 5, he was deprived of his command. He was, however, reinstated in 1673 by the stadtholder William, afterwards king of England, and in the actions of June 7, and 14, against the allied fleets of England and France, manifested a skill

and bravery which completely justified his reappointment In 1675 he visited England, where he was received with honour by King Charles II. In the following year he was named lieutenant-admiral of the United Provinces He died at Amsterdam on May 29, 1691, shortly after he had been appointed to the command of a fleet against France Like his father he was buried at Delft

See H. de Jager, *Het Geslacht Tromp* (1883); and T. de Liefde, *Great Dutch Admirals* (trans 1873).

TRØSO, a seaport of Norway, capital of the *fylke* (county) and *bispedømme* (diocese) of the same name on the northwestern coast. Pop. (1946) 11,146. It stands on an islet between Kvalø and the mainland. The town has fish oil factories and tanneries, and makes boots and shoes, there are boats for whaling The buildings, many of wood, include the town hall and a museum. Sealskins and other furs, dried and smoked fish and whale and seal oil are exported, and the herring fishery is productive. The port was occupied by German troops in April 1940.

TRONDHEIM or TRONDHJEM, a city and seaport of Norway; chief town of the diocese of Trondheim and the county of Sør-Trøndelag, 384 mi by rail N of Oslo. Pop. (1946) 56,522 It lies on the Trondheim fjord on a peninsula between the fjord and the river Nid. The cathedral is the finest church in Norway, and the scene of coronation of the Norwegian kings Building was begun in the 11th century and continued through the 12th and 13th centuries. Repeatedly the church was burned, but as often restored. In the 20th century it was expanded and enriched with Vigeland sculptures. The port ordinarily maintains communications up and down the coast and with Hull, Newcastle, Hamburg, etc ; trade is chiefly in timber, wood pulp, oil, fish and copper. In the town are shipbuilding, fish-curing, sawmills and machine works. Olaf Tryggvessön founded the town of Nidaros here in 996, building a church and a royal residence. (For a brief time from 1930 the town was renamed Nidaros.) It became an archbishopric (1152) and was the capital to 1380. It was an important pilgrimage centre, but suffered many sieges Declining after the Reformation period, its commerce and population grew rapidly again in the 20th century, aided by new port facilities and the railway from Oslo (1921). Here is Norway's great technical school. Trondheim was one of the first ports attacked by the Germans in 1940, and although taken and held, it became a centre of popular resistance to the invaders.

TROON, a small burgh, seaport and watering place of Ayrshire, Scotland. Pop. (est. 1938) 8,666. Area 2 sq.mi. It is 6 mi N.W. of Ayr, and 35 mi. S W. of Glasgow by the L M S. railway. It has a fine natural harbour with a breakwater 3,000 ft. long, and two graving docks. Shipbuilding is the leading industry, coal the chief export and iron the chief import

TROPHY (Gr. *τρόπαιον*), a memorial of victory set up on the field of battle at the spot where the enemy had been routed. It consisted of captured arms and standards hung upon a tree (preferably an olive or an oak) and booty heaped up at its foot, dedicated to the god to whom the victory was attributed. If no suitable tree was at hand, a lopped trunk was fixed in the ground on an eminence. The tree or trunk bore an inscription containing the names of the god and the combatants, a list of the booty and the chief incidents of the battle. In the case of a naval victory the trophy, composed of the beaks of ships, was set up on the nearest beach and consecrated to Poseidon It was regarded as a sacrilege to destroy a trophy, since it was dedicated to a god.

To facilitate reconciliation with their conquered foes, neither the Macedonians nor the Romans in early times erected such trophies. The Romans showed a preference for setting up the memorials of victory in Rome rather than on the field of battle: such were the trophies of Marius recording his victories over Jugurtha and the Cimbri and Teutones. In imperial times their place was taken by columns or triumphal arches (*see* ROMAN ARCHITECTURE; TRIUMPHAL ARCH).

TROPICAL AGRICULTURE. From the humid tropics come the world's bananas, pineapples, coconuts, coffee, cacao (chocolate) and tea; most of the sugar; jute, abacá (Manila hemp) and ramie fibre; quinine, strychnine, rotenone and other medicinal and insecticidal materials; black and white pepper, cloves, nutmegs, mace, cinnamon and other spices; tapioca (sago); kapok; palm, coconut and sesame oils; and much of the rice The tropics are also the source of many of the fine cabinet woods such as mahogany, teak, Spanish "cedar," rosewood and ebony. Other important tropical forest products are rubber, gutta percha and balata, rattan; chicle, the basis of chewing gum, shellac, and the varnish gums copal and dammar

Tropical fruits and root crops extensively utilized and much prized in the regions where grown, such as papaya, durian, mangosteen, mango, breadfruit, yams and cassava (manioc), either do not ship well or for other reasons are little known outside the tropics Better known are the more widely adaptable tropical or subtropical crops of cotton, corn (maize), sweet potatoes, tobacco, citrus fruits, sisal and henequen.

In different parts of the tropics the total amount as well as the distribution of the rainfall throughout the year varies widely The sunshine is very bright, and the maximum temperature of the day often is affected more by the presence or absence of clouds than by the position of the sun at midday, for at noon the year around the sun is never far from the zenith In humid tropical lowlands the temperature in the shade is usually between 70° and 90° F , even at night it seldom falls [illegible] F per day is often much [illegible] F The high humidity,

[illegible]

tant and much prized temperate zone plants do not thrive no matter how temperate the mountain-top climate, because for flowering and fruiting these plants must have dormant periods as well as seasonal changes in the relative length of day and night.

Indigenous or subsistence methods of production of tropical crops vary widely, depending upon local traditions and food habits, the fertility of the soil, the density of the population and the degree to which trading for rice culture is possible. On well-drained soils the simplest crop production method is to modify the wild forest slightly by thinning and clearing the underbrush, to leave wild fruit or other trees, or to provide shade for such crops as abacá, coffee or ginger, which may be planted under the forest trees.

Usually misunderstood by travellers from the temperate zone is shifting cultivation (*kaingining*, Tagalog), or the production of annual food, fibre or tobacco crops in temporary clearings (*kaingins*) in the forest Early in the dry season the brush and forest trees, which have served as the cover crop on the land selected, are cut and burned. The forest had exterminated the weeds, restored the physical condition of the soil, and some of the nutrients liberated for the crop plants by the burning had been brought up by the forest tree roots from deep below the surface. After the first showers of the rainy season have moistened the soil, the seed of the crop plants is dibbled into the unstirred soil. An occasional weeding, and protection against birds and other animals, is the only care given. Since the soil is not stirred, erosion is kept at a minimum even though the very steep slopes are *kaingined*. Usually only one or two crops are raised in a clearing before the weeds and other pests become serious, or the fertility declines. Then the land is abandoned to forest. Often *kaingining* is the only method by which annual subsistence crops can be produced on infertile upland soils. As long as there is abundant land, *kaingining* is a practicable and usually justifiable method of crop production, requiring much human labour per unit of crop, but no draught animals, nor tools other than a heavy knife and a planting stick. However, where the pressure of population increases, and the land must be cleared again and planted before the forest cover

crop has choked out the weeds and restored the structure, coarse grasses and other weeds in the *kamgon* cannot be kept under control Then annual grass fires prevent the natural return of the forest, and the land will no longer yield crops by this method Plowing or other means of controlling the grass and maintaining satisfactory tilth must be employed, and since forest ash is no longer added to the soil, manures must often be applied to provide the nutrients necessary for the shallow-rooted annual crop plants

Where the land can be flooded for some months annually, lowland rice can be grown. If the soil is plowed and harrowed while flooded, and the rice seedlings transplanted into the mud, relatively good yields can be obtained even from very infertile soils This is an important factor in supporting the high density of the population in southeastern Asia, where rice is the principal food crop The world market price for rice, or other crops produced by the small farmer in the tropics, is no criterion of the costs of production, the farmer sells his excess crops for what they will bring

Black and white pepper, vegetables and tropical fruits are often grown by intensive Chinese gardening methods which require laborious soil management, draining, fertilization and other practices

On the less steep lands in Central America, the plow and other animal-drawn implements are employed for maize and other subsistence crop production In India a crude plow is used in the production of wheat, sorghum, cotton and other crops. But in other tropical regions the use of the plow is often limited to the preparation of lowland flooded rice fields, for not only is it not necessary to plow *kamgins*, but the general practice of spreading the seed by planting a mixture of different crops in the same field, reduces the utility of animal-drawn implements

Tropical Animal Husbandry.—Neither draught animals nor animal manures are used in *kamgoing* in the forestry methods of rubber or fruit production. Nevertheless, livestock are important in subsistence agriculture in the tropics. Water buffaloes and cattle are used for draught and as pack animals, and in certain regions are valued for their milk and their manure Moreover, their sale is often the chief source of cash for subsistence farmers In some regions hogs are also important. Horses, mules and donkeys are used for riding and for pack animals, while in some regions elephants are used in logging and as pack animals Goats in certain regions are the chief source of meat. Chickens are valued for fighting as well as for eggs and for meat Ducks are raised in great numbers in certain regions, while the pond culture of fish is deservedly important.

By comparison with temperate zone livestock, animals in tropical regions are usually considerably smaller and of far from ideal conformation Growth is slow, and yield of milk is low; eggs are small and the annual number laid is low. Nevertheless, the livestock of tropical regions are relatively resistant to several of the more serious endemic diseases and parasites and are able to exist on the relatively poor pastures and other local feeds, without being fed concentrates Since highly-bred, temperate-zone livestock rapidly decline under such conditions, and generally succumb to the diseases unless most carefully attended by a competent veterinarian, practically all importations of highly-bred temperate-zone livestock into the tropics have been failures. In Hong Kong, air-conditioned barns were used at one time for imported dairy cows The most promising line of improvement of tropical livestock is by selection and breeding of the best from the native breeds. In some cases crossbreeding with temperate-zone strains is effective, providing hardiness and disease-resistance can be retained while improving the desired milk or meat yield and other characteristics

Plantation Agriculture.—Tea, cacao, coffee, Hevea rubber, oil palms and sugar cane are often grown in large plantations financed and supervised by Europeans Where plantation agriculture has been a success, it has primarily been because of: (1) the utilization of specialized processes requiring technical control and heavy investments for machinery and equipment (tea and sugar); or (2) carefully worked out and specialized rapid transportation and cold storage and marketing facilities, as in the banana industry; or (3) some accident, as in the absence of the leaf disease in the far east, high-yielding strains (clones) of Hevea rubber were easily selected and propagated Where, as a result of engineering and agricultural research, intensive crop production and disease-control methods have been applied, as in the overhead irrigation and spraying of banana plantations from high-pressure piping installations, and soil rejuvenation by silt deposition, additional advantages may be gained which more than offset the heavy overhead expenses of plantation enterprises.

Although the natives have always grown their tree and shrub crops as "forest" crops, it was long the practice of plantations to employ European-style clean culture, soil-stirring, horticultural methods for the production of tea, coffee and rubber Such exploitive methods, particularly ill-suited to tropical soils exposed to heavy rainfall, have, to an increasing degree, been replaced by appropriate permanent cover crop, shade tree and mulching methods, combined with the use of commercial fertilizers. Such practices greatly retard erosion and maintain production at a satisfactory level.

Scientific research of high quality has been supported generously by individual plantation corporations and associations of planters, particularly in the Hawaiian Islands and in the Netherlands Indies, and by increasing the yields and the quality of the products has proven a profitable investment. The relatively less well-staffed and equipped government-supported experiment stations and extension activities in tropical regions have ministered mainly to the needs of the peasant farmers producing subsistence crops

To an increasing degree, native farmers located near plantation processing and shipping facilities are producing improved varieties of coffee, tea and sugar cane developed by the experiment stations, and selling their crop fresh to the central factory for processing and marketing More and more Hevea rubber is also being produced by peasant farmers in small plantings. (R. L. PR.)

TROPICAL MEDICINE. Tropical medicine, by definition, is the practice of medicine in the warm climates The scope of tropical medicine includes the majority of those ills that affect the human race in temperate climates, and in addition, a small group of disease entities that are in some manner dependent for their existence on factors peculiar to a tropical environment Aside from this small group of inherently tropical entities, the major health problems are diseases intimately associated with the uniformly low levels of sanitation, education and economic well-being prevalent in many tropical regions Thus the infectious diseases and the nutritional deficiencies assume major importance; malignancy and chronic degenerative diseases, although present, are of relatively little consequence from the public-health standpoint.

Concepts of tropical medicine frequently overemphasize those diseases that are exotic in the more highly developed temperate regions and tend to minimize the role of cosmopolitan diseases such as tuberculosis, pneumonia and syphilis, which in the tropics are major causes of mortality and morbidity. That the criteria for defining a disease as tropical are often rather arbitrary is indicated by the fact that certain diseases so regarded have, in the past, been prevalent in the temperate zones Thus, malaria, acknowledged to be the most important tropical disease, was prevalent in the northern United States during the 19th century. Samuel Pepys and Daniel Defoe vividly described the 17th-century outbreaks of plague in England and France. In the 18th century, outbreaks of cholera, dengue and yellow fever occurred in Boston and Philadelphia.

Tropical medicine, as taught in medical schools, includes a few diseases prevalent only in tropical areas, and in addition considers a larger group of entities that are exotic in the more developed countries in temperate regions In practice, the specialty of tropical medicine deals with all diseases prevalent in the tropics and with the complex interrelationships between man and disease in the tropical environment This involves knowledge of human ecology, of the various sociologic, economic, anthropologic, and demographic factors affecting the distribution of disease, as well as knowledge of general medicine and its ancillary sciences

Development of the Specialty of Tropical Medicine.—The evolution of the science of tropical medicine has been a corollary of progressive colonization and commercialization of the tropics Measures originally developed to safeguard the health of travellers and colonial officials in tropical areas were modified and directed toward improving the health of the native populace. Preventive medicine with reference to the individual was supplanted by the concept of tropical public health with emphasis on improvement of health standards of the community

The 50-year period from 1875 to 1925 witnessed the elucidation of the causative agents and modes of transmission of many tropical diseases Alphonse Laveran's discovery of the parasites of malaria in the blood of man preceded by 17 years the report of Ronald Ross in 1897, describing malaria oocysts in anopheline mosquitoes. In 1878 Patrick Manson had focused attention on mosquitoes with the observation that the larval stages of the nematode parasite, *Wuchereria bancrofti*, the cause of tropical elephantiasis, develop in this insect. Walter Reed and his coworkers demonstrated mosquito transmission of yellow fever in 1901. These pioneering achievements at the turn of the century were followed by the discovery of the trypanosomes which produce African sleeping sickness and Chagas' disease, with the demonstration that tsetse flies transmit the former, and reduviid bugs, the latter entity. Kala-azar and oriental sore were established as infections with species of protozoa belonging to the genus *Leishmania* and sandflies were incriminated as vectors The complex and biologically interesting life cycles of various trematodes para-

sitic in man were defined These flat worms, which produce serious diseases including schistosomiasis, require a fresh-water snail as the first intermediate host. Certain species require an additional host, such as a fish or crab, before the parasite becomes infective for man.

Later, the aetiological agents of additional diseases were discovered It seemed that the list of important tropical infections of man produced by the helminths, protozoa and bacteria was nearing completion by mid-20th century. It was probable, however, that a number of diseases caused by filterable viruses or rickettsiae, as yet unknown, remained to be defined

The development of methods of prophylaxis and treatment followed the advance of medical science in general Effective vaccines were prepared, of these, yellow fever vaccine developed in the laboratories of the International Health division of the Rockefeller foundation is an outstanding example Notable achievements in chemotherapy were made Chloroquine and chlorguanide largely replaced quinine in the treatment of malaria Vermifuges were developed for most of the intestinal helminths Organic compounds were synthesized for the therapy of amoebiasis, schistosomiasis, kala-azar, trypanosomiasis and filariasis Certain sulfonamide compounds were found to be highly effective in the treatment of bacillary dysentery The advent of the antibiotics provided specific agents for the therapy for the rickettsial diseases, as well as invaluable aids in the treatment of yaws, plague, tropical ulcer and amoebiasis.

Measures to combat the vectors of tropical disease have required the combined efforts of scientists possessing a variety of skills. Brief mention of certain aspects of the evolution of techniques used in the control of malaria will serve to illustrate the debt of tropical public health to its ancillary sciences. The pioneering mosquito-control programs instituted in 1901 by the army surgeon W. C. Gorgas and J. A. LePrince in Havana, and by Malcolm Watson in the Federated Malay States, focused attention on drainage and the engineering aspects of the problem. Entomological studies demonstrated that different anopheline mosquitoes vary in their ability to transmit malaria. The habits and breeding requirements of the important vectors were defined With this information mosquito control was directed against individual species and the widely accepted principle of "species sanitation" evolved Mosquito larviciding programs, employing first petroleum products and later Paris green, were used effectively. Biological control techniques, as for example the alteration of the salinity of a mangrove swamp, found practical application. Modification of agricultural practices such as the introduction of intermittent irrigation of rice fields proved of value An extreme example of the complexities of species sanitation was encountered in the cacao plantations of Trinidad, where *Anopheles bellator* was found to breed in collections of water in the leaves of epiphytes growing on the plantation shade trees; control hinged on the development of a selective herbicide for the epiphytes. The introduction of DDT (dichloro-diphenyl-trichloroethane) during World War II, and the demonstration of its residual toxicity for adult mosquitoes when sprayed on surfaces, focused attention on destruction of mosquitoes in houses by the use of residual sprays, and stimulated research on the development of insecticides With all these techniques available, consideration of "species eradication" became feasible. (For "suppressant" drugs used in the treatment of malaria, *see* MALARIA.)

Problems in Control.—Climatic conditions in the tropics directly affect the distribution of disease by providing habitats optimal for parasitic agents or their vectors Little scientific information was available at mid-20th century regarding the direct effect of the hot climates on native peoples, although the indirect effects are obviously manifold. With the exception of alluvial deposits, the soils of the humid tropics are leached and generally of low fertility. In sparsely populated areas native agriculture is therefore migratory in type, and housing and sanitation accordingly primitive. In densely populated areas, intensive cultivation and fertilization of the soil is mandatory. Lacking other sources of fertilizer, the use of human excrement as manure, with its accompanying health hazards, then becomes a biologic necessity Nutritional deficiencies in the tropics are a reflection of climatic, as well as of economic and sociologic factors. Native diets generally are deficient in animal protein and certain minerals and vitamins. In densely populated areas, a higher yield of food per unit of land is usually obtainable from agriculture than from animal husbandry; in addition, climatic conditions adversely affect the raising of livestock, and facilities for transportation and refrigeration of animal products are not available

It has long been recognized that a malarious community is an impoverished community This statement is equally applicable to other endemic chronic tropical diseases The extent of mutually interrelated and self-perpetuating poverty, disease and ignorance in many tropical areas is almost beyond the comprehension of an individual accustomed to life in the developed temperate regions In 1951 it was authoritatively estimated that the annual income per person in southeast Asia was about $30, and in south Asia, $55. The average life expectancy in these areas was in the neighbourhood of 30 years, and approximately one-half of the children died before attaining 10 years of age Such regions lacked both the trained personnel and the financial resources necessary for the application of modern techniques of environmental sanitation

To correct these deficiencies, assistance on an international scale was required. The activities in the International Health division of the Rockefeller foundation, initiated in 1914, provided a successful example of this type of endeavour The expenditure of relatively small sums of money on the training of personnel and for the control of diseases such as yellow fever, hookworm and malaria has benefited mankind throughout the tropics

International public health also received great impetus from the formation of the World Health organization At the first World Health assembly in 1948 malaria was one of the diseases selected for immediate attention Malaria control teams formed by WHO and composed of scientists of varying nationalities, began operation in many countries Other problems were attacked in a similar manner The rapid development of international co-operation in the field of tropical public health following World War II reflected increasing acceptance of the view that alleviation of the human misery in the underdeveloped regions is an essential step toward attaining a stable and peaceful world

Improvement of health standards in the tropics in the absence of the concomitant development of education, agriculture and industry may paradoxically augment, rather than alleviate, human misery In terms of natural resources, many areas are becoming over-populated to an alarming degree. The population of Java increased by 10,000,000 during the decade ending in 1940, at which time the population density was about 1,000 per square mile. By 1950 the population of India was increasing by approximately 6,000,000 per year, which in terms of food meant an additional annual requirement of 1,000,000 tons In Puerto Rico the accelerated population growth associated with the introduction of environmental sanitation was strikingly demonstrated The population in 1948 was increasing at a rate that, if maintained, would result in a doubling of the number of people on this small island in 24 years No brief can be held for denying underdeveloped regions the benefits of tropical medicine On the other hand, knowledge that its successful practice will eliminate infectious disease as a check on the growth of population cannot be disregarded.

(*See* also articles on separate diseases: MALARIA; YELLOW FEVER, etc.)

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TROPICAL STORMS. Severe cyclonic disturbances of the atmosphere in low latitudes are called tropical storms. In the western Atlantic they are known regionally as hurricanes and in the western Pacific as typhoons. It is the fury of the weather associated with tropical storms that distinguishes them from the many minor weather disturbances that more commonly produce periods of greater than normal rainfall in the tropics. They are, roughly, 50 to 500 mi. in diameter.

Description.—Tropical storms frequent the tropical oceans between latitudes of approximately 5° and 30° of both hemispheres. Their characteristics are not entirely uniform, but depend somewhat on age, size, and latitude of the storms They are cyclonic whirls (*See* CYCLONE.) The winds near the centre form an almost circular vortex, with a slight inward motion toward the centre near the ocean surface. As a result of the effect of the earth's rotation (*see* MOTION, LAWS OF), the rotation of the vortex is clockwise in the southern hemisphere and counterclockwise in the northern

A cyclonic whirl is called a hurricane or typhoon if the surface winds exceed 75 m.p.h (Beaufort force 12) The area covered by such high winds may have a diameter of only 10 mi when the storm is in its early stage. In fully grown storms the diameter is rarely less than 50 mi. and may attain 150 mi The diameter of the entire area affected in some measure by a large storm may exceed 500 mi Even the largest tropical storms, however, have an area which is only one-half or less the area covered by the average cyclones of middle and high latitudes. An outline of the wind and weather distribution connected with a mature storm is given in fig. 1.

Winds.—While the areal extent of tropical cyclones is small compared with storms outside the tropics, the violence of the weather within the disturbed zone is usually far greater. This is the most spectacular fea-

ture of tropical storms Sustained winds in excess of 100 m p h. are common near the centre, and winds higher than 150 m p h. have occurred. Since mature storms usually lie within the broad easterly trade winds, the distribution of the hurricane winds around the centre tends to be asymmetrical On the poleward side of the cyclones the trade winds reinforce the wind field produced by the disturbances themselves;

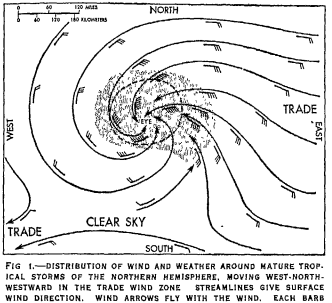


FIG 1.—DISTRIBUTION OF WIND AND WEATHER AROUND MATURE TROPICAL STORMS OF THE NORTHERN HEMISPHERE, MOVING WEST-NORTH-WESTWARD IN THE TRADE WIND ZONE STREAMLINES GIVE SURFACE WIND DIRECTION. WIND ARROWS FLY WITH THE WIND. EACH BARB REPRESENTS TWO BEAUFORT FORCES. DASHED LINE SURROUNDS AREA WITH WINDS HIGHER THAN BEAUFORT FORCE 12 SHADED AREA OUTLINES REGION OF HEAVY RAINFALL

on the equatorward side they counter this wind field. Thus, the high winds around centres located in the trades extend a far greater distance poleward than equatorward. In a mature storm of the northern hemisphere, for instance, hurricane winds may extend for only 30 to 40 mi. south of the centre but they will occur for twice that distance to the north.

Pressure.—Coincident with the rise of wind speed from the edge of the storm inward, the atmospheric pressure as measured by the barometer drops Tropical storms are low pressure centres, and the lowest sea level pressures observed on earth occur in or near the eye of hurricanes Up to 1946, the lowest official pressure on record was registered at Key West, Fla , on Sept. 2, 1935, with a reading of 26 35 in of mercury. This low pressure existed in a storm of small diameter, indicating that the intensity of a tropical storm does not depend on its areal extent There are many other instances to substantiate this conclusion The drop of the barometer can be exceedingly rapid as the winds increase to hurricane strength, and its rise after passage tends to be equally rapid

Clouds and Rainfall.—The interior of a tropical storm is filled with a great mass of cumulonimbus clouds (*see* CLOUD) from which heavy rain is falling Only in the eye is there a lightening of the clouds; here many times the sky is even entirely clear. The distribution of the rainfall around the central core often is not symmetrical, paralleling the winds During the formation of a storm cumuliform clouds and showers

[illegible] intensity. Precipitation in excess of 20 in. in one day has occurred on several occasions along the southern coast of the United States and in various parts of the tropics. At Baguio in the Philippines 42 in fell within 24 hr in 1911 For a rough estimate, a rainfall of 10 to 15 in. should be expected during the passage of a fully developed cyclone over coastal regions.

Dangers to Flying.—The dangers caused by turbulence as well as other dangers to flying in and near tropical storms are not quite so prohibitive in most instances as was supposed prior to 1940 After 1944, military bombing aircraft have carried out regular reconnaissance flights in tropical cyclones at a height of about 1,000 ft or less. Most missions succeeded in flying through and around the centres, spending at times several hours in the zone of very rough weather Others have flown over hurricanes at great heights It appears that most dangerous clouds can be topped at 30,000 ft and occasionally at much lower elevations.

Sequence of Events at Fixed Location.—Young, developing disturbances will give little or no advance indication of their arrival, except to the meteorologist who has wind measurements from the upper parts of the atmosphere at his disposal.

A mature cyclone is preceded by a distinct ocean swell with a frequency two or four times less than that of normal waves In the Gulf of Mexico, for example, waves normally reach the shore about every four to five seconds The presence of a hurricane may be suspected if they arrive only every 12 to 15 sec and if the swell is correspondingly higher At sea, moreover, the direction of the swell indicates the direction in which the storm is located, since the swell travels outward from the central area It can precede the centre by 500 mi. and more, a great distance compared with the diameter of the hurricane winds

The drop of the barometer often does not begin until 12 hr before the arrival of the storm centre. Appearance of a sheet of cirrus clouds (*see* CLOUD), gradually thickening, frequently supplies an earlier warning. In addition, the inhabitants of the tropics often rely on other abnormalities of the local weather, such as brilliant, red sunsets and winds from unusual directions, as precursory signs of a cyclone None of these indications are entirely reliable, however, and may fail badly. On Sept. 13, 1945, a hurricane of great intensity was approaching the southeastern Bahamas. Nevertheless, the fishermen of South Caicos island went out in their boats. They did not believe that there was a hurricane because the usual warning signs were missing. More than 50 of them drowned.

The arrival of the storm area itself begins with a gradual picking up of the wind and increasing gustiness, followed by a thickening of low clouds in the sky and intermittent squally showers. Sometimes the main wall of cumulonimbus clouds can be seen approaching in the distance It is called the bar of the storm

When a storm is observed from a point that is not on the path of the centre itself, it will be noted that the hurricane winds gradually change

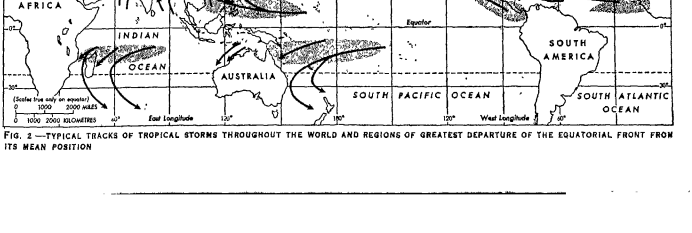


FIG. 2.—TYPICAL TRACKS OF TROPICAL STORMS THROUGHOUT THE WORLD AND REGIONS OF GREATEST DEPARTURE OF THE EQUATORIAL FRONT FROM ITS MEAN POSITION

direction. They will not let up materially, however, until the cyclone passes Should the eye travel over the observation point, however, it will be noted that the winds drop from hurricane strength to light breezes within a few minutes. At the same time the rain ceases and the clouds lighten. After passage of the eye the winds and the precipitation resume with full force, but the winds come from the opposite direction

The duration of the hurricane winds depends on the size of the storm and its rate of movement If the high winds extend over 100 mi and the storm moves 20 m.p.h., then the gales will last for ten hours If the cyclone advances at 15 m.p.h., the winds will last for twice that, seven hours. The same consideration applies to the eye The central calm may remain for only a few minutes or stay for one to two hours

Origin.—The development and maintenance of any vortex of the dimension of a tropical storm depend on the effect of the earth's rotation (*see* METEOROLOGY) As the component of this rotation is zero on the equator, tropical cyclones cannot develop in its immediate vicinity. Areas of strong squalliness and heavy rainfall appear near the equator, but tropical storms have not been observed between latitudes 5° N and S. On the poleward margin of the tropics, conditions favourable for the development of tropical cyclones occasionally exist even beyond latitude 30° Formation between latitudes 20° and 30° is fairly common, especially in the western Atlantic ocean and in the Gulf of Mexico.

All tropical storms develop over water Long before the turn of the 20th century some authors drew attention to the fact that most of them develop along a narrow zone of air convergence, where the trades of both hemispheres meet This zone, which girdles the globe, has been variously called doldrums, intertropical front and equatorial front. It is not of uniform strength around the globe, and it changes its position and intensity with the seasons of the year, following the sun with a lag of two to three months The equatorial front penetrates to about latitude 15° N between July and October and to latitude 10° to 15° S. from January to March or April These months, then, represent the principal cyclone seasons of the respective hemispheres In the northern hemisphere, the peak month of activity usually is September

The distance by which the equatorial front moves away from the equator in the course of a year is not uniform around the globe but is greatest in the regions indicated in fig. 2 The formation of tropical storms is most frequent in those places where the zone deviates far from the equator Where there is little or no seasonal variation of its position cyclonic developments are rare or nonexistent. The zone appears in the transition periods between summer and winter in the Arabian sea and the western part of the Caribbean sea. Over those parts of the tropical oceans, therefore, the cyclone frequency is greatest about June and October, with a lull in midsummer There is also a tendency toward two peaks of cyclone activity in the Bay of Bengal

Tropical storms can develop also in the absence of the equatorial front, although they do so less frequently The storms of the western North Atlantic and the Gulf of Mexico are the outstanding examples of formation without equatorial front However, cyclonic development will not take place near the equatorial front or near other disturbances of the tropics, unless a broad-scale atmospheric circulation pattern is present in the low and high atmosphere that is favourable for formation. The high atmospheric observations taken over the oceans during World War II have shown that tropical weather is greatly dependent on the atmospheric flow in middle latitudes In order to predict the formation of a tropical storm in the West Indies region, for instance, a weather forecaster must have knowledge of weather conditions over all of the North Atlantic ocean and the United States, besides the information as to conditions over the tropics themselves.

Those regions of the earth where tropical storms form principally are shaded in fig. 2 The greatest frequency should be found over those parts of the tropical oceans where the equatorial front is strong and has large seasonal departures from its average position and where, moreover, the average atmospheric flow in middle and high latitudes is favourable. In the western North Pacific ocean these conditions are fulfilled to a higher degree than anywhere else. On the average, about 20 tropical storms form in that area each year. Although statistics are lacking, the cyclone frequency of the South Indian ocean is thought to be almost as high. Compared with these large areas, other hurricane areas of the world have few storms In the western North Atlantic, the Caribbean, and the Gulf of Mexico the mean annual frequency is about six. The deviations from this average, however, are very large. In 1933, 21 tropical cyclones appeared in the area just mentioned; in 1929 and 1930 there were only 2 each The South Atlantic is the only ocean where tropical storms are unknown. The equatorial front does not penetrate far enough southward

Movement.—Within the tropics, storms that have attained maturity usually drift westward with the prevailing trade wind. While the speed of the winds within the disturbances frequently exceeds 100 m.p.h., the rate of movement of the disturbances themselves is about 15 m.p.h. on the average It may deviate, however, by five m.p.h or more from this mean figure in individual cases Besides the westward movement there is also a tendency for most storms to approach the poleward limit of the tropics gradually. When they reach this limit near latitude 30°, they leave the tropical easterlies and come under the influence of the prevailing westerlies of higher latitudes Their direction of motion then reverses and they are said to recurve. After the recurvature they drift eastward while continuing to approach the high-latitude regions. During the recurvature the speed of the cyclones is lowest, and they frequently become almost stationary for 12 to 24 hr After recurving, their speed increases rapidly and they may be moving at 50 to 60 m.p.h when they reach the polar zone

The general path of tropical storms just outlined has a large number of exceptions because of constant changes of the broad-scale atmospheric currents and their effect on the tropics Weather observation networks extending over large portions of the globe and experienced forecasters are necessary to predict the path of individual storms These predictions become especially difficult when a storm lies between the broad-scale easterlies and westerlies (*see* WINDS, GENERAL CIRCULATION OF) so that it is temporarily controlled by neither of these currents

End of Storms.—Dissipation of tropical storms over the tropical oceans is rare. Most disturbances eventually enter the middle and high [illegible] pation is far slower than over rugged country

Damages.—The loss of life and property on tropical islands and coastal areas of continents is caused by the direct and indirect effects of the high winds and the excessive rains.

Winds.—The pressure exerted by the air on solid objects, for instance houses, is proportional to the square of the wind speed. Thus an increase of the wind from 40 to 50 m.p.h. produces far less added danger to buildings than a rise from 90 to 100 m.p.h. Moreover, the resistance capacity of many types of structures appears to become exhausted rapidly when the winds exceed 75 to 80 m.p.h. In industrial and city areas, the danger to industrial and electrical installations is great. Short circuits in the midst of a raging storm and the explosion of gasoline tanks have led to uncontrollable fires Much damage also results from the impact of flying debris

Storm Waves—Some of the most disastrous losses of life and property have been caused by a sudden rising of the ocean and widespread inundations of low-lying, poorly protected coastal areas. The abrupt increase of the water level, referred to as the storm wave, is caused by the action of the wind on the water. The storm wave appears so quickly and is carried with tremendous force so far inland that often there is no time for the coastal inhabitants to rescue themselves or their belongings

Rainfall—The heavy rainfall often accompanying tropical storms frequently causes landslides in mountainous and hilly areas Because of the great and sustained intensity of the precipitation, the runoff of the water is extreme and produces rapid and excessive rises of the water level of the rivers along which the human settlements and most valuable agricultural activities are usually concentrated.

The damaging power of tropical storms is not confined to the tropics. Occasionally, storms moving up against Japan, China and the northeastern coast of the United States have struck with a violence equal to that of storms within the lower latitudes.

Storm Warning Services.—Forecasting of the appearance of tropical storms was attempted long before the start of the 20th century. These activities were begun largely by the Society of Jesus whose members developed a high forecasting standard, notably in the West Indies and the Philippines With the gradual *expansion of governmental* weather services after 1900, the forecasting work passed more and more into official hands, aided also by the *military weather services during* World War II. From 1935, for instance, the United States weather bureau has maintained special hurricane forecast centres which advise the public concerning the position, intensity, and probable movement of hurricanes and indicate what type of precautions are necessary.

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(*H. RR.*)

TROPIC BIRD, a genus (*Phaethon*) of sea birds of the order Steganopodes with webbed feet and long forked tails. The flight is by rapid strokes of the wing. The yellow-billed tropic bird (*P. flavirostris*) has the widest range, inhabiting the Atlantic, Indian and Pacific oceans, and breeding on trees in various islands, including the Bermudas. It lays a single pinkish-white egg, mottled with brownish-purple. The plumage is white, with black patches. *P. aethereus* is larger and lacks the yellow bill. It does not occur in the western part of the Indian ocean. *P. rubricauda* is still larger and has a red tail and a roseate tinge to the rest of the plumage. It is confined to the Pacific and Indian oceans. The tropic birds form the family *phaethontidae*.

TROPINE (Tropanol), $C_8H_{15}NO$, the amino-alcohol portion which is formed, together with tropic acid, when the ester linkage

in atropine (*q v.*) or hyoscyamine is hydrolyzed with acids or alkalies. It forms white, hygroscopic crystals melting at 63° C and does not rotate the plane of polarized light Its synthesis (Richard Willstatter, 1901) furnished proof of the structure of the parent alkaloids Tropine has no medical uses but is employed in the manufacture of homatropine (*see* ATROPINE) and similar mydriatic agents. Tropine is closely related to ecgonine, the basic portion of cocaine (*q v*). (L. F St.)

TROPISM, a term introduced by plant physiologists by 1835, grew to designate the bending of a plant in relation to some definite stimulus like that furnished by gravity (geotropism) or light (phototropism) The turning continues until the plant is so oriented that symmetrically placed parts are equally stimulated As outlined in ANIMAL BEHAVIOUR (*q v*), tropism has retained essentially this same meaning except that it also includes the orientation of sessile animals Jacques Loeb initiated and developed the transfer of concepts centring about tropisms from plant physiology to animal behaviour. He believed that, despite the more complicated reaction system of animals, plants and animals behave fundamentally alike. The tropism theory of orientation as applied to higher animals postulates that these bilaterally symmetrical organisms give a quantitatively different reaction of the locomotor appendages or tissues on opposing sides in direct proportion to the strength of stimuli received by the corresponding receptors After being oriented, a motile organism is held on its path by balanced thrusts of its locomotor apparatus, much as a rudderless boat is guided and propelled by laterally operated oars or by a tail-like sculling oar at the stern." This tropism theory of oriented response—also called the muscle-tonus theory—is an incomplete explanation of oriented behaviour. The term tropism has been expanded to include all aspects of unlearned, reflex actions of whole organisms that appear to result from the direct interaction of physical forces in the environment with physiological processes within the organism. Taxes (taxis, singular), as well as tropisms in the restricted sense, were called tropisms with the implication that the reacting organism is mechanically forced to behave as it does Loeb skilfully developed this mechanistic conception of behaviour; after 30 yr of study he wrote (1918). "Motions caused by light or other agencies appear to the layman as expressions of will and purpose on the part of the animal, whereas in reality, the animal is forced to go where carried by its legs For the conduct of animals consists of forced movements." (Jacques Loeb, *Forced Movements, Tropisms, and Animal Conduct*, J B. Lippincott Co., 1918.) According to this theory, behaviour is not primarily adaptive, the male moth is not trying to find a mate, and fishes do not will to swim upstream, they are mechanically forced to do so. Loeb applied this interpretation very widely and (1918) suggested that, with the enlargement resulting from memory, the tropism theory might include human conduct Largely because of its close association with unproved theories, some students avoid the word tropism entirely; others use it descriptively, without theoretical implications, for orientation reflexes of sessile organisms

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TROPPAU: *see* OPAVA

TROPPAU, CONGRESS OF, a conference of the allied sovereigns or their representatives to discuss a concerted policy with regard to the questions raised by the revolution in Naples of July 1820. At this congress, which met on Oct. 20, 1820, the emperors Alexander I of Russia and Francis I of Austria were present in person; King Frederick William III of Prussia was represented by the crown prince (afterward Frederick William IV). The three eastern powers were further represented by the ministers responsible for their foreign policy: Austria by Prince Metternich, Russia by Count Capo d'Istria, Prussia by Prince Hardenberg. Great Britain, on the other hand, which objected on principle to the suggested concerted action against the Neapolitan Liberals, sent no plenipotentiary, but was represented by Lord Stewart, ambassador in Vienna. France, too, had given no plenary powers to her representatives.

In a series of conferences—to which the representatives of Great Britain and France were not admitted, on the excuse that they were only empowered to "report," not to "decide"—was drawn up the famous preliminary protocol signed by Austria, Russia, and Prussia on Nov 19 The main pronouncement of the "Troppau protocol" is as follows "States which have undergone a change of government due to revolution, the results of which threaten other States, *ipso facto* cease to be members of the European Alliance, and remain excluded from it until their situation gives guarantees for legal order and stability. If, owing to such alterations, immediate danger threatens other States the powers bind themselves, by peaceful means, or if need be, by arms, to bring back the guilty State into the Great Alliance."

No effort was made by the powers to give immediate effect to the principles enunciated in the protocol; and after its promulgation the conferences were adjourned, it being decided to resume them at Laibach in the following January (*see* LAIBACH, CONGRESS OF).

BIBLIOGRAPHY.—*See* W Alison Phillips, *The Confederation of Europe*, 2nd ed (1916); *Cambridge Mod. Hist.*, bibl to ch i, vol x, p. 787

TROSSACHS, THE (Gaelic, "the bristled country," a crude allusion to its physical features), a defile in the southwest of Perthshire, Scotland It is a narrow, beautifully wooded glen, of no great depth, extending from Loch Achray to Loch Katrine, and continued thence by a strip on the northeastern shore to a point above the now submerged Silver Strand opposite to Ellen's Isle—a total distance of 2¼ mi It is situated 8 mi. W of Callander and 5 mi N of Aberfoyle, between the steep green slopes of Ben Venue (2,393 ft) on the southwest and the precipitous crags of Ben A'an (1,326 ft) on the northeast. The region has been famous for its beautiful scenery since the appearance of Sir Walter Scott's *The Lady of the Lake* and *Rob Roy*, with their vivid descriptive passages.

TROTSK (Gatchina, Krasnogvardeisk), a town in the Leningrad region of the Russian S.F S.R., in 59° 33′ N., 30° 7′ E, situated among lakes and pine forests on the Izhora river It was originally a Swedish estate presented by Peter I to his sister. Catherine II gave it to Prince Orlov, and a castle and grounds were constructed by the Italian architect, Rinaldi, in 1770. Later it became a military camp, and, toward the end of the 18th century, a summer residence of the tsars. Near the palace is the priory built by Lvov in 1797 for the Knights of Malta, of which order Paul I was grand master. In the civil wars following 1917, Gatchina was used as a base by L G Kornilov and A. F Kerensky in 1917, and N N Yudenich in 1919. In 1923 it was renamed after Trotsky Later it was renamed Krasnogvardeisk

See *Guide to the Soviet Union* (Moscow, 1925) in English

TROTSKY, LEV DAVIDOVICH (1879–1940), Russian politician, whose real name was Bronstein, was born near Elizavetgrad, the son of middle-class Jews. He was educated at the Peter and Paul *Real Schule* in Odessa and at the university of that town. He was arrested as a revolutionary in 1898, and soon after exiled to eastern Siberia. In 1902 he escaped to England by means of a forged passport in the name of Trotsky (which name he used thenceforward). In London, despite his youth, he soon became an important member of the small body of social democrats which included Plekhanov and Lenin He collaborated with the latter and others in the publication of *Iskra* (Spark), the most famous of the Russian revolutionary newspapers. In 1905 he returned to Russia, was elected a member of the St Petersburg Soviet of Workers' Deputies and was chairman of the meeting at which the whole soviet was arrested He was exiled to Tobolsk but escaped immediately on his arrival in Siberia and went to Vienna, where he worked for the *Arbester Zeitung* and the *Pravda*. He also worked in a chemical factory. In 1910 he attended the Social Democratic congress at Copenhagen, defending a position of his own, midway between that of the bolshevists and that of the menshevists In 1913 he was in Constantinople as a war correspondent. The following year found him in Zurich and Paris, taking part in the publication of a revolutionary paper. He wrote a book on the origins of World War I, published in German, and was sentenced to eight months'

imprisonment But he opposed the War not only in Germany but in the Allied countries, and in 1916 was expelled from France. He was arrested by the Spanish authorities on crossing their frontier but was allowed to leave for America, where he edited the Russian revolutionary *Novy Mir* (The New World).

When the revolution broke out in March 1917 Trotsky's friends and subscribers to the paper collected the money for his journey to Russia He was, however, arrested by the British authorities and taken ashore at Halifax, where he was interned until the Russian Provisional government asked for his release. He arrived in Petrograd soon after Lenin He was the leader of a small party of social democrats and soon joined the Bolsheviks but did not actually become a member of the Bolshevik party until July 1917, when he was arrested for being concerned in the rising which took place in that month. He played a part hardly less important than that of Lenin in organizing the Bolshevik revolution in 1917 and became People's Commissar for foreign affairs in the new Soviet Government.

Trotsky was the most important figure in the Russian delegation during the negotiation of the Brest-Litovsk peace treaty. Believing that the moral effect of the revolution had already been such that the Germans would be unable to force their troops to move against Russia, he met the oppressive German demands with the statement that Russia would not sign a treaty on such terms but that she considered the War to be at an end and would demobilize her troops. The Germans thereupon continued their advance. Lenin had disagreed with Trotsky, considering that the risk was too great since at that time the Germans could easily have taken Petrograd After a series of debates, Trotsky announced that he now sided with Lenin and by a majority of one it was decided to sign an even more unfavourable treaty than that previously refused Trotsky was replaced by Chicherin as Commissar for foreign affairs and took over the Commissariat of war. In spite of opposition he made great use of officers of the old régime in organizing a new Red army The results obtained were used to justify the employment of "bourgeois" technical experts in the factories When he had made a new army that showed itself superior to those of the Whites his energies were used in preventing the complete collapse of the railways In 1920 he organized as "labour armies" the troops that were not needed for war.

Until the introduction of the new economic policy Trotsky urged industrial conscription, but wholeheartedly accepted the new policy which made such measures impossible During the Polish war of 1920, he opposed the disastrous advance on Warsaw but was overruled by Lenin In the autumn of 1923 he adopted a position that made it possible for the "old guard" of the Communist leaders to accuse him of canvassing for the support of the younger men. He was violently attacked by Stalin, Zinoviev and others. Many of his friends were shifted from their posts and he himself was on the way to the Caucasus to take a cure, when Lenin died. Throughout the revolution the names of Lenin and Trotsky had been coupled and the death of the one seemed to leave the other alone in the field. This was not really so. Seniority counts for much in the Communist party and the older leaders never forgot that Trotsky had only joined the party in 1917 The campaign to discredit him was continued. He lost his post as Commissar of war. When he returned from the Caucasus he was given work of small political significance, being made head of the committee for the development of electric power in Russia In 1925 he resigned from this post and was made head of the Central Committee for Concessions. In Nov 1927 he was expelled from the Communist party for his anti-party activities, and in Jan. 1928 he was exiled to Vierne in Turkestan. He was subsequently banished and went to Constantinople (1929).

In 1936 he made his home in Norway; in Jan. 1937 he went to live in Mexico He was (1936) accused of joining Zinoviev and Kamenev in a plot to murder Stalin but emphatically repudiated the charge. On Aug. 20, 1940 he was attacked in his suburban home at Mexico city by a "friend" whom the exile's intimates described as a Stalinist agent. He died the next day. (A.R.A.; X.)

WORKS IN ENGLISH: *Defence of Terrorism* (1920); *The Lessons of October* (1925), *Lenin* (1924); *Where Is Britain Going?* (1926). American edition *Whither England?* (1925); *Towards Socialism or Capitalism?* (1926); *Problems of Life* (1924); *Literature and Revolution* (1925), *My Life* (1929), *The Revolution Betrayed* (1937).

TROTZENDORFF (or TROCEDORFIUS), **VALENTIN FRIEDLAND** (1490–1556), German educationist, called Trotzendorff from his birthplace, near Gorlitz, in Prussian Silesia, was born on Feb. 14, 1490, of parents so poor that they could not keep him at school Nevertheless he was sent to study at Görlitz, and became a schoolmaster there He resigned presently to study under Luther and Melanchthon, supporting himself meanwhile by private teaching He then became master in the school at Goldberg in Silesia, and in 1524 rector There he remained three years, when he was sent to Liegnitz He returned to Goldberg in 1531 and began that career which has made him the typical German schoolmaster of the Reformation period He made his best elder scholars the teachers of the younger classes, and insisted that the way to learn was to teach He organized the school in such a way that the whole ordinary discipline was in the hands of the boys themselves. Every month a "consul," twelve "senators" and two "censors" were chosen from the pupils, and over all Trotzendorff ruled as "dictator perpetuus" One hour a day was spent in going over the lessons of the previous day. The lessons were repeatedly recalled by examinations, which were conducted on the plan of academical disputations. Every week each pupil had to write two "exercitia styli," one in prose and the other in verse, and Trotzendorff took pains to see that the subject of each exercise was something interesting. The fame of the Goldberg School extended over all Protestant Germany, and a large number of the more famous men of the following generation were taught by Trotzendorff. He died on April 20, 1556

See Herrmann, *Merkwürdige Lebensgeschichte eines berühmten Schulmanns, V. F. Trotzendorffs* (1727); Frosch, *V F. Trotzendorff, Rektor zu Goldberg* (1818); Pinzger, *V F Trotzendorff* (with the Goldberg portrait, and a complete list of his writings, 1825), Koehler, *V F Trotzendorff, ein biographischer Versuch* (1848), G Bauch, *Valentin Trozendorf und die Goldberger Schule* (1921). The biographical facts appear to be derived from a funeral or memorial oration delivered by Balthasar Rhau in the university of Wittenberg on Aug 25, 1564, and published in an edition of Trotzendorff's *Rosarium* (1565).

TROUBADOUR, the name given to the poets of southern France and of northern Spain and Italy who wrote in the *langue d'oc* from the 12th to the 14th centuries. In Provençal the word is spelt *trobaire* or *trovador*, and is derived from the verb *trobar*, to find, or to invent (Fr *trouver*) The troubadour was one who invented, and originally improvised, poetry, who "found out" new and striking stanzaic forms for the elaborate lyrics he composed.

The earliest troubadour of whom anything definite is known is Guilhem IX. (b 1071), count of Poitiers and duke of Aquitaine, whose career was typical of that of his whole class, for "he knew well how to sing and make verses, and for a long time he roamed all through the land to deceive the ladies" The high rank of this founder of the tradition was typical of its continuation; by far the largest number of the troubadours belonged to the noble class, while no fewer than 23 of their number were reigning princes Among them is a king of England, Richard I., who is believed to have written in *langue d'oil* as well as in *langue d'oc*, and who has left at least one canzo, that written in prison, of remarkable beauty. These noble troubadours were distinguished by their wealth and independence from those who made their song their profession, and who wandered from castle to castle and from bower to bower. But whether dependent or independent, the poets exercised a social influence paralleled by nothing before it in the history of mediæval poetry They had great privileges of speech and censure, they entered into questions of politics, and above all they created around the ladies of the court an atmosphere of cultivation and amenity which nothing had hitherto approached. The troubadour was occasionally accompanied by an apprentice or servant, called a *joglar*, who provided a musical setting for the poet's words, and sometimes sang the songs

There were recognized about 400 troubadours, during the whole period in which they flourished, from Guilhem de Poitiers down

to Guiraut Riquier (*c.* 1230–94). Several ms. collections of biographies have been preserved, and from these we gain some idea of the careers of no fewer than 111 of the poets. The principal source of the lives of the troubadours is a collection, by various hands, made towards the middle of the 13th century. Of these Uc of Saint Cyr (*c.* 1200–40), himself a troubadour, was certainly one of the authors. Another, but unreliable, source of information is the *Vies des plus célèbres et anciens poètes provencaux*, published by Jehan de Notredame or Nostradamus, in 1575. Even the numerous genuine biographies are often embroidered with fantastic and whimsical statements which make a severe demand upon the credulity of a modern reader One late troubadour, Rambaud of Orange, left a commentary on his own poems, and Guiraut Riquier one on those of a fellow troubadour, Guiraut of Calanson (1280). This proves the poetry of Provence to have passed early into the critical stage, and to have been treated very seriously by those who were proficient in it This is further shown by the respect with which the Provençal poets are mentioned by Dante, Petrarch and others.

The verse form most frequently employed by the troubadours was the *sirventés*, a term which is earliest met with in the second half of the 12th century. The troubadours also employed the *ballada*, which was a song with a long refrain, not much like the formal ballade of the north of France; the *pastourella;* and the *alba* This last took its name from the circumstance that the word *alba* (dawn) was repeated in each stanza. This was a morning-song, as the *serena*, a later invention, was an evensong The *planh* was a funeral elegy, composed by the troubadour for the obsequies of his protector, or for those of the lady of his devotion. Most interesting of all, perhaps, was the *tenson*, which was a lyrical dialogue between two persons, who discussed in it, as a rule, some point of amorous casuistry, or matters of a religious, metaphysical or satirical nature. The troubadours were essentially lyrical (*see* Provençal Language and Literature).

The biographies of the troubadours, which throw an unparalleled light upon mediaeval literary life, may perhaps be most conveniently treated in connection with the courts at which each group of them flourished. It is in Poitou that we trace them first, where Guilhem, count of Poitiers, who reigned from 1087 to 1127, was both the earliest patron and the earliest poet of the school The daughter of Guilhem X carried on her grandfather's tradition This was Eleanor of Aquitaine, at whose court Bernart of Ventadour rose to eminence. This poet seems to have been the son of a kitchen-scullion in the castle of Ebles II, viscount of Ventadour. Eble, himself a poet, was early impressed by the talents of his serving-boy, and trained him to be a poet. The beautiful wife of Eble, the viscountess Agnes of Montluçon, encouraged the suit of the youthful Bernart, indeed, they had secretly loved one another from their childhood. The poems which this passion inspired are among the most admirable lyrics which have come down to us from the middle ages. The husband at last discovered the intrigue and exiled Bernart from Ventadour. The troubadour took shelter with Eleanor of Aquitaine, who became in 1152 the queen-consort of Henry II. of England, himself a protector of poets

Henry, eldest son of Henry II., was the patron of another eminent troubadour, Bertran de Born, viscount of Hautefort in Perigord Dante saw Bertran de Born in hell, carrying his severed head before him like a lantern, and compared him with Achitophel, who excited the sons of David against their father. This referred to the subtle intrigues by which the troubadour had worked on the jealousy existing between the three sons of the king of England. The death of Prince Henry (1183) produced from Bertran de Born two *planhs*, which are among the most sincere and beautiful works in Provençal literature The poet was immediately afterwards besieged in his castle of Hautefort by Richard Cœur de Lion, to whom he became reconciled and whom he accompanied to Palestine. He grew devout in his old age, and died about 1205.

There were poetesses in the highly refined society of Provençe, and of these by far the most eminent was Beatrix, countess of Die, whose career was inextricably interwoven with that of another noble troubadour, Rambaut III., count of Orange, who held his court at Courthézon, a few miles south of Orange. Rambaut said that since Adam ate the apple no poet had been born who could compete in skill with himself, but his existing lyrics have neither the tenderness nor the ingenuity of those of his illustrious lady-love. The poems of Beatrix are remarkable for a simplicity of form rare among the poets of her age. Marcabrun (*c.* 1129–95), from whose pen some 40 poems survive, was an innovator and a reformer, to him the severity of classical Provençal style is mainly due, and he was one of the first to make use of that complex form which was known as the *trobar clus* He posed as a violent misogynist—"I never loved and I was never loved." Marcabrun expresses great affection for "that sweet poet," Jaufre Rudel, prince of Blaye, whose heart turned, like the disk of a sunflower, towards the Lady of Tripoli. Little else than that famous adventure is known about the career of this ultra-romantic troubadour, except that he went as a crusader to the Holy Land, and that his surviving poems have so mystical a tone that Jaufre Rudel has been suspected of being a religious writer who used the amorous language of his age for sanctified purposes, and whose "Princess Far-away" was really the Church of Christ. Peire d' Alveona (Peter of Auvergne), like Marcabrun, was of mean birth, son of a tradesman in Clermont-Ferrand, but he was handsome and engaging, and being the first troubadour who had appeared in the mountain district, "he was greatly honoured and fêted by the valiant barons and noble ladies of Auvergne" It is believed that Peire's poems were produced between 1158 and 1180. He flourished at the court of Sancho III, king of Castile, and afterwards at that of Ermengarde, viscountess of Narbonne.

It is doubtless owing to the repeated praise which was given by Dante, in the *Inferno* and elsewhere, to Arnaut Daniel that this name remains the most famous among those of the troubadours He was a knight of Riberac, in Perigord, and attached himself as a troubadour to the court of Richard Cœur de Lion. Dante calls Daniel the "smith," the finished craftsman, of language, and it is evident that it was the brilliant art of the Provençal's elaborated verse which delighted the Italian. His invention of forms of verse (*see* Sestina), in particular, dazzled the great Italian. Dante was curiously anxious to defend Arnaut Daniel as being a better artist than his immediate rival, Giraut de Bornelh; critical posterity, however, has reversed this verdict. Giraut laments, in his poems, the brutality of the age and the lawlessness of princes. A troubadour of the same district of south-western France was Arnaut de Mareuil, to whom is attributed the introduction into Provençal poetry of the amatory epistle.

Peire Vidal of Toulouse was the type of the reckless and scatterbrained troubadour His biographer says that he was "the maddest man in all the world" His early life was a series of bewildering excursions through France and Spain At Marseilles he made a mortal enemy of Azalaïs, the wife of Viscount Barral de Baux, from whom he stole a kiss (1180). He committed a thousand follies; among others, being in love with a lady called Louve (she-wolf), the poet dressed himself as a wolf, and was hunted by a pack of hounds in front of the lady's castle Folquet of Marseilles was a troubadour of Italian race, the son of a merchant of Genoa; Dante met Folquet in paradise, and gives an interesting notice of him It is in the *sirventés* of Folquet that critics have seen the earliest signs of that decadence which was so rapidly to destroy Provençal poetry.

Gaucelm Faidit came from Uzerche, in the Limousin. He seems to have been a wandering minstrel of gay and reckless habits, and to have been accompanied by a light-o'-love, Guilelma Monja, who was the object of much satire and ridicule Another troubadour, Raimbaut of Vaquières, passed the greater part of his life at the same court of Montferrat; he devoted himself to the Lady Beatrix, sister of the marquis The most celebrated of the Italian troubadours was Sordello, born at Mantua, at the beginning of the 13th century, who owes his fame to the benevolence of later poets, from Dante to Robert Browning.

We have now mentioned the troubadours who were most famous in their own time, and on the whole modern criticism has

been in unison with contemporary opinion There are, however, still one or two names to be recorded The English historian of the troubadours, Dr. Hueffer, gave great prominence to the writings of Guillem de Cabestanh (or Capestang). This was a knight of Roussillon, who made love to Seremonda, countess of Castel-Roussillon. The lady's husband slew him in a paroxysm of jealousy and, having cut out his heart, had it delicately cooked and served to his wife at dinner When Seremonda had eaten her lover's heart, her husband told her what she had done, and she threw herself out of the window and was killed. Feeling grew so strong that the surrounding nobles, with Alfonso, king of Spain, at their head, hunted the murderer down and killed him. The bodies of the lady and the troubadour were buried side by side, in the cathedral of Perpignan, and became the objects of pilgrimage.

The great cause of the decadence and ruin of the troubadours was the struggle between Rome and the heretics. This broke out into actual war in June 1209, when the northern barons, called to a crusade by Pope Innocent III, fell upon the Albigenses and pillaged Béziers and Carcassonne. Most of the protectors of the troubadours were, if not heretics, indulgent to the heretical party, and shared in their downfall. The poets, themselves, were not immediately injured, but the darkness began to gather round them as the ruin of Languedoc became more and more complete, culminating with the siege of Toulouse in 1218. The greatest name of this period, which was the beginning of the end, is that of Peire Cardenal, of Le Puy. He was protected by Jacme I, king of Aragon, having apparently fled from Narbonne and then from Toulouse in order to escape from the armies of Simon de Montfort. He was the inventor of the moral or ethical *sirventés;* and the author of singularly outspoken satires against the clergy. Another troubadour of this time was Guilem Figueira, the son of a Toulouse tailor, an open heretic who attacked the papacy with extraordinary vigour, supported and protected by Raimon II. Figueira was answered, strophe by strophe, by a female troubadour, Gormonda of Montpellier. The ruin of the southern courts, most of which belonged to the conquered Albigensi party, continued to depress the troubadours, whose system was further disintegrated by the establishment of the Inquisition. The genial and cultured society of Provence and Languedoc sank rapidly into barbarism, and there was no welcome anywhere for secular poets

The last of the French troubadours was Guiraut Riquier (*c* 1230–94), who was born at Narbonne, and found protection at the Spanish court of Alfonso X, the Learned. Riquier, in a *sirventé* of about 1285, gives pathetic expression to his sense of the gathering darkness, which makes it useless and almost unbecoming for a troubadour to practise his art, while of himself he mournfully confesses. "Song should express joy, but sorrow oppresses me, and I have come into the world too late." Guiraut Riquier passed away about 1294, and left no successor behind him.

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TROUBETZKOY, AMÉLIE RIVES, PRINCESS (1863–1945), U.S. author, was born on Aug. 23, 1863, in Richmond, Va A popular novelist of the 1890s, she created a literary sensation with her first novel, *The Quick or the Dead?* (1888), which originally appeared in a magazine. The theme, a young widow's conflict between her love for her dead husband and a new lover, considered a taboo subject, caused considerable furor and resulted in enormous sale of her book. Prince Pierre Troubetzkoy (q.v.) was her second husband; the marriage took place at her family's estate in Virginia in 1896 Princess Amélie was also a playwright, poet and essayist. Her writings include: *Seléné* (1905), *Augustine the Man* (1906), *The Golden Rose* (1908), *Pan's Mountain* (1910), *Hidden House* (1911), *The World's End* (1913), *Shadows of Flames* (1915), *The Ghost Garden* (1918), *As the Wind Blew,* poems (1922), *The Queerness of Celia* (1926) and *Firedamp* (1930). She died in Charlottesville, Va., on June 15, 1945

TROUBETZKOY, PIERRE, PRINCE (1864–1936), portrait painter of Russian parentage, was born on April 19, 1864, at Milan, Italy He received his education at the Collegio Calchi Taeggi in Milan and emigrated to the United States in his early thirties. One of his portraits of the British statesman, Gladstone, hangs in the National Gallery at Edinburgh and another in the National Portrait gallery, London Other examples of his work are to be found in Town hall, Dover, England, at the Instituto de Valencia de Don Juan, Madrid, and at the University of Virginia. He died on Aug. 25, 1936

TROUBRIDGE, SIR THOMAS, BART. (*c* 1758–1807), English admiral, was educated at St. Paul's school, London, and entered the navy in 1773 Having seen some service in the East Indies, he was taken prisoner by the French in 1794 In Feb. 1797 he commanded his ship, the "Culloden," at the battle of Cape St. Vincent. In the following July he assisted Nelson in the unsuccessful attack on Santa Cruz He served in the Mediterranean and was created a baronet in 1799, from 1801 to 1804 he was a lord of the admiralty, being made a rear admiral just before his retirement. In 1805 Troubridge was given a command in the east and he went out in the "Blenheim." He was drowned in the wreck of the "Blenheim" off Madagascar, in Jan. 1807

TROUPIAL, a collective name suggested by Ridgway for the American family Icteridae, which includes the North American orioles, meadow larks, cowbirds, grackles and blackbirds and the Central American cacíques

TROUT. The general common name applied to certain species of the family of fishes called Salmonidae and discussed under this heading.

TROUVÈRE, the name given to the mediaeval poets of northern and central France, who wrote in the *langue d'oil* or *langue d'oui.* The trouvères flourished abundantly in the 12th and 13th centuries They were court poets who devoted themselves almost exclusively to the composition and recitation of a particular kind of poetry, the subject of which was some refinement of love

The first appearance of trouvères seems to date from 1137, when Eleanor of Aquitaine, herself the granddaughter of an illustrious troubadour, arrived in the court of France as the queen of Louis VII, speaking the Poitiers dialect of the *langue d'oc.* She was queen for 15 years (1137–52), the period during which the southern influence was strongest in the literature of northern France, and the successive crusades tended to produce relations between the two sections of poetical literature. The northern poets rarely approach the grace and delicacy of the troubadours, while their verse shows less ingenuity and less variety. The earliest trouvères, like Conon de Béthune and Hugues de Berze, in writing their amatory lyrics, were, however, certainly influenced by what troubadours had written.

The poetical forms adopted by the trouvères bore curious and obscure names, the signification of which is still in some cases dubious. The *retruenge* was a song with a refrain; the *serventois* was, in spite of its name, quite unlike the sirventes of the troubadours and had a more ribald character; the estrabot was allied to the *strambotto* of the Italians, and was a strophic form "composed of a front part which was symmetrical, and of a tail which could be varied at will" (Gaston Paris).

The court poetry of the trouvères particularly flourished under the protection of three royal ladies. Marie, the regent of Champagne, was the practical ruler of that country from 1181 to 1197, and she encouraged the minstrels in the highest degree and discussed the art of verse with Chrètien of Troyes Her sister, Aélis or Alice, welcomed the trouvères to Blois; she was the protector of Gautier d'Arras and of Le Châtelain de Coucy. Another Aélis, who became the second queen of Louis VII in 1160, received

Conon de Béthune in Paris, and reproved him for the Picard accent with which he recited his poetry. At the end of the 12th century the refinement and elegance of the court poets was recognized in the north of France by those who were responsible for the education of princes. A trouvère, Gui de Ponthieu, was appointed tutor to William III of Macon, and another, Philippe of Flanders, to Philippe Auguste. The vogue of the trouvères began during the third crusade; it rose to its greatest height during the fourth crusade and the attack upon the Albigenses. The first 40 years of the 13th century was the period during which the courtly lyrical poetry was cultivated with most assiduity. At first it was a purely aristocratic pastime, and among the principal trouvères were princes such as Thibaut IV of Navarre, Louis of Blois and John, king of Jerusalem. About 1230 the taste for court poetry spread to the wealthy bourgeoisie, especially in Picardy, Artois and Flanders. Before its final decline, and after the courts of Paris and Blois had ceased to be its patrons, the poetry of the trouvères found its centre at Arras, where some of the most skilful of all the trouvères, such as Jacques Bretel and Adam de la Halle, exercised their art. About 1280 the poetical system suddenly disappeared.

The poet was invariably a lover, devoted to a married lady who was not his wife, and to whose caprices he was bound to submit blindly and patiently. The progress of this conventional courtship was laid down according to certain strict rules of ceremonial, love became a science and a religion, practised by the laws of precise etiquette. The *rondel* of Adam de la Halle (published in E. de Coussemaker's edition, 1872) beginning

"À Dieu comant amouretes,
Car je m'en vois
Souspirant en tere estrange!"

marks perhaps the highest point to which the delicate, frosty art of the trouvères attained. Music took a prominent place in all their performances, but little is known of the melodies which they used. But enough has been discovered to justify the general statement of Tiersot that "we may conclude that the musical movement of the age of the trouvères was derived directly from the most ancient form of popular French melody." A precious ms. in the Faculty of Medicine of Montpellier contains the music of no fewer than 345 part-songs attributed to trouvères.

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TROUVILLE, a seaside town of northwestern France, in the department of Calvados, on the English channel, 34 mi. N.E of Caen by rail. Pop. (1946) 7,052. Trouville stands at the mouth of the Touques on its right bank opposite Deauville. Its fine stretches of sand and excellent bathing make it the most frequented French resort on the channel. Deauville is well known for its racecourse and villas. The port, shared with Deauville and formed by the Touques, is entered by a channel between jetties with a depth at high tide of 17½ ft.; it is supplied with a half-tide dock, filled to scour the channel, and a floating dock, with average depth of 18 ft.

Timber, coals and cement are imported. The London and South Western railway company has a daily steamboat service from LeHavre to Trouville in connection with its Southampton and LeHavre boats.

TROWBRIDGE (tro'brij), a market town, Westbury parliamentary division, Wilts., England, 974 mi W. by S of London by the G. W. railway. Pop of urban district (1938 est.) 12,470.

Trowbridge was mentioned in Domesday under the name of Strabung, a manor held by one Brictric together with Staverton and Trowle, now both included within its limits. The first reference to the "town" of Trowbridge occurs early in the 16th century; previous to that date mention is made of the manor and castle only. Trowbridge is now a non-corporate town and is the chief centre of the West of England woollen industry and makes kerseymere, broadcloth and other woollen goods. Area, 3.5 sq mi.

TROY, JOHN WEIR (1868–1942), U.S. politician, was born in Dungeness, Wash., on Oct. 31, 1868. He began work in the newspaper field, starting as a reporter in his 18th year, and rotated his experience in journalism with work as county clerk and auditor. During the Klondike gold rush, Troy landed a job as manager of a pack train and stayed on in Alaska as editor of an Alaskan newspaper. Later he founded a magazine but it was short-lived, in 1913 he became editor of the *Daily Alaska Empire* in Juneau. In the following year he purchased the newspaper. Six times Alaskan delegate to the National Democratic convention, he was chairman of the Democratic Alaska Territorial committee, 1932–34.

Troy became governor of Alaska in 1933, serving until 1939. He died in Juneau on May 2, 1942.

TROY, a city of southeastern Alabama, U.S.A., county seat of Pike county; on federal highway 231, and served by the Atlantic Coast and the Central of Georgia railways. Pop. (1950) 8,474; (1940) 7,055; and (1920) 5,696 (50% Negroes). It is the seat of a state teachers college (1887); the trade centre of a rich agricultural region, producing especially cotton, cattle, hogs and peanuts; and has several manufacturing industries. The city was incorporated in 1843.

TROY, a city of eastern New York, U.S., the county seat of Rensselaer county, on the east bank of the Hudson river, 7 mi. above Albany, at the mouth of the Mohawk. It is on federal highway 4 and the State Barge canal, and is served by the Boston and Maine, the Delaware and Hudson, the New York Central and motorbus and truck lines and river steamers. Pop. (1950) 71,659; 70,304 in 1940, by federal census. Across the river are Cohoes, Watervliet, Green Island and Waterford, connected with Troy by bridges, and Schenectady is only 15 mi. northwest. The city has a water front of 7 mi. and an area of 9.32 sq.mi., rising from the river to hills on the east 400 ft. high. Its 10 parks cover 300 acres. The Catskill mountains are visible on the southwestern horizon. Troy is at the head of steamboat navigation on the Hudson. Two rapid streams, Poesten kill and Wynants kill, flowing into the Hudson from the east through deep ravines, furnish water power, and hydroelectric current also is available. Troy has long been an important industrial and commercial city. It is the principal centre in the United States for the manufacture of shirts and collars, and among its other leading products are men's clothing, surveying instruments, abrasives, valves, hydrants, bells, coke, chains, brushes and automobile parts. Among the educational institutions in the city are the Rensselaer Polytechnic institute, founded in 1824 by Stephen van Rensselaer of Albany, and Russell Sage college for women (est. 1916).

The site of Troy was part of the Van Rensselaer manor grant of 1629. In 1659 it was bought from the Indians, with the consent of the patroon, by Jan Barentsen Wemp, and in 1707 it passed into the hands of Derick van der Heyden. In 1777 Gen. Philip Schuyler had his headquarters on Van Schaick's Island, in the Mohawk and Hudson. After the close of the Revolution there was an influx of settlers from New England; a town was laid out on the Van der Heyden farm; in 1789 the name of Troy was adopted in town meeting; in 1793 the county seat was established there; in 1794 the village was incorporated, and in 1816 it was chartered as a city. A newspaper, *The Farmer's Oracle*, began publication in 1797. In 1812 a steamboat line was established between Troy and Albany, and in 1825 the Erie canal was opened. During the War of 1812 Troy filled large contracts for army beef. Puddling works were opened in 1839, and for many years the city was the centre of the iron and steel industry of New York. The second Bessemer steel works in the United States was established there in 1865. During the Civil War Troy supplied much cannon and ammunition, and made the armour plate and part of the machinery for the "Monitor." The last steel and iron works discontinued operations about 1896. The collar industry dates its origin from 1819, when Hannah Lord Montague of Troy had the ingenious idea of making separate collars for her husband's shirts. The idea spread, and in 1829 Ebenezer Brown, a local

merchant, had collars made to sell in his store The manufacture of cuffs was begun in 1845. After the introduction of the sewing machine in 1852 the industry grew rapidly, reaching its peak about the time of World War I. The city had a population of 28,985 in 1850; 39,235 in 1860, 56,747 in 1880, 60,051 in 1900; 76,813 in 1910 In 1820, 1834 and 1862 it suffered from destructive fires

TROY, a city of western Ohio, U S , the county seat of Miami county, on federal highway 25, and the west bank of the Great Miami river, 20 mi N of Dayton It has an airport, and is served by the Baltimore and Ohio and the Big Four railways The population in 1950 was 10,628; it was 9,697 in 1940 and 8,675 in 1930 by federal census. Troy was settled in 1807 and was chartered as a city in 1890.

TROY and **TROAD. The Troad** (ἡ Τρωάς), or land of Troy, is the north-west promontory of Asia Minor, between the valleys of the Caicus on the south and the Aesepus flowing into Propontis on the east. The eastern limit was variously defined by ancient writers Geographically, it is undoubtedly (as Strabo says) the range of Ida, which, from the north shore of the Adramyttian gulf, sends its north-western spurs nearly to the coast of the Propontis. The greatest length of the Troad from north-west at Cape Sigeum (Yeni Shehr), to the south-west at Cape Lectum (Babâ Kale), is about 40 m ; the breadth, not much greater. The central area is drained by the Menderes (anc. *Scamander*), which rises in Ida and reaches the Hellespont east of Cape Sigeum.

Timber is supplied by pine forests on Mt. Ida. But the plains and hills are fairly wooded. Besides valonia oak, there are elm, willow, cypress and tamarisk, with lotus, galingale and reeds, as in Homeric days, about the streams. The vine is cultivated; watermelons are abundant; cotton, wheat and maize are grown. Even under Turkish rule, the natural advantages of the land mitigated the poverty of its inhabitants; in antiquity it was fertile and populous.

Early History.—In Greek legend, Priam of Troy ruled all that is bounded by "Lesbos, Phrygia and the Hellespont" (*Il.* xxiv. 544). The Achaeans under Agamemnon destroyed Troy, and overthrew Priam's dynasty. But there is Homeric prophecy that Aeneas and his descendants shall still rule over the Troes, in a passage probably later than the bulk of the book, and it is certain that in the 7th or 6th century B C. reputed descendants reigned somewhere in the Troad. Thracian tribes, including Bithynians and Treres, swept into Asia Minor from Europe in the 7th century B.C., and the Ionian poet, Callinus, recorded the terror which they caused.

Greek Settlements.—The earliest and most important of the Greek settlements were Aeolic, mainly from Lesbos and Cyme in Aeolis; some may have been as early as the 13th century B C. About 620 B.C. Athenians occupied Sigeum, and were resisted by Aeolic colonists from Mytilene, already established in that neighbourhood.

Chief Greek towns in the Troad were Ilium in the north, Assus (*q v.*) in the south, and Alexandria Troas (*q v.*) in the west. The site of the Greek Ilium is marked by the low mound of Hissarlik (Turk. "place of fortresses") in the Trojan plain, about 3 m from the Hellespont, the traditional site of Homer's "Troy" When Xerxes visited the Trojan plain, he "went up to the Pergamon of Priam," and sacrificed to the Ilian Athena. Ilium yielded to Dercyllidas in 399 B.C , and was captured by Charidemus in 359 B.C , but was evidently still of small importance when, in 334 B.C , Alexander visited it on landing in the Troad. In their temple of Athena the Ilians showed him arms which had served in the Trojan war, including the shield of Achilles. Either then or after the battle of Granicus, Alexander enlarged the town to be a "city," with political independence and exemption from tribute. Lysimachus executed the intentions of Alexander when north-west Asia Minor fell to him in 301 B.C., building a wall 5 m in circumference, incorporating decayed towns of the neighbourhood, and building a temple of Athena. In the 3rd century B C Ilium was the head of a federal league of free Greek towns, from Lampsacus on the Hellespont to Gargara on the Adramyttian gulf. In 278 B.C. the Gauls, under Lutarius, occupied Ilium, but abandoned it. Forty years later (218 B.C.) other Gauls brought by Attalus I for his war against Achaeus, deserted his standard, pillaged the towns on the Hellespont, and besieged Ilium, from which, however, they were driven off by the troops of Alexandria Troas In the 2nd century B C Ilium was in decay; as Demetrius of Scepsis says, the houses "had not even roofs of tiles" The temple of Ilian Athena, however, retained its prestige, in 192 B.C. Antiochus the Great visited it before sailing to the aid of the Aetolians In 190 B C , before the battle of Magnesia, Romans and Ilians were alike eager to recall the legend of Roman descent from Aeneas; Lucius Scipio offered sacrifice to the Ilian Athena; and after the defeat of Antiochus the Romans annexed Rhoeteum and Gergis to Ilium, "not so much in reward of recent services, as in memory of the source from which their nation sprang." The later history of Ilium is a catalogue of Roman benefactions, though, in 85 B C , when Fimbria took it, he left it in ruins, Sulla, however, was careful to rebuild it; Augustus confirmed its ancient privileges and gave it new territory, Caracalla (A D 211–217), like Alexander, paid honours to the tomb of Achilles In the 4th century, the Ilians were attracting tourists by their pseudo-Trojan memorials. After the 4th century the place is lost to view.

Of the other ancient cities, *Neandria* seems to be rightly fixed at Mt. Chigri, not far from Alexandria Troas, remarkable for its fine view of the whole Troad. *Cebrene* has been located in the eastern part of the plain of Bairamich, *Palaescepsis*, farther east, on Ida, while the new *Scepsis* was near Bairamich. At Kulakli, south of the mouth of the Tuzla, Corinthian columns mark the temple of Apollo Smintheus (excavated in 1866 by Pullan) and (approximately) the Homeric *Chryse*. *Colonae* was on the coast opposite Tenedos *Scamandria* was at Eneh, in the plain of Bairamich, and *Cenchreae* probably some way north of it The shrine of Palamedes, *Polymedium*, has been discovered by J T. Clarke between Assus and Cape Lectum; the sacred enclosure and the statue of Palamedes were on the acropolis. Clarke also found very ancient walls on Gargarus, the highest peak of Ida.

The Site of Troy.—The traditional site, at the Hellenistic Ilium, is the mound of Hissarlik, on a spur between the main Scamander valley and its last tributary from the east (anc. *Simois*), about 3½ m. from the Hellespont and from the Aegean shore, north of Besika bay The famous academic dispute concerning the site, which began about A D 160 with Demetrius of Scepsis, may be regarded as settled by the discovery, made in 1893, of a fortress on the mound of Hissarlik, contemporary with the great period of Mycenae, and overlying the smaller and the earlier acropolis first identified by Schliemann in 1872. The rival ruins of a small hill fort on the Bali Dagh which, with another on an opposite crag, commanded the gorge where the Scamander descends into the plain neither accord with Homeric description nor challenge the remains at Hissarlik in importance

No site in the Troad accords completely with all the topographical clues ingeniously derived from the text of Homer. The hot and cold springs that lay just without the gate of "Troy" are no more to be identified with Bunarbashi, which wells out more than a mile from the Bali Dagh ruins, than with the choked conduits south of Hissarlik, opened by Schliemann in 1882 But the broader topography is recognizable in the modern plain of the Menderes. The old bed of that river is the Scamander, and its little tributary, the Dumbrek Su, is the Simois In their fork lies Hissarlik or Troy. In sight of it are, on the one side, the peak of Samothrace (Il xiii. 12–14); on the other Mt Ida (Kaz Dagh viii. 52). Hissarlik lies in the plain (xx. 216), easily reached by foes from the shore, or left and regained in a night by a Trojan visiting the Achaean camp (vii. 382–421).

Archaeological Investigation of Troy.—Schliemann's excavations at Hissarlik in 1872–74, supplemented and confirmed by W. Dörpfeld in 1891–94, established the existence of nine superposed settlements, as follows:—

1. On the virgin soil of the natural hillock a small village of the late Aegean Neolithic period, at the dawn of the Bronze age, contemporary with the upper part of the Cnossian Neolithic bed, includes what were supposed by Schliemann to be two primitive settlements. Thin walls of rough stones, bonded with

mud, reveal no house-plans, nor traces of fortress wall Implements in obsidian and various kinds of stone, clay whorls, a little worked ivory, accompany dark monochrome pottery, hand-polished, with simple geometric decoration, incised and often filled with white.

2. Superposed and comprehending a larger area, lies the "second city," better constructed and preserved, and twice rebuilt Its massive fortress wall of rudely squared "Cyclopean" masonry suffered several restorations and eventual destruction, except on the south Double gates at south-east and south-west are well-preserved. The most complete and most important structures within are a *megaron* and vestibule of the type familiar in "Mycenaean" palaces, with one or more smaller replicas alongside it, like the "women's quarters" at Tiryns (*q v*) and Phylakopi (*See* AEGEAN CIVILIZATION) This is the fortress proclaimed by Schliemann in 1873 to be the "Pergamos" of Troy, mainly because it perished by fire But this second stratum belongs to a primitive stage of local civilization preceding the "Mycenaean," which is the earliest recalled by the Homeric poems. The pottery now shows the first rare use of paint, and of technique and fantastic forms parallel to those of the pre-Mycenaean Cyclades. Trough-spouted vases are characteristic, and rude reproductions of human features are common in this ware, which seems all native. Bronze had come into use for implements, weapons and vessels; a hoarded treasure found in the ruins of the fortification wall includes much gold and silver But the forms are primitive and the workmanship very rude Personal ornaments are cut out of thin plate gold or built of coiled wire. But some of the discs, bracelets and pendants, with advanced spiral ornament, found in 1878 and ascribed to this stratum, belong undoubtedly to the sixth or "Mycenaean." Rough fiddle-shaped idols, whorls, a little worked ivory and some lead make up a find, of whose early period (probably about 2000 B.C) comparison of objects found elsewhere leaves no doubt. This treasure is now deposited in Berlin with the bulk of Schliemann's collection

3, 4, 5. After the burning of the "second city," Hissarlik ceased for a time to have any considerable population Three small village settlements have left their traces superposed and show only slight advances of material culture.

6 The mound, however, occupied too important a site, in relation to the plain and the sea, to remain desolate, and it was occupied in the 14th or 13th century by a great fortress, while a city not yet explored, spread below. This "sixth city" was first distinguished clearly by Dörpfeld in 1882, but Schliemann's drastic methods confused its commoner pottery and metal objects with those of lower strata; and some grey ware, to which Schliemann gave the name "Lydian" was alone referred to this sixth or "Lydian" city, in his *Troja* (1884). This ware has been compared with the "Minyan" fabric at Orchomenus, but also resembles the "Lausitz" pottery, which originated on the middle Danube, and was intruded into Macedonia at the close of the 12th century For years this "sixth city" was neglected.

In 1893, however, excavations in hitherto undisturbed ground outside the earlier fortress, exposed a wall of massive ashlar masonry resembling the fortifications of Mycenae itself, and "Mycenaean" walls at Phylakopi in Melos. With this wall occurred not only the grey ware, but painted potsherds unmistakably "Mycenaean"; and further search showed that such sherds were characteristic of "sixth city" deposits. The inevitable inference is that this city imported contemporary "Mycenaean" ware to supplement its own ruder products. The area of its citadel is larger than the "second city," its buildings, which include a large *megaron*, are of finer construction. This was the most important city yet built on the mound It belonged to the "Mycenaean" age, which precedes the composition of the Homeric poems, and is reflected by them. Therefore this is Homer's Troy.

Its remains, however, having been obliterated on the crown of Hissarlik, almost escaped recognition, for when, long afterwards, the Hellenistic Ilium was built, the top of the mound was cut away and the uppermost strata vanished. Thus we find them now on the southern slope of the mound only, but have no difficulty in estimating their original extent. Tombs and the outer quarters of this city will doubtless be found eventually.

7. The "sixth," or "Mycenaean" Troy, perished by violence like the "second city," but its inhabitants reoccupied its ruins, until, in early Hellenic times, the small unfortified settlement was established which maintained itself till the Homeric enthusiasm of Alexander the Great called a city again into being on Hissarlik

8. The Hellenistic Ilium, however, has left comparatively little trace; fortifications erected by Lysimachus are visible on the acropolis and in the plain A small Doric temple belongs to this city, and a larger one, probably dedicated to Athena, seems to be of Pergamene age. Fragments remain of its metopes, representing Helios and a Gigantomachia. Coins of this city show Athena on both faces, and inscriptions prove that Hellenistic Ilium was of some importance.

9 Lastly, about the Christian era, the Graeco-Roman city built a theatre and an ornate gateway on the south-east slope, a large building on the south-west and others to north-east. This city seems to have decayed in the 5th century A.D

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The Legend of Troy.—In Greek legend, the oldest town in the Troad was that founded by Teucer, who was a son of the Scamander (a Cretan stream, according to Tzetzes) and the nymph Idaea. In his reign, Dardanus, son of Zeus and the nymph Electra, daughter of Atlas, in consequence of a deluge, drifted from Samothrace to the Troad, where he received land from Teucer, married his daughter Batea, and founded Dardana, at the foot of Mt. Ida. On the death of Teucer, Dardanus succeeded him, and called the whole land Dardania He begat Erichthonius, who begat Tros by Astyoche, daughter of Simois Tros called the country Troy and the people Troes (Trojans) By Callirrhoe, daughter of Scamander, Tros had three sons—Ilus, Assaracus and Ganymede. From Ilus and Assaracus sprang two separate lines; Ilus, Laomedon, Priam, Hector, and Assaracus, Capys, Anchises, Aeneas Ilus went to Phrygia, where he received, as a wrestling prize from the king of Phrygia, a spotted cow, with an injunction to found a city where she lay down. The cow lay down on the hill of the Phrygian Atē; here Ilus founded Ilion; and Dardania, Troy and Ilion became one city. Desiring a sign from Zeus, Ilus prayed and found lying before his tent the Palladium, a wooden statue of Pallas, for which he built a temple. By Eurydice, daughter of Adrastus, he had a son, Laomedon, who married Strymo, daughter of Scamander (or Placia, daughter of Atreus or of Leucippus) In his reign, Poseidon and Apollo (or Poseidon alone), built the walls of Troy, but Laomedon withheld their reward. In his reign also, Heracles besieged and took the city, slaying Laomedon and his children, except one daughter, Hesione, and one son, Podarces. The life of Podarces was granted at the request of Hesione, on condition that Podarces first be a slave and then be redeemed by Hesione; she gave her veil for him; hence his name of Priam (Gr πριάσθαι, to buy). Priam married first Arisbe and afterwards Hecuba, and had 50 sons and 12 daughters. Among the sons were Hector and Paris, and among the daughters Polyxena and Cassandra. Paris, betrothed to Oenone, awarded the golden "apple of strife" to Aphrodite (who promised him the love of the fairest of women) and brought upon Troy the resentment of Hera and Athena Thereafter, Paris, visiting Sparta, found favour with Helen, heiress of

Tyndareus and wife of Menelaus, son of Atreus, and carried her to Troy. To recover Helen, the Achaeans under Agamemnon, brother of Menelaus, besieged Troy for ten years. In the tenth year Hector was killed by Achilles, and he by Paris. At last a wooden horse was contrived in whose hollow many Achaean heroes hid themselves Their army and fleet then withdrew to Tenedos, feigning to have raised the siege The Trojans conveyed the wooden horse into Troy; in the night the Greeks stole out, opened the gates to their friends, and Troy was taken *See also* HOMERIC POEMS.

See Homer, *Il.* vii. 452 *seq.*, xx. 215 *seq.*, xxi 446 *seq.*; Apollodorus ii. 6, 4, iii 12; Diodorus iv 75, v. 48, Tzetzes, *Schol on Lycophron*, 39, 72, 1302; Conon, *Narrat.* 22; Dionysius Halicarn., *Antig. Rom.* 1 68 *seq.* The *Iliad* deals with a period of 51 days in the tenth year of the war. the *Odyssey* with the wanderings and homecoming of an Achaean leader, Odysseus For the wooden horse *see* Homer, *Od.* iv. 272 *seq.*; Virgil, *Aen* ii. 13 *seq.*

The Historical Background of the Trojan War.—The "Tale of Troy," with legends of heroes who "fought in the war," was popular when the *Odyssey* (*see* HOMER) was composed; wherein minstrels sing lays about it, and the Sirens boast that they "know it all." From the 7th century B.C., at least, it supplied subjects to vase painters and other craftsmen, and in the 5th, to the sculptors of the Aegina pediments (*see* GREEK ART), and to Athenian dramatists. (*See* DRAMA: *Greek*.) Herodotus and Thucydides, like ancient writers generally, accepted the Trojan war as historical, though they criticized epic statements in detail, and Herodotus noted discrepancy between the *Cypria* and the *Iliad* Ephorus, and afterwards Strabo, marshalled geographical learning as commentary on the Achaean and Trojan "catalogues" in *Il* ii; the scholars of Alexandria elucidated Homeric antiquities, those of Pergamum their topographical and historical background; Demetrius of Scepsis in the Troad, misdoubted, on geological grounds, the reputed site of Troy Traditional genealogies, collated by Hecataeus (*see* HECATAEUS OF MILETUS) and others, enabled Eratosthenes (*q.v.*) to date the "Fall of Troy" to 1194 B.C., in the third generation before the "coming of the Dorians" and in the second after Laomedon's foundation. Homeric references to Egypt (where Thebes, not Memphis, is the capital) and to Phoenicia (where Sidon is known, but not Tyre) supply a historical background for the war, not later than the 12th century; but the names of Egyptian kings (*Thôs, Thuôris*) in epic and classical tradition, are not identified: Pliny (36.64) alludes to a Rameses "in whose time Troy fell." Egyptian references, however, to repeated sea-raids into the Levant, between 1230 and 1190 B.C., depict a situation closely resembling Homeric descriptions; and the *Aquiusha* (*Akhaywasha*), *Danauna*, *Tukkara* (*Teukaroi*) and probably other participants in these raids may be safely recognized as Achaeans, Danaans, and Teucrians in Greek tradition. Hittite documents confirm the existence of an oversea régime called Akkhayawa, aggressive against south-west Asia Minor, one of whose leaders, Attarissyas, active in Caria and north Syria about 1230, was a contemporary, if not namesake, of Atreus, father of Agamemnon Consequently, 13th century doubts as to the historical content of epic tradition, and attempts to discover "solar" and other mythological allegories in the personages and events of the war, are being superseded by recognition of a social and political régime historically assignable to the 13–12th centuries, of which the following are turning-points: (1) The establishment of the Trojans, with other Thraco-Phrygian peoples, in north-west Asia Minor before 1260 B.C fully justifying the defensive alliance between the Hittite king and Rameses II. in 1271 B.C. (2) The consolidation of a dominion, of which the "sixth city" at Hissarlik was an important centre; the geographical range of Priam's vassals, from the Axius river to the Xanthus, and the memory of a great fight "on the Sangarius river" far inland, are instructive (3) The overthrow of Hittite dominion by this new régime, about 1200 B.C., followed by the land-and-sea-raids of 1197–94 as far as south Palestine, where they were stopped by Rameses III. (4) The counterparts, west of the Aegean, of the dynasty Laomedon-Priam-Hector, are the "divine born" kingships (Pelops-Atreus-Agamemnon, Aeacus-Peleus-Achilles, and the like) established by adventurers of unknown antecedents, and foreign names. from Ithaca and Aetolia to Crete and Rhodes, and as far north as Thessaly, their distribution closely covering that of the "Late Mycenaean" settlements, which are surely dated archaeologically to these generations, in Egypt, Cyprus and Palestine (5) Whether the destruction of the "sixth city" resulted from an attack of this "Achaean" confederacy of the south-west Aegean on the Hellespontine citadel of its Thraco-Phrygian cousins, or directly from those Danubian representatives of the "Lausitz" culture which characterizes the "seventh city," and is recognizable as a disturbing factor in Macedonia also, later in the 12th century, cannot at present be determined, nor the value of the synchronism between the attack on Troy and the great sea-and-land-raids towards Egypt, of which the tale of Tithonus and Memnon may preserve echoes. (6) Traditions of the establishment of settlements, eventually Greek, round the margins of the Late Mycenaean world, are so numerous, and coherent both with Homeric and with archaeological evidence, that they may be accepted as an essentially historical counterpart of the situation described in the *Odyssey;* which, however, was transformed as profoundly by the "coming of the Dorians" as the Mycenaean world had been by the irruption of the "divine born" adventurers five generations before. Between those two crises lies the "Heroic Age" of the Aegean, of its central episodes one is the struggle between Argos and Thebes, ended by the tragic fall of the Cadmeian dynasty, the other is the Trojan war, as disastrous to the victors as to the conquered (J. L. MY.)

The Mediaeval Legend of Troy.—The mediaeval *Roman de Troie*, exercised greater influence in its day and for centuries after its appearance than any other work of the same class Just as the *chansons de geste* of the 10th century were the direct ancestors of the prose romances which afterwards spread throughout Europe, so, even before Heliodorus and Achilles Tatius, there were quasi-histories, which reproduced in prose, with more or less exactness, the narratives of epic poetry. The *Heroikos* of Flavius Philostratus (*fl.* 3rd century A.D.) is a discourse on 26 heroes of the war. A fictitious journal (*Ephemeris*), professing to give the chief incidents of the siege, and said to have been written by Dictys of Crete, a follower of Idomeneus, is mentioned by Suidas, and was largely used by John Malalas and other Byzantine chroniclers This was abridged in Latin prose, probably in the 4th century, under the title of *Dictys Cretensis de bello Trojano libri VI.* It is prefaced by an introductory letter from a certain L. Septimius to Q. Aradius Rufinus, in which it is stated that the diary of Dictys had been found in his tomb at Knossos in Crete, written in the Greek language, but in Phoenician characters The narrative begins with the rape of Helen, and includes the adventures of the Greek princes on the return voyage With Dictys is always associated Dares, a pseudo-historian of more recent date. Old Greek writers mention an account of the destruction of the city earlier than the Homeric poems, and in the time of Aelian (2nd century A.D.) this *Iliad* of Dares, priest of Hephaestus at Troy, was believed to be still in existence. Nothing has since been heard of it; but an unknown Latin writer, living between 400 and 600, took advantage of the tradition to compile *Daretis Phrygii de excidio Trojae historia*, which begins with the voyage of the Argo It is in prose and professes to be translated from an old Greek manuscript. Of the two works that of Dares is the later, and is inferior to Dictys The matter-of-fact form of narration recalls the poem of Quintus Smyrnaeus. In both compilations the gods and everything supernatural are suppressed, even the heroes are degraded. The permanent success, however, of the two works distinguishes them among apocryphal writings, and through them the Troy legend was diffused throughout western Europe. The Byzantine writers, from the 7th to the 12th century, exalted Dictys as a first-class authority, with whom Homer was only to be contrasted as an inventor of fables. Western people preferred Dares, because his history was shorter, and because, favouring the Trojans, he flattered the vanity of those who believed that people to have been their ancestors Many mss. of both writers were contained in old libraries; and they were translated into nearly every language and turned into verse.

In the case of both works, scholars were long undecided whether a Greek original ever existed but fragments of the Greek text of Dictys have been recovered. (*See* Dictys Cretensis) The Byzantine grammarian, Joannes Tzetzes (*fl.* 12th century), wrote a Greek hexameter poem *Iliaca* on the subject. In 1272, a monk of Corbie translated "sans rime *L'Estoire de Troiens et de Troie* (de Dares) du Latin en Roumans mot à mot" because the *Roman de Troie* was too long. Geoffrey of Waterford put Dares into French prose; and the British Museum has three Welsh mss. translations of the same author, of a much later period

For a thousand years the myth of descent from the dispersed heroes of the conquered Trojan race was a sacred literary tradition throughout western Europe. The first Franco-Latin chroniclers traced their history to the same origin as that of Rome, as told by the Latin poets of the Augustan era; and in the middle of the 7th century Fredegarius Scholasticus (*Rer. gall. script.* ii. 461) relates how one party of the Trojans settled between the Rhine, the Danube and the sea. In a charter of Dagobert occurs the statement, "ex nobilissimo et antiquo Trojanorum reliquarum sanguine nati." This statement is repeated by chroniclers and panegyrical writers, who also considered the *History of Troy* by Dares to be the first of national books. Succeeding kings imitated their predecessors in giving official sanction to their legendary origin; Charles the Bald, in a charter, uses almost the same words as Dagobert, "ex praeclaro et antiquo trojanorum sanguine nati." In England a similar tradition had been early formulated, as appears from Nennius's *Historia Britonum* and Geoffrey of Monmouth. The epic founder of Britain was Brutus, son, or in another tradition, great-grandson, of Aeneas, in any case of the royal house of Troy. The tradition, repeated in Wace's version of Geoffrey, by Matthew Paris and others, persisted to the time of Shakespeare. Brutus found Albion uninhabited except by a few giants. He founded his capital on the banks of the Thames, and called it New Troy. Otto Frisingensis (12th century) and other German chroniclers repeat similar myths. About 1050 a monk named Bernard wrote *De excidio Trojae*, and in the middle of the 12th century Simon Chèvre d'Or, canon of the abbey of Saint-Victor, Paris, followed with another poem in leonine elegiacs on the fall of the city and the adventures of Aeneas, in which the Homeric and Virgilian records were blended

About the year 1184 Benoît de Sainte-More (*q.v.*) composed a poem of 30,000 lines entitled *Roman de Troie*. He derived his information chiefly from the pseudo-annals of Dictys and Dares, but we may justly consider the *Roman de Troie* as an original work. From this source subsequent writers drew their notions of Troy, mostly without naming their authority and generally without even knowing his name. This is the masterpiece of the pseudo-classical cycle of romances: and in the Latin version of Guido delle Colonne it passed through every country of Europe.

The *De bello trojano* of Joseph of Exeter, in six books, a genuine poem of no little merit, was written soon after Benoît's work or about the years 1187–88. At first ascribed to Dares Phrygius and Cornelius Nepos, it was not published as Joseph's until 1620, at Frankfurt It was directly drawn from the pseudo-annalists, but the influence of Benoît was considerable Of the same kind was the *Troilus* of Albert of Stade (1249), a version of Dares, in verse, characterized by the old severity and affected realism. But these Latin works can only be associated indirectly with Benoît, who had closer imitators in Germany at an early period. Herbort of Fritzlar reproduced the French text in his *Lied von Troye* (early 13th century), as did also Konrad von Würzburg (d 1287) in his *Buch von Troye* of 40,000 verses, which he himself compared to the "boundless ocean." It was completed by an anonymous poet. To the like source may be traced a poem of 30,000 verses on the same subject by Wolfram von Eschenbach; and Jacques van Maerlant reproduced Benoît's narrative in Flemish The Norse or Icelandic *Trojumanna saga* repeats the tale with some variations.

In Italy, Guido delle Colonne, a Sicilian, began in 1270 and finished in 1287 a prose *Historia trojana*, in which he reproduced the *Roman de Troie* of Benoît, and so closely as to copy the errors of the latter. The vivacity and poetry of the Anglo-Norman trouvère disappear in a dry version. The immense popularity of Guido's work is shown by the large number of existing manuscripts. In the 14th and the commencement of the 15th century four versions appeared in England and Scotland. The best known is the *Troy Book*, written between 1414 and 1420, of John Lydgate, who had both French and Latin texts before him An earlier and anonymous rendering exists at Oxford (Bodleian ms Laud Misc. 595). There is the *Gest Hystoriale of the Destruction of Troy* (Early Eng. Text Soc, 1869–1874), written in a northern dialect about 1390; a Scottish version (15th century) by a certain Barbour, not the poet, John Barbour; and *The Seege of Troy*, a version of Dares (Harl. ms. 525 Brit. Mus) The invention of printing gave fresh impetus to the spread of Guido's work. The first book printed in English was *The Recuyell of the Hystoryes of Troye*, a translation by Caxton from the French of Raoul Lefèvre

Bibliography.—The Troy legend is dealt with in the elaborate work of A Joly, *Benoît de Sainte-More et le Roman de Troie* (1870–71); G Körting, *Der altfrzs. Roman de Troie* (1883), F. Settegast, *Benoît de Ste-More* (Breslau, 1870); G. C. Frommann, *Herbort v. Fritzlar u Benoît de Ste-More* (Stuttgart, 1837), R. Jackel, *Dares Phrygius u. Benoît de Ste-More* (Breslau, 1875); *Le Roman de Troie*, ed L. Constans (Soc. d anc. textes fr. Paris, 1904).

TROYES, a town of France, capital of the department of Aube, 104 mi. E.S E. of Paris on the Eastern railway to Belfort. Pop. (1936) 57,961 The town stands in the wide alluvial plain watered by the Seine, the main stream of which skirts it on the east. It is traversed by several small arms of the river, and the Canal de la Haute-Seine divides it into an upper town, on the left bank, and a lower town, on the right bank The churches of the town are numerous, and especially rich in stained glass of the Renaissance period. St. Pierre, the cathedral, 13th to 16th centuries, consists of an apse with seven apse chapels, a choir with double aisles, on the right of which are the treasury and sacristy, a transept without aisles, a nave with double aisles and side chapels and a vestibule. There are stained glass windows of the 15th and 16th centuries The treasury contains some fine enamel work and lace. The church of St. Urban has windows dating for the most part from the years 1265–80. Most of the old houses of Troyes are of wood, but some are of stone of the 16th century, notably the hôtels de Vauluisant, de Mauroy and de Marisy. The prefecture occupies the buildings of the old abbey of Notre-Dame-aux-Nonnains; the *hôtel de ville* dates from the 17th century.

Troyes is the seat of a bishop and a court of assize. Its public institutions include a tribunal of first instance, a tribunal of commerce, a board of trade arbitrators and a chamber of commerce It has a school of hosiery. The dominant industries in Troyes are the manufacture of cotton, woollen and silk hosiery, printing and dyeing of fabrics.

History.—At the beginning of the Roman period Troyes was the principal settlement of the Trecassi, from whom it derives its name. In the first half of the 4th century its bishopric was created as a suffragan of Sens. St. Loup, the most illustrious bishop of Troyes, occupied the episcopal seat from 426 to 479. In the early middle ages the bishops were supreme in Troyes, but in the 10th century this supremacy was transferred to the counts of Troyes (*see* below), who from the 11th century were known as the counts of Champagne. Under their rule the city attained great prosperity. Its fairs, which had already made it a prominent commercial centre, flourished under their patronage, while the canals constructed at their expense aided its industrial development. The union of Champagne with the domains of the king of France in 1304 was disastrous to the city, since one of the first measures of Louis le Hutin was to forbid the Flemish merchants to attend its fairs. For a short time (1419–25), during the Hundred Years' War, the town was the seat of the royal Government, and in 1420 the signing of the Treaty of Troyes was followed by the marriage of Henry V of England with Catherine, daughter of Charles VI. in the church of St. Jean. In 1429 the town capitulated to Joan of Arc. The next 100 years was a period of prosperity, marred by the destruction of half the town by the fire of 1524 In the 16th

century Protestantism made some progress in Troyes, but in 1562, after a short occupation, the Calvinist troops were forced to retire, and in 1572 fifty Protestants were put to death The revocation of the Edict of Nantes in 1685 was a severe blow to the commerce of Troyes, which was not revived by the re-establishment of the former fairs in 1697 The population fell from 40,000 to 24,000 between the beginning of the 16th century and that of the 19th century.

See T. Boutiot, *Histoire de Troyes et de la Champagne méridionale* (4 vols. Troyes, 1870–80); R. Koechlin and J. J Marquet de Vasselot, *La Sculpture à Troyes et dans la Champagne méridionale au seizième siècle* (1900).

TROYON, CONSTANT (1810–1865), French painter, was born on Aug 28, 1810, at Sèvres, near Paris, where his father was connected with the porcelain factory. Troyon was an animal painter of the first rank, and was closely associated with the artists who painted around Barbizon Until he was twenty he laboured assiduously at the minute details of porcelain ornamentation By the time he reached twenty-one he was travelling the country as an artist, and painting landscapes. Troyon was a favourite with Roqueplan, and became one of his pupils Roqueplan introduced Troyon to Rousseau, Jules Dupré, and the other Barbizon painters In 1846 Troyon went to the Hague, and saw Paul Potter's famous "Young Bull" From the studies he made of this picture, of Cuyp's sunny landscapes, and Rembrandt's masterpieces he evolved a new method of painting, and it is only in works produced after this time that Troyon's true individuality is revealed Troyon died at Paris on Feb. 21, 1865. All his famous pictures are of date between 1850 and 1864. In the Wallace Gallery in London are "Watering Cattle" and "Cattle in Stormy Weather"; in the Glasgow Corporation Gallery is a "Landscape with Cattle"; the Louvre contains his famous "Oxen Going to Their Work" and "Returning to the Farm"; while the Metropolitan Museum of Art and other galleries in America, contain fine examples His "Vallée de la Toucque, Normandy," is one of his greatest pictures. Émile van Marcke (1827–1891) was his best-known pupil.

See H. Dumesnil, *Constant Troyon: Souvenirs intimes* (Paris, 1888), A Hustin, "Troyon" (1893), D C. Thomson, *The Barbizon School of Painters* (London, 1890), W Gensel, *Corot und Troyon* (Leipzig, 1906).

TRÜBNER, WILHELM (1851–1917), German painter, was born at Heidelberg on Feb. 3, 1851. He studied at Karlsruhe, Stuttgart and afterwards with Diez at Munich, where he came under the influence of Leibl and the impressionist group He did not, however, join this or any other group, but went his own independent way, although he too aimed at achieving the effect of light and air in his painting, and worked with broad strokes of the brush For some years he made Munich his home In 1896 he settled in Frankfurt and in 1903 was made professor at the Karlsruhe academy. He died at Karlsruhe on Dec. 21, 1917 Trübner's colour was always warm and rich; but from the Frankfurt period onward he adopted a more restricted scheme and relied on strong contrasts in place of the tender intermediate tones of his earlier days. He had an admirable sense of values and his landscapes are sometimes built up almost in the manner of Cézanne His portraits were also particularly successful.

His landscapes include the series of Heidelberg landscapes (1889) with the "View from the Castle" (Darmstadt); those painted at Chiemsee, and the later series at Amorbach and the Neuburg (1913) Among his portraits are those of the artist Schuch (Berlin), of his son in armour, and of the "Boy with Mastiff" (Dusseldorf)

See Fritz Knapp, *Kunstlerische Kultur des Abendlandes* III, pp. 330 *et seq.*

TRUCE OF GOD, an attempt of the Church in the middle ages to alleviate the evils of private warfare The two measures which were adopted by the Church to remedy this evil—the *pax ecclesiae* or *Dei* and the *treuga* or *treva Dei*—are usually both referred to as the Truce of God, but they are distinct in character. The latter was a development of the former.

The *pax ecclesiae* is first heard of in the year 990 at three synods held in different parts of southern and central France—at Charroux, Narbonne and Puy. It enlisted the immediate support of the regular clergy, particularly the vigorous congregation of Cluny, and of William V. of Aquitaine, the most powerful lord of southern France, who urged its adoption at the councils of Limoges (994) and Poitiers (999) The peace decrees of these various synods differed considerably in detail, but in general they forbade, under pain of excommunication, every act of private warfare or violence against ecclesiastical buildings and their environs, and against certain persons, such as clerics, pilgrims, merchants, women and peasants, and against cattle and agricultural implements With the opening of the 11th century, the *pax ecclesiae* spread over northern France and Burgundy, and diocesan leagues began to be organized for its maintenance. The bishop, or count, on whose lands the peace was violated was vested with judicial power, and was directed, in case he was himself unable to execute sentence, to summon to his assistance the laymen and even the clerics of the diocese, all of whom were required to take a solemn oath to observe and enforce the peace At the council of Bourges (1038), the archbishop decreed that every Christian 15 years and over should take such an oath and enter the diocesan militia. The idea that peace is a divine institution seems to have given rise to a new name for the peace, the *pax Dei*, or peace of God

The *treuga* or *treva Dei*, the prohibition of every act of private warfare during certain days, goes back at least to the Synod of Elne (1027) which suspended all warfare from Saturday night till prime on Monday. Like the *pax ecclesiae* it found ardent champions in the regular clergy, especially in Odilo (962–1049), the fifth abbot of Cluny, and soon spread over all France It penetrated Piedmont and Lombardy in 1041 and Normandy in 1042 By this time the truce extended from the Wednesday evening to the Monday morning in every week and also, in most places, lasted during the seasons of Lent and Advent, the three great vigils and feasts of the Blessed Virgin, and those of the 12 apostles and a few other saints. The *treuga Dei* was decreed for Flanders at the Synod of Thérouanne (1063) and was instituted in southern Italy in 1089, probably through Norman influence The bishop of Liége introduced it in Germany in 1082, and three years later a synod held at Mainz in the presence of the emperor Henry IV. extended it to the whole empire. It did not extend to England, where the strength of the monarchy made it unnecessary. The popes took its direction into their own hands towards the end of the 11th century; and the first decree of the Council of Clermont (1095), at which Urban II. preached the first crusade, proclaimed a weekly truce for all Christendom, adding a guarantee of safety to all who might take refuge at a wayside cross or at the plough The Truce of God was reaffirmed by many councils, such as that held at Reims by Calixtus II. in 1119, and the Lateran councils of 1123, 1139 and 1179 When the *treuga Dei* reached its most extended form, scarcely one-fourth of the year remained for fighting, and even then the older canons relating to the *pax ecclesiae* remained in force. The means employed for its enforcement remained practically the same: spiritual penalties, such as excommunication, special ecclesiastical tribunals, sworn leagues of peace, and assistance from the temporal power The Council of Clermont prescribed that the oath of adherence to the truce be taken every three years by all men above the age of 12, whether noble, burgess, villein or serf The results of these peace efforts were perhaps surprisingly mediocre, but it must be borne in mind that not only was the military organization of the dioceses always very imperfect, but Continental feudalism, so long as it retained political power, was inherently hostile to the principle and practice of private peace. The Truce of God was most powerful in the 12th century, but with the 13th its influence waned as the kings gradually gained control over the nobles and substituted the king's peace for that of the Church.

See Du Cange, *Glossarium, s.v. Treuga;* A. Kluckhohn, *Geschichte des Gottesfriedens* (Leipzig, 1857), J Fehr, *Der Gottesfriede und die katholische Kirche des Mittelalters* (Augsburg, 1861), E Sémichon, *La Paix at la trève de Dieu* (2nd ed. 1869), L. Huberti, *Studien zur Rechtsgeschichte des Gottesfreden und Landfreden*, Bd 1. *Die Friedens-Ordnungen in Frankreich* (Ansbach, 1892); E. Mayer, *Deutsche und franzosische Verfassungsgeschichte* (1899), vol 1; A. Luchaire, "La Paix et la trève de Dieu," in E. Lavisse's *Histoire de France*, II. 2, pp. 133–138 (1901). (C. H.)

TRUCK SYSTEM. The payment of the wages of workmen *in kind*, or in any other way than the unconditional payment of money, a practice known as the "truck system" Sometimes the workman was paid with "portion of that which he has helped to produce," but the more usual form was to give the workman the whole or part of his wages in the shape of commodities suited to his needs. There was also a practice of paying in money, but with an express or tacit understanding that the workman should resort for such goods as he required to shops or stores kept by his employer. The truck system led in many cases to grave abuses and was made illegal in Great Britain by the Truck Acts, under which wages must be paid in current coin of the realm, without any stipulations as to the manner in which the same shall be expended (*See* LABOUR LAW.)

TRUFFLE, the name of several kinds of subterranean fungi of the family Ascomycetes (*See* FUNGI.) Truffles have been famous for their esculent qualities from classical times Several were recognized by the ancient Greeks and Romans, Theophrastus (*c* 300 B.C.) gives one of them a name which apparently refers to a common belief that truffles were produced by thunder Pliny thought that they were amongst the most wonderful of all things in springing up and living without a root There are numerous references to truffles in classical writings and Coelius Apicius gives six recipes for cooking them

The subterranean Ascomycetes are usually placed in two main groups, the Tuberales and the Plectascales, depending upon the possession of fruit-bodies with or without an opening to the exterior during development The suggestion is that these have arisen along parallel lines. A point of interest is that we also have subterranean forms of similar external appearance in Phycomycetes and Basidiomycetes.

The best-known genus of the Tuberales is *Tuber*, which is mainly native to temperate regions. The different species range in size from that of a pea to that of an orange A section of a young specimen shows a whitish homogeneous flesh which, as maturity is approached, becomes a rich dark colour showing a lighter "marbling." Microscopical examination reveals that the trama plates bearing the hymenium are thrown into elaborate folds (*venae internae*) whereas other plates of tissue which are light-coloured, sterile and joined either directly or indirectly to the exterior run between them (*venae externae*). This complicated arrangement is reached by a series of advances which may be traced in the allied genera The spores of *Tuber* are large and are usually not more than four in an ascus; in the same fruit-body a range from one to four may usually be seen These were the first ascospores to be observed; Tournefort described them in 1710–11 and Micheli figured them in 1729. It was a common belief that they became truffles merely by enlargement, though fermentation of the earth, exudations of branches and leaves, excretion of roots, gall production by insects were frequently regarded as reasonable explanations of their formation Truffles principally occur in open woodland on calcareous soil, being rare in or absent from sandy soil and pastures They are usually associated with the roots of trees and are possibly mycorrhizal fungi

The most valued truffle in French cookery is the Périgord truffle (*T. melanosporum*) which is said to have first gained favour towards the end of the 15th century It is brownish black, roundish and covered with polygonal warts having a depression at their summit; the flesh (*gleba*) is first white, then brownish grey, and when mature becomes violaceous black, with white veins having a brown margin. The odour is well-marked and not unpleasant. The main French truffières are in Périgord and the Department of Vaucluse, though truffles are gathered throughout a large part of France The truffle industry is an important one and about one-third of the gatherings are now exported; foreign trade began seriously about a century ago and before the World War reached to as much as £3,000,000 annually As the truffles often occur at the depth of a foot it is difficult to detect them unaided Truffles, when occurring near the surface of the ground, crack it as they reach full size and experienced gatherers are thereby enabled to locate them. Further, many species of fly live on truffles and in the morning and evening columns of small yellow flies (*Helomisa lineata*, etc.) may be seen hovering over the place where truffles are present.

Occasionally man is sufficiently "susceptible" to the scent of truffles to be able to locate them. Several kinds of animals, however, recognize the scent without difficulty. Truffle hunting is therefore carried on with their aid; pigs and dogs being generally used, though goats are said to be so trained in Sardinia.

The truffle industry has proved so profitable in France that the government has taken in hand the reforesting of many large and barren areas, for many of the best truffle regions have become productive by the private planting of the appropriate trees These are oaks (*Quercus cocifera*, *Q. ilex* with admixture of *Q robur*, *Q sessiliflora* and hazel); "si voulez des truffes, semez des glands" is an adage which has been handed on for generations Direct attempts at cultivation have so far proved unsatisfactory. Calcareous ground is dug over and acorns or seedlings planted. Soil from truffle areas is usually spread about and the ground is kept in condition by light ploughing and harrowing After three years clearings are made and the trees are pruned Truffles if they are to appear do so only after five years or so; gathering begins then but it hardly pays until after from eight to ten years. The yield is at its maximum from five to twenty-five years later. *Tuber melanosporum* has not been recorded for England

The English truffle is *T. aestivum* which is found principally in beech woods. It is bluish black, roundish and covered with coarse polygonal warts, the gleba is white when immature, then ochraceous and finally brownish with whitish, branched, labyrinthine markings It was formerly hunted on the south downs by the aid of mongrel terriers and was sold in Covent Garden. (J. RM.)

TRUJILLO or TRUXILLO, a seaport on the Atlantic coast of Honduras, department of Colón, in 15° 54′ N. and 86° 5′ W. Pop (1950 census) 3,265. The harbour, an inlet of the bay of Honduras, is sheltered on the north by the promontory of Cape Honduras; it is deep and spacious, but insecure in westerly winds Mahogany, dye woods, sarsaparilla, cattle, hides and fruit are exported, grain, flour, hardware and rum are imported. Trujillo was founded in 1524, and became one of the most prosperous ports of the new world, and the headquarters of a Spanish naval squadron.

During the 17th century it was frequently and successfully raided by buccaneers, and thus lost much of its commerce, which still more, in modern times, has been diverted to Puerto Cortés and to Puerto Castilla, across the bay.

TRUJILLO, the capital of the department of La Libertad in northern Peru, lies some 300 mi. up the coast and north of Lima. It is Peru's second oldest Spanish city, having been founded by Pizarro's orders in 1535 and named in honour of his birthplace in Spain. In size it is the fifth city of Peru (pop 47,728 in 1950) and the most important city in the north. In 1945 Trujillo became the seat of a Roman Catholic archdiocese. The city is 4 mi from the coast at its nearest point and 8 mi. by rail from Salaverry, its port.

Trujillo serves the important mining region of Quiruvilca (copper) and Milluachaqui (gold and silver), exploited by the Northern Peru Mining and Smelting company, a subsidiary of the American Smelting and Refining Company of New York, and ships quantities of bar-copper, gold and silver ores, concentrates and precipitates It also serves two agricultural districts, that of the valley of the Macke river and of the valley of the Chicama, the last-named being probably the most important sugar cane growing district of Peru. Much of the traffic that formerly passed through Trujillo from the Chicama valley was diverted to Puerto Chicama (formerly known as Malabrigo).

Though Trujillo is in the tropics, the climate is distinctly temperate because of the Humboldt current that sweeps up the western coast of South America from the Antarctic ocean to Punta Pariña, Peru, where it flows out to sea, the average temperature of this current being about 60° F. An extended observation of meteorological conditions at Trujillo shows a maximum temperature of 85° F. and a minimum of 55°, the mean variation between diurnal and nocturnal extremes being ten degrees. The region is

ordered shift from civilian to military production to make the U S. and its allies capable of resisting Russian attack.

As a further bulwark against the U S S R the United States inspired formation of the North Atlantic Treaty organization (NATO), consisting of the U S, Canada, Iceland and nine western European states On Dec 19, 1950. the NATO council approved the appointment of Gen Dwight D Eisenhower, then president of Columbia university, as organizer of a western European army under NATO auspices

On April 11, 1951, President Truman removed General MacArthur from his posts as commander of U S and U N forces in the far east. Truman justified his action on the ground that MacArthur's proposed tactical plan, which included bombing of Communist bases in North Korea and China, would have transformed a local conflict into a possible global war. Returning to the U S, MacArthur delivered a series of speeches attacking the administration's policies in the far east.

Domestic Problems; Decision Not to Run Again.—In view of unsettled conditions at home and abroad, Truman's election in 1948 had been a minor miracle of U S. politics. Powerful influences within the party, including political professionals and liberals, wanted to sidetrack him in favour of General Eisenhower. The election of Gov Thomas E. Dewey of New York, the Republican nominee, was forecast by almost every public-opinion poll and political prophet. But Truman made what he called a "whistle stop" campaign, appearing before thousands of voters in every section except the south. He assailed the Republicans as reactionaries and isolationists. His most effective sally, perhaps, was his reiterated declaration that "any workingman or farmer who votes against the Democratic party ought to have his head examined."

Truman received 303 electoral votes and Dewey 189, with 39 going to the States' Rights Democrats ("Dixiecrat") ticket, which was entered in the race as a southern protest against the strong civil rights plank in the Democratic platform. The "Dixiecrat" ticket was headed by J Strom Thurmond of South Carolina, with Fielding L. Wright of Mississippi the vice-presidential candidate

Congressional revelations of corruption and maladministration in several executive agencies, notably the bureau of internal revenue, the Reconstruction Finance corporation and the department of justice, embarrassed the administration in 1950–51. After defending his appointees, including Democratic National Chairman William M Boyle, Jr, for almost a year, the president discharged many high government and political officials He named Frank E. McKinney as Boyle's successor. He ordered Attorney General J Howard McGrath to "clean up" venal conditions among federal officeholders

On Nov. 1, 1950, President Truman was the object of an attempted assassination. He escaped unharmed One assassin was killed and the other wounded, one secret service guard was killed and two others were wounded. The would-be assassins, Griselio Torresola (who was killed) and Oscar Collazo, were Puerto Rican nationalists.

Truman's seizure of the steel industry April 8, 1952, to avoid a strike precipitated a grave constitutional issue which was settled only when the supreme court, by a vote of six to three, ruled that the seizure was unconstitutional.

Truman announced March 29, 1952, that he would not run for the presidency again, although he made another "whistle stop" tour of the nation in support of the unsuccessful Democratic nominee, Adlai E. Stevenson. (R. Tu.; X.)

TRUMBIĆ, ANTON (1863–1938), Yugoslav statesman, was born at Split. He became successively mayor of Split, and deputy for the city in the Dalmatian Diet, and after 1907 deputy in the Austrian parliament. In 1905 he and his fellow Dalmatians, Pero Čingrija, Smodlaka and Supilo, as delegates of the Croat National party, worked for the renewed co-operation between Serb and Croat, which culminated in the resolutions of Fiume and Zara in 1905, and in the parallel negotiations with the Magyar coalition parties.

In 1917 Trumbić and others negotiated, with the exiled Serbian government in Corfu and representatives of all the Serbian parties, the so-called "Declaration of Corfu," which provided the basis for a united Yugoslav state Trumbić met representative Italians in Dec. 1917 and March 1918, and shared in the arrangements for the congress of oppressed nationalities held in Rome in April In Oct. 1918 Trumbić was appointed foreign minister in the Yugoslav provisional government and peace delegate in conjunction with Pašic and Vesnić The Yugoslavs were obliged to come to a direct agreement with Italy, and the Treaty of Rapallo was signed in Nov. 1920.

Trumbić's long absence in Paris, coupled with the policy of abstention pursued by the Croat Peasant party under Radić, placed him at a fatal disadvantage when the question of the new constitution came up in 1921 The sudden *volte face* of Radić after the elections of 1925 left Trumbić somewhat isolated, as the leader of the newly constituted "Croat Federalist Peasant party."

TRUMBULL, JOHN (1750–1831), American poet, was born in what is now Watertown, Conn, where his father was a Congregational preacher, on April 24, 1750 At the age of seven he passed his entrance examinations at Yale, but did not enter until 1763; he graduated in 1767, remained at the college studying, and in 1771–73 was a tutor He spent a year in Boston in the office of John Adams, and after 1774 practised law in Connecticut He was state's attorney in 1789, a member of the Connecticut assembly in 1792 and 1800, a judge of the superior court in 1801–19, and finally a judge in the supreme court of errors. The last six years of his life were spent in Detroit, Mich., where he died on May 10, 1831. While studying at Yale he had contributed in 1769–70 ten essays, called "The Meddler," imitating *The Spectator*, to the *Boston Chronicle*, and in 1770 similar essays, signed "The Correspondent" to the *Connecticut Journal* and *New Haven Post Boy* While a tutor he wrote his first satire in verse, *The Progress of Dulness* (1772–73), an attack in three poems on educational methods of his time. His great poem, which ranks him with Philip Freneau and Francis Hopkinson as an American political satirist of the period of the Revolutionary War, was *McFingal*, of which the first canto, "The Town Meeting," appeared in 1776 (dated 1775). This canto, about 1,500 lines, contains some verses from "Gage's Proclamation," published in the *Connecticut Courant* for Aug. 1775; it portrays a Scotch Loyalist, McFingal, and his Whig opponent, Honorius, apparently a portrait of John Adams. This first canto was divided into two, and with a third and a fourth canto was published in 1782 After the war Trumbull was a rigid Federalist, and with the "Hartford Wits," David Humphreys, Joel Barlow and Lemuel Hopkins, wrote the *Anarchad*, a poem directed against the enemies of a firm central government.

See the memoir in the Hartford edition of Trumbull's *Poetical Works* (1820); J H Trumbull, *The Origin of "McFingal"* (Morrisania, New York, 1868), and the estimate in M C Tyler's *Literary History of the American Revolution* (New York, 1897).

TRUMBULL, JOHN (1756–1843), American artist, was born at Lebanon (Conn), on June 6, 1756, the son of Jonathan Trumbull (1710–1785), governor of Connecticut He graduated at Harvard in 1773, served in the War of Independence, rendering a particular service at Boston by sketching plans of the British works, and was appointed second aide-de-camp to Gen Washington and in June 1776, deputy adjutant general to Gen. Gates, but resigned from the army in 1777. In 1780 he went to London to study under Benjamin West, but his work had hardly begun when the news of the arrest and execution of Major André, who was deputy adjutant general in the English army, suggested the arrest of Trumbull as having been an officer of similar rank in the Continental army; he was imprisoned for seven months. In 1784 he was again in London working under West, in whose studio he painted his "Battle of Bunker Hill" and "Death of Montgomery," both of which are in the Yale School of Fine Arts.

In 1785 Trumbull went to Paris, where he made portrait sketches of French officers for "The Surrender of Cornwallis," and began, with the assistance of Jefferson, "The Signing of the Declaration of Independence," well known from the engraving by Asher B Durand. These paintings, with "The Surrender of

Burgoyne" and "The Resignation of Washington," were bought by the United States government and placed in the capitol at Washington, D C. Trumbull's "Sortie from Gibraltar" (1787), owned by the Boston Athenaeum, is now in the Boston Museum of Fine Arts, and a series of historical paintings, the "Trumbull Gallery," by far the largest single collection of his works (more than 50 pictures), has been in the possession of Yale college since 1831, when Trumbull received from the college an annuity of $1,000 His portraits include full lengths of General Washington (1790) and George Clinton (1791), in the city hall of New York—where there are also full lengths of Hamilton and of Jay; and portraits of John Adams (1797), Jonathan Trumbull and Rufus King (1800); of Timothy Dwight and Stephen Van Rensselaer, both at Yale; of Alexander Hamilton (in the Metropolitan Museum of Art, New York city, and in the Boston Museum of Fine Arts, both taken from Ceracchi's bust), a portrait of himself painted in 1833, a full length of Washington, at Charleston, S C.; a full length of Washington in military costume (1792), now at Yale, and portraits of President and Mrs. Washington (1794), in the National museum at Washington. Trumbull's own portrait was painted by Stuart and by many others. He died in New York on Nov 10, 1843

BIBLIOGRAPHY.—*See* his *Autobiography* (1841); J F Weir, *John Trumbull, A Brief Sketch of His Life, to Which is Added a Catalogue of His Works* (1901), and John Durand, "John Trumbull," *American Art Review*, vol ii, pt 2, pp 181–191 (1881)

TRUMBULL, JONATHAN (1710–1785), American political leader, was born at Lebanon, Conn, on Oct 12, 1710 He graduated from Harvard in 1727 and began the study of theology, but in 1731 engaged in business with his father. He next studied law, was elected to the assembly in 1773 and held public office almost continuously afterward. He served for 7 years in the assembly, being speaker for 3 years; for 17 years as county judge of Windham county, for 22 years (after 1740) as governor's assistant; for 2 years as deputy governor (1767–69); and for 3 years (1766–69) as chief justice of the colony. In 1769 he was elected governor and continued in office until his voluntary retirement in 1784. During the War of Independence he was a valued counsellor of Washington The story that the term "Brother Jonathan," a sobriquet for the United States, originated in Washington's familiar form of addressing him seems to be without any foundation. After the war Trumbull was a strong Federalist He died in Lebanon on Aug 17, 1785.

BIBLIOGRAPHY.—His public papers have been printed in the Massachusetts Historical Society's *Collections*, 5th series, vol ix, x (1885–88), and 7th series, vol ii, iii (1902). *See* I W. Stuart, *Life of Jonathan Trumbull, sen* (1859)

TRUMPER, VICTOR (1877–1915), Australian cricketer, was born at Sydney, N.S W., Austr., on Nov. 2, 1877, and died there June 28, 1915. His first appearance against England was in a second-class match against Stoddart's team in 1894–95. In 20 seasons of first-class cricket, 1894–1914, he made 17,000 runs for an average of 45.

TRUMPET, in music, a brass wind instrument with cup-shaped mouthpiece and a very characteristic tone. It consists of a brass or silver tube with a narrow cylindrical bore except for the bell joint, forming from one-third to one-fourth the whole length, which is conical and terminates in a bell of moderate diameter The tube of the trumpet is doubled round upon itself to form a long irregular rectangle with rounded corners A tuning slide consisting of two U-shaped cylindrical tubes fitting into each other is interpolated between the bell joint and the long cylindrical joint to which the mouthpiece is attached.

The mouthpiece consists of a hemispherical cup with a rim across which the lips stretch. The shape of the cup, and more especially of the bottom, in which is pierced a hole communicating with the main bore, is of the greatest importance on account of its influence on the tone quality and on the production of the higher harmonics It is recognized that the shallower and smaller the cup the more easily are the higher harmonics produced; the sharper the angle at the bottom of the cup the more brilliant and incisive is the timbre, given, of course, the correct style of blowing. The diameter of the cup varies according to the pitch and to the lip power of the player who chooses a cup to suit him

There are three principal kinds of trumpets (1) the natural trumpet, mainly used in cavalry regiments, in which the length of the tube and pitch are varied by means of crooks; (2) the slide and double-slide trumpets, in which a chromatic compass is obtained, as in the trombone, by double tubes sliding upon one another without loss of air; (3) the valve trumpet, similar in its working to all other valve instruments. The first and second of these alone give the true trumpet timbre. The tone of the valve trumpet approximates that of the cornet, nevertheless, it is now almost universally used.



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THE TRUMPET, SHOWING THE MODERN FORM EQUIPPED WITH VALVES

In the trumpet the notes of the harmonic series from the 3rd to the 10th or 16th upper partials are produced by the varied tension of the lips and pressure of breath called overblowing. The fundamental and the second harmonic are rarely obtainable, and are therefore left out of consideration; the next octave from the fourth to the eighth harmonics contains only the third, fifth and minor seventh, and is therefore mainly suitable for fanfare figures based on the common chord The diatonic octave is the highest and its upper notes are only reached by very good players on trumpets of medium pitch

The lituus (*q v*) or cavalry trumpet of the Romans seems to have vanished with the fall of the Roman empire Its successor, the cavalry trumpet of the 15th and succeeding centuries, was evolved from the straight *buisne*, an instrument traced, by means of its name no less than by the delicate proportions of its tube and the shape of the bell, to the Roman buccina (*q v*). The bending of the tube of the trumpet in three parallel branches, thus creating its modern form, has usually been claimed for a Frenchman named Maurin (1498–1515). But the transformation was really made much earlier, probably in the Low Countries or north Italy; in any case it had already been accomplished in the bas-reliefs of Luca della Robbia intended to ornament the organ chamber of the cathedral of Florence where a trumpet having the tube bent back as just described is very distinctly figured. And this shape the instrument retained for more than 300 years. Later crooks and slides were introduced, then keys, and finally in 1815 Heinrich Stolzel made the first completely satisfactory chromatic trumpet by the invention of the ventil or piston (*See* VALVES, WIND INSTRUMENTS.)

TRUMPETER or TRUMPET BIRD, a South American bird of the Psophiidae family, so called from the sound it utters The family contains the single genus *Psophia* with half a dozen species, differing in little but colour and size The range of several species seems to be separated by rivers (Wallace, *Geogr. Distr. Animals*) and in this connection it may be observed that the birds seldom fly, though they run very fast. The best-known species, *P crepitans*, inhabits Guiana and is about the size of a large barn-door fowl, but with longer legs and neck The plumage is black with the exception of the green and violet reflections on the tips of the neck feathers and a brown and gray patch on the back The legs are bright green and the bird lays white eggs, about the size of a bantam's egg

Although the trumpeters must undoubtedly be accorded the rank of a distinct family, Psophiidae, like so many other South American birds they seem to be the less specialized descendants of an ancient generalized group—perhaps the common ancestors of the Rallidae and Gruidae. The structure of the trachea, though different from that described in any crane (*q v*), suggests an early form of the structure which in some of the Gruidae is so marvellously developed, for in *Psophia* the windpipe runs down the breast and belly immediately under the skin to within about an inch of the anus, whence it returns in a similar way to the

front of the sternum, and then enters the thorax Analogous instances of this formation occur in several other groups of birds not at all allied to the Psophiidae

TRUNK (Fr. *tronc*, Lat *truncus*, cut off, maimed), properly the main stem of a tree from which the branches spring, especially the stem when stripped of the branches; hence, in a transferred sense, the main part of a human or animal body without head, arms or legs. It is from this last sense that the term "trunk hose" is derived These were part of the typical male costume of the 16th century, consisting of a pair of large puffed and slashed overhose, reaching from the waist to the middle of the thigh, the legs clad in the long hose being thrust through them; the upper part of the body was covered by the jerkin or jacket reaching to the thigh (*see* DRESS). The word "trunk" as applied to the elongated proboscis of the elephant is the result of a mistaken confusion of French *trompe*, trump, with "trunk," meaning the hollow stem of a tree A somewhat obscure meaning of French *tronc* (*i.e.*, an alms box) has given rise to the general use of "trunk" for a form of travellers' luggage

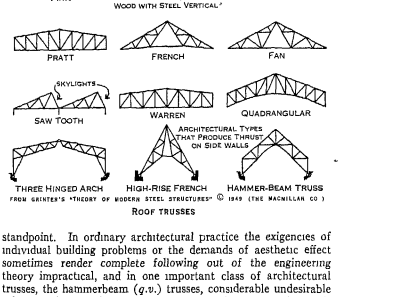
TRURO, THOMAS WILDE, 1ST BARON (1782–1855), lord chancellor of England, was born in London on July 7, 1782, being the second son of Thomas Wilde, an attorney He was educated at St. Paul's school and was admitted an attorney in 1805 He subsequently entered the Inner Temple and was called to the bar in 1817, having practised for two years before as a special pleader Retained for the defense of Queen Caroline in 1820, he distinguished himself by his cross-examination and laid the foundation of an extensive common-law practice He first entered parliament in the Whig interest as member for Newark (1831–32 and 1835–41), afterward representing Worcester (1841–46). He was appointed solicitor general in 1839, and became attorney general in succession to Sir John (afterward Baron) Campbell in 1841 In 1846 he was appointed chief justice of the common pleas, an office he held until 1850, when he became lord chancellor and was created Baron Truro of Bowes, Middlesex He held this latter office until the fall of the ministry in 1852. He died in London Nov. 11, 1855. His son Charles (1816–91) succeeded as 2nd baron, but on the death of his nephew, the 3rd baron, in 1899 the title became extinct

Lord Truro was the uncle of JAMES PLAISTED WILDE, BARON PENZANCE (1816–99), who was appointed a baron of the court of exchequer in 1860 and was judge of the court of probate and divorce from 1863 to 1872. In 1875 he was appointed dean of the court of arches, retiring in 1899 He was created a peer in 1869, but died without issue and the title became extinct

TRURO, an episcopal city and municipal borough of Cornwall, Eng., 11¼ mi. N of Falmouth, on the Western Region railway. Pop. (1951) 12,851. Area, 3 8 sq mi It lies in a shallow valley at the junction of the Kenwyn and Allen at the head of Falmouth harbour. Truro (Trueret, Treurok, Treueru) was a comparatively small manor in Domesday held by Jovin of Count Robert of Mortain Its municipal charter dates from Richard Lucy, the chief justiciar who held the demesne lands. Reginald, earl of Cornwall, by an undated charter, added other privileges. Henry II confirmed them A new charter was given in 1589 and in 1877 the borough was declared a city. From 1295 to 1885 Truro had separate parliamentary representation, returning two members The cathedral church of St Mary was begun in Early English style in 1880 The episcopal see, founded in 1876, covers the whole of Cornwall, the Scilly Isles and three parishes in Devonshire. Industries include a pottery, sawmills, a biscuit factory and jam factories Small vessels can lie at the quays, though the harbour is dry at low water. China clay is the chief export.

TRURO, the chief town of Colchester county, Nova Scotia, Can., on the Salmon river, 1 mi. from the head of Cobequid bay and 61 mi. N. of Halifax by rail. Pop. (1951) 10 756. It is an important junction on the Canadian National and Dominion Atlantic railways, and the thriving centre of a lumbering and agricultural district It is the seat of the Nova Scotia Normal college and the Nova Scotia Agricultural college. Manufactures include clothing, condensed milk and building hardware.

TRUSS, in engineering and architecture, a combination of structural members, usually straight, and so arranged in one plane that by being connected at their ends they form a rigid frame on which to support a roof, floor, bridge or other similar weight In the theoretically perfect truss the component parts are so designed as to enclose between themselves rigid triangles and so arranged that every member is stressed only in the direction of its own length, either in compression or tension, with no bending forces present This, the controlling ideal of modern truss design, governs in the design of those trusses which are purely structural, or designed primarily from the utilitarian



ROOF TRUSSES

standpoint. In ordinary architectural practice the exigencies of individual building problems or the demands of aesthetic effect sometimes render complete following out of the engineering theory impractical, and in one important class of architectural trusses, the hammerbeam (*q.v.*) trusses, considerable undesirable side thrust is exerted upon the supporting walls or piers Although the basic principle of truss design, that of the rigidity of a triangle, is so simple, the scientific design of trusses is a matter of comparatively recent development, and in the greater number of classic, Romanesque and Gothic trusses, despite the ingenuity of their construction and, especially in late Gothic work, the beauty of their design and execution, it is only rarely, and as it were by accident, that a perfect triangulation of the members is achieved. The illustration shows a number of different kinds of roof trusses all made up of adjacent bars forming triangles.

A truss diagram is a graphic method of discovering the stresses in the component members of a truss, based upon the mechanical theory of the resolution of two angular forces into the diagonal of the parallelogram constructed upon them. (*See* BRIDGES, MECHANICS; ROOFS)

TRUST, INVESTMENT: *see* INVESTMENT TRUSTS.

TRUST and **TRUSTEES.** *Use in Early English Law.*—The use or trust is said to have been the invention of ecclesiastics well acquainted with Roman law, the object being to escape the provisions of the laws against mortmain by obtaining the conveyance of an estate to a friend on the understanding that they should retain the use (*i.e.*, the actual profit and enjoyment) of the estate. Uses were soon extended to other purposes. They were found valuable for the defeat of creditors, avoiding of attainder and charging of portions. A use had also the advantage of being free from the incidents of feudal tenure, it could be alienated *inter vivos* by secret conveyance, and could be devised by will. In 1535 the famous Statute of Uses (27 Hen. VIII, *c* 10) was passed, forming the basis of conveyancing until it was repealed in 1925 by the Law of Property act. The statute does not, however, apply indiscriminately to all cases, as only certain uses are executed by it. It does not apply to leaseholds or copyholds, or to cases where the grantee to uses is anything more than a mere passive instrument, *e.g.*, where there is any direction to him to sell the property. The

publicity of transfer, which it was the special object of the Statute of Uses to effect, was almost at once defeated

Trusts.—A trust in English law is defined in Lewin's *Law of Trusts*, adopting Coke's definition of a use, as "a confidence reposed in some other, not issuing out of the land, but as a thing collateral, annexed in privity to the estate of the land, and to the person touching the land, for which *cestui que trust* has no remedy but by *subpoena* in Chancery." The term *trust* or *trust estate* is also used to denote the beneficial interest of the cestui que trust A trust has some features in common with contract (*q v*); but the great difference between them is that a contract can only be enforced by a party or one in the position of a party to it, while a trust can be, and generally is, enforced by one not a party to its creation A division often adopted in modern textbooks and recognized by parliament in the Trustee Act 1850, is into *express*, *implied* and *constructive* An express trust is determined by the person creating it It may be either *executed* or *executory*, the former where the limitations of the equitable interest are complete and final, the latter where such limitations are intended to serve merely as minutes for perfecting the settlement at some future period, as in the case of marriage articles drawn up as a basis of a marriage settlement to be in conformity with them. An implied trust is founded upon the intention of the person creating it, examples of it are a resulting trust, a precatory trust, and the trust held by the vendor on behalf of the purchaser of an estate after contract and before conveyance A constructive trust is judicially created from a consideration of a person's conduct in order to satisfy the demands of justice, without reference to intention The law was consolidated by the Trustee Act 1893 and some subsequent amending statutes as the Law of Property Act, 1925

Who May Be a Trustee or *Cestui que Trust*.—The Crown and corporations aggregate can be trustees. Provision is made by the Municipal Corporations Act 1882, for the administration of charitable and special trusts by municipal corporations. There are certain persons who for obvious reasons, even if not legally disqualified, ought not to be appointed trustees Such are infants, lunatics, persons domiciled abroad, felons, bankrupts and *cestuis que trustent* Any one may be a cestui que trust except a corporation aggregate, which cannot be a cestui que trust of real estate without a licence from the Crown. For the Public Trustee, *see* below. The disabilities affecting some Roman Catholic charities were abolished by the Roman Catholic Relief Act 1926.

Creation and Extinction of the Trust.—A trust may be created either by act of a party or by operation of law. The Statute of Frauds altered the common law by enacting that all declarations or creations of trusts or confidences of any lands, tenements or hereditaments shall be manifested and proved by some writing, signed by the party who is by law enabled to declare such trust, or by his last will in writing, or else they shall be utterly void and of none effect. For the purpose of conveying or creating a legal estate they must be made by deed (Law of Property Act, 1925, s. 52). Interests created by parol are by will only (s. 54). Trusts arising or resulting by implication or construction of law are excepted, and it has been held that the statute applies only to real estate and chattels real, so that a trust of personal chattels may still be declared by parol. The declaration of a trust by the Crown must be by letters patent Trusts created by will must conform to the requirements of the Will Act. (*See* WILL) Except in the case of charitable trusts, the cestui que trust must be a definite person A trust, for instance, merely for keeping up family tombs is void By s. 10 of the Trustee Act 1893 (superseding Lord St. Leonards's Act of 1860 and the Conveyancing Act 1881), the surviving or continuing trustee or trustees, or the personal representative of the last surviving or continuing trustee, may nominate in writing a new trustee or new trustees On such appointment the number of trustees may be increased Existing trustees may by deed consent to the discharge of a trustee wishing to retire. Trust property may be vested in new or continuing trustees by a simple declaration to that effect Also a separate set of trustees may be appointed for any part of the property held on distinct trusts. Trusts created by operation of law are those which are the effect of the application of rules of equity. They include resulting and constructive trusts A resulting trust is a species of implied trust, and consists of so much of the equitable interest as is undisposed of by the instrument creating the trust, which is said to result to the creator and his representatives. An example is the purchase of an estate in the name of the purchaser and others, or of others only. Here the beneficial interest is the purchaser's. An example of a constructive trust is a renewal of a lease by a trustee in his own name, where the trustee is held to be constructively a trustee for those interested in the beneficial term Besides being duly created, it is necessary for the validity of the trust that it should be a lawful one. An unlawful trust is one which contravenes the policy of the law in any respect. Examples of such trusts are trusts for a corporation without licence, for a perpetuity, and for purposes subversive of morality, such as trusts for illegitimate children to be hereafter born Superstitious uses also fall under this head There are also certain trusts which are avoided by statute under particular circumstances, such as settlements in fraud of creditors (*See* BANKRUPTCY) The law cannot be evaded by attempting to constitute a secret trust for an unlawful purpose. If an estate be devised by words prima facie carrying the beneficial interest, with an understanding that the devisee will hold the estate in trust for such a purpose, he may be compelled to answer as to the secret trust, and on acknowledgment or proof of it there will be a resulting trust to the heir-at-law In the case of an advowson suspected to be held for the benefit of a Roman Catholic patron, there is a special enactment to the same effect. (*See* QUARE IMPEDIT.) The rules of equity in charitable trusts are less strict than those adopted in private trusts Charitable trusts must be lawful, *e.g.*, they must not contravene the Statutes of Mortmain; but a wider latitude of construction is allowed in order to carry out the intentions of the founder, and they will not be allowed to fail for want or uncertainty of objects to be benefited. The court, applying the doctrine of *cy près* (*q.v.*), will, on failure of the original ground of the charity, apply the funds as nearly as possible in the same manner. On this principle gifts originally made for purely charitable purposes have been extended to educational purposes Further, trustees of a charity may act by a majority, but ordinary trustees cannot by the act of a majority (unless specially empowered so to do) bind a dissenting minority or the trust property. A trust estate is subject as far as possible to the rules of law applicable to a legal estate of a corresponding nature, in pursuance of the maxim, "Equity follows the law." Thus trust property as assets for payment of debts, may be taken in execution, passes to creditors in bankruptcy, and is subject to dower and curtesy, to the rules against perpetuities, and to the Statutes of Limitation A trust is extinguished, as it is created, either by act of a party or by operation of law. An example of the former mode of extinction is a release by deed, the general means of discharge of a trustee when the purposes of the trust have been accomplished Extinction by operation of law takes place when there is a failure of the objects of the trust: *e.g.*, if the cestui que trust die intestate without heirs or next of kin Equitable interests in real estate in other countries are as a rule subject to the *lex loci rei sitae*, and an English court has no jurisdiction to enforce a trust or settle a scheme for the administration of a charity in a foreign country. An English court has, however, jurisdiction to administer the trusts of a will as to the whole real and personal estate of a testator, even though only a very small part of the estate, and that wholly personal, is in England (See *Ewing* v *Orr-Ewing*, L R 9, A C 34)

Rights and Duties of the Trustee.—The principal general properties of the office of trustee are these (1) A trustee having once accepted the trust cannot afterwards renounce (2) He cannot delegate it, but an inconvenience which formerly attached to dealings with trustees and trust property, in consequence partly of this rule, and partly of the liability of persons dealing with trustees to see that money paid to them was properly applied, was largely obviated by s 17 of the Trustee Act 1893 (replacing s 2 of the Trustee Act 1888), which in effect provides that a trustee may appoint a solicitor to be his agent to receive and give a discharge

for any money or valuable consideration or property receivable by the trustee under the trust, by permitting the solicitor to have the custody of and to produce a deed having in the body thereof or endorsed thereon a receipt for the consideration money or other consideration, the deed being executed or the endorsed receipt being signed by the trustee; and a trustee is not chargeable with breach of trust by reason only of his having made or concurred in making any such appointment; and the producing of any such deed by the solicitor is a sufficient authority to the person liable to pay for his paying to the solicitor without the solicitor producing any separate or other direction or authority in that behalf from the trustee (3) In the case of co-trustees the office must be exercised by all the trustees jointly (4) On the death of one trustee there is survivorship. that is, the trust will pass to the survivors or survivor. (5) One trustee shall not be liable for the acts of his co-trustee. (6) A trustee shall derive no personal benefit from the trusteeship. The office cannot be renounced or delegated, because it is one of personal confidence. It can, however, be resigned, and legislation has given a retiring trustee large powers of appointing a successor The liability of one trustee for the acts or defaults of another often raises very difficult questions. A difference is made between trustees and executors An executor is liable for joining in a receipt *pro forma*, as it is not necessary for him to do so, one executor having authority to act without his co-executor; a trustee can show that he only joined for conformity, and that another received the money The rule of equity by which a beneficiary who consented to a breach of trust was liable to indemnify the trustees to the extent of his interest has taken definite statutory shape in s 45 of the Trustee Act 1893 (replacing s 6 of the Trustee Act 1888), which enacts that when a trustee commits a breach of trust at the instigation or request, or with the consent in writing of a beneficiary, the High Court may, if it thinks fit, and notwithstanding that the beneficiary is a married woman entitled for her separate use and restrained from anticipation, make such order as to the court seems just for impounding all or any part of the interest of the beneficiary in the trust estate by way of indemnity to the trustee The rule that a trustee is not to benefit by his office is subject to some exceptions. He may do so if the instrument creating him trustee specially allows him remuneration, as is usually the case where a solicitor is appointed. The main duties of trustees are to place the trust property in a proper state of security, to keep it (if personalty) in safe custody, and properly to invest and distribute it. A trustee must be careful not to place himself in a position where his interest might clash with his duty. As a rule he cannot safely purchase from his cestui que trust while the fiduciary relation exists between them. Investments by trustees demand special notice The Trustee Act, 1925, has consolidated the law on this point, and provides, as it were, a code or charter of investment authorizing trustees, unless expressly forbidden by the instrument (if any) creating the trust, to invest trust funds in various modes, of which the more important are as follows. In any of the parliamentary stocks or public funds or government securities of the United Kingdom, in real or heritable securities in Great Britain; in stock of the Bank of England or the Bank of Ireland; in India 7, 5½, 4½, 3½, 3 and 2½ stock; in any securities, the interest of which is for the time being guaranteed by parliament; in consolidated stock created by the Metropolitan Board of Works, the London County Council; debenture stock created by the Receiver for the Metropolitan Police District, Metropolitan Water stock; in the debenture or rent-charge or guaranteed or preference stock of any railway company in the United Kingdom incorporated by special act of parliament, and having during each of the ten years last past before the date of investment paid a dividend at the rate of not less than 3% on its ordinary stock and in certain other railway or canal stocks; in the debenture stock of any railway company in India, the interest on which is paid or guaranteed by the secretary of state in council of India; in the "B" annuities of the Eastern Bengal, the East Indian and the Sindh, Punjaub and Delhi Great Indian Peninsula and Madras Railways, etc.; and also in deferred annuities—comprised in the register of holders of annuity Class D, and annuities comprised in the register of annuitants Class C of the East Indian Railway Company, in the stock of any railway company in India upon which a fixed or minimum dividend in sterling is paid or guaranteed by the secretary of state in council of India, or upon the capital of which the interest is so guaranteed, in the debenture or guaranteed or preference stock of any company in Great Britain or Ireland established for the supply of water for profit, and incorporated by special act of parliament or by royal charter, and having during each of the ten years last past before the date of investment paid a dividend of not less than 5% per annum on its ordinary stock, in nominal or inscribed stock issued, or to be issued under any Act of Parliament or provisional order by the corporation of any municipal borough in the United Kingdom having, according to the returns of the last census prior to the date of investment, a population exceeding 50,000, or by any county council in the United Kingdom in certain water stocks; in securities authorized under the Colonial Stock Act, 1900, etc.; the Housing (Additional Powers) Act, 1919, loan securities issued by the Government of Northern Ireland, in any of the stocks, funds or securities for the time being authorized for the investment of cash under the control or subject to the order of the High Court. Trustees may from time to time vary any such investments for others of an authorized nature The statutory power to invest on real securities does not, of course, authorize the purchase of realty; but by s. 5 of the Trustee Act 1893 a power to invest in real securities (in the absence of express provision to the contrary) authorizes investment on mortgage of leasehold property held for an unexpired term of not less than 200 years and not subject to a greater rent than one shilling a year, or to any right of redemption or condition of re-entry except for non-payment of rent. The Trustee Act 1925 must be consulted for full information

The position of trustees in respect of what was frequently an undue personal responsibility for the administration of their trust has been much improved by s. 8 of the Trustee Act 1888 which enables an honest trustee to plead the Statutes of Limitation It has been decided that in the case of a breach of trust consisting of an improper investment of the trust funds, time begins to run in favour of the trustee from the date of the investment. Subsection (3) of the Judicial Trustees Act 1896 gives power to the Court further to relieve honest trustees for breaches of trust

Under the old law trustees could not safely advance on mortgage more than two-thirds of the actual value of agricultural land or one-half of the value of houses This "two-thirds rule" is now made statutory by s. 8 of the Trustee Act 1893 The same section protects trustees for not investigating the lessor's title when lending on the leasehold security, and for taking a shorter title than they might be otherwise entitled to on the purchase or mortgage of any property, if they act with prudence and caution. By s 9 (replacing s 5 of the Trustee Act 1888) trustees who commit a breach of trust by lending more than the proper amount on any property are excused from making good any more than the excess of the actual loan over the sum which they might have properly lent in the first instance (*See* generally the Trustee Act, 1925, for full information)

Rights and Duties of the Cestui que Trust—The cestui que trust has a general right to the due management of the trust property, to proper accounts and to enjoyment of the profits. He can as a rule only act with the concurrence of the trustee, unless he seeks a remedy against the trustee himself.

Judicial Trustees.—The Judicial Trustees Act 1896, inaugurated a semi-official system of trusteeship which was new in England, but had been known in Scotland for upwards of 150 years

Public Trustee.—A step further was taken by the Public Trustee Act 1906, which established the office of public trustee. By the act he is a corporation sole, with perpetual succession and an official seal and may sue and be sued under his official title. He may, if he thinks fit, act in the administration of estates of small value; as custodian trustee, or as an ordinary trustee; he may be appointed a judicial trustee, or administrator of a con-

vict's property. The law of trusts generally is applicable to him Full information as to the machinery and procedure of the office and the requirements necessary to obtain the services of the public trustee are obtainable on application to the Public Trustee Office, Kingsway, London

Scotland.—The history of the law differs considerably from that of England, though perhaps the position of the Scottish trustee is now not very different from that of the trustee in England The Statute of Uses did not apply to Scotland, since neither that nor any similar legislation was necessary in a system in which law and equity were administered by the same tribunals Trusts seem to have existed from time immemorial, and have been frequently regulated by statute The policy of the English Statute of Frauds was no doubt intentionally imitated in the Act 1696, c. 25, enacting that no action of declarator of trust should be sustained as to any deed of trust made for thereafter, except upon a declaration or back-bond of trust lawfully subscribed by the person alleged to be trustee and against whom or his heirs or assignees the declarator should be intended, or unless the same were referred to the oath of the party *simpliciter*. The act does not apply to all cases, but only to those in which by the act of parties documents of title are in the name of a trustee, but the beneficial interest in another The person creating the trust is called the *truster*, a term unknown in England. On the other hand the term *cestui que trust* is unknown in Scotland The office of trustee is prima facie gratuitous, as in England, it being considered to fall under the contract of mandate Some of the main differences between English and Scottish law are these. There is no presumption in Scotland of a resulting trust in favour of a purchaser. A trust which lapses by the failure of a beneficiary goes to the Crown as *ultimus heres*. The office of trustee is not a joint office, therefore there is no right of survivorship, and on the death of a trustee the survivors are incompetent to act, unless a certain number be declared or presumed to be a *quorum*, or the office be conferred on trustees and the accedors and survivors of them. Sometimes the concurrence of one trustee is rendered absolutely necessary by his being named *sine qua non*. The Court of Session may appoint new trustees, but generally appoints a judicial factor. There has been a considerable amount of legislation, chiefly in the direction of extending the powers of trustees and of the court in trust matters The powers of investment given to trustees are much the same as those allowed in England

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United States.—It is generally true that the institutions of the English law were adopted bodily by the American colonists and became part of their jurisprudence modified only in such details as the exigencies of the new country demanded That this was true of trusts is, however, somewhat remarkable in view of American hostility during the 18th and early 19th centuries to the English system of equity jurisprudence. Indeed, several colonies possessed no chancery courts and not until the late 19th century had full equity powers been vested in State courts such as Massachusetts and Pennsylvania. Despite this, however, the trust as developed in England was well-known in America Remedies were administered in the absence of equity powers by law courts through their own legal forms. The institution consequently followed the English law in its major outlines and only the more important differences need here be considered

Passive trusts, in which the trustee performs no active duties but is simply a receptacle of the legal title, have under various theories ceased to exist for practical purposes, such a grant being deemed to vest the beneficiary with legal title. This result, reached in the American States through a judicial extension of the Statute of Uses or by local legislation, has in substance done away with all passive trusts except such resulting or constructive trusts as are created by operation of the law. Consequently for the effective creation of a trust it is necessary to impose affirmative duties of administration upon the trustee. Furthermore legislation in the several States similar to the provisions of the English Statute of Frauds requires trusts of real property to be in writing, though trusts of personal property unless created by will may be established by oral evidence.

Notable American legal doctrines concern the purposes for which trusts may be created. The spendthrift trust, a distinct American institution, seeks to secure the beneficiary against his own improvidence or incapacity by providing against alienation by anticipation of the trust income by the beneficiary either by his own voluntary act or *in invitum* by his creditors. The beneficiary cannot assign his right to receive future income nor can such income be subjected to the payment of his debts In England such trusts have been held invalid on the ground that it is against public policy to permit the ownership of property without permitting its alienation nor burdening it with liability for its owner's debts The majority of the American States have upheld the validity of such trusts, following the views enunciated by the Massachusetts court in *Broadway Nat Bank* v. *Adams*, 133 Mass. 170 and the Supreme Court of the United States in *Nichols* v *Eaton*, 91 U.S. 716 American legal doctrines surrounding the creation of charitable trusts have had a curious development. After intimating that their validity depended solely upon statute, the Supreme Court of the United States in the famous *Girard Will Case* (2 How. 127) concluded that the English Statute of Charitable Uses of 1601, 43 Eliz c. 4, was but declaratory of the common law and that such trusts were valid in the absence of legislation. Several State courts had heretofore repudiated the Statute, and the early legislation of these States failed to recognize the existence of charitable trusts. The failure of the famous Tilden trust devising several millions for charitable purposes to the city of New York under a decision of the Court of Appeals of New York led in 1893 to legislation in that State and similarly situated States restoring the old English system of charitable trusts. Indeed, since then the American courts have generally been more liberal than the English courts in their interpretation of what uses may be regarded as charitable. The policy involved in the English mortmain statutes finds its counterpart in different types of American statutes. Some restrict the amount of property a charitable corporation may hold; others prohibit a testator from giving more than a certain portion of his fortune to charity; and still others invalidate all gifts to a charity made within a brief period before the death of the donor.

There are numerous distinctions between English and American law concerning the rights of the trustee, of which the more important may be noted Unlike the English rule, the trustee even in the absence of a provision in the trust deed for remuneration, is entitled either by statute or under equity rules to a reasonable compensation for his services Such remuneration is commonly calculated on a commission basis, and the trustee possesses a lien upon the trust property for his services. Two or more trustees are entitled to one commission only. Strict rules, however, prevent a trustee from deriving any personal benefit from his trusteeship by action antagonistic to the best interests of the beneficiary The various States have many different rules governing the manner in which the trustee shall invest the trust property. The subject is largely controlled by legislation setting forth the specific types of securities which the trustee may purchase Corporate bonds of approved railroads and public utility companies are generally considered legal investments and a few of the States permit investments in the common stock of reputable corporations. Though mortgages upon real property are permissible investments, real estate as such is commonly considered too speculative and too unconvertible for purchase by the trustee. Two different rules prevail in America concerning the distribution of income of trust estates as between life tenants and remaindermen. When such income is represented by dividends, the rule of some States requires the payment of cash dividends to the beneficiary, whereas

stock dividends are to be held as capital Other States, however, regard the source of the dividend as the test, holding that all dividends whether in stock or cash accruing from profits earned subsequent to the creation of the trust are payable to the beneficiary.

Of interest also is the development in America of the institution of the trust as a means for aggregations of capital to carry on business. This development should be distinguished from the monopolistic illegal "trust." The legal trust contemplates contributions by a number of persons of capital to trustees who, under a declaration of trust executed to them, carry on the business for the benefit of such persons as are beneficiaries Transferable certificates are issued to the contributors and income from the conduct of the trust is paid to them in the manner of dividends. Since the organization is simply an adaptation of the common law trust no legislative authorization is a condition precedent to the right to carry on business in this manner. The declaration of trust also provides that title to the trust property and neither the trustees nor the shareholders are to be individually liable to creditors. The chief distinction between such an organization and a partnership is that the shareholders as beneficiaries cannot control the management of the business by the trustees, and if power to manage the business is vested in the shareholders or if they are permitted to appoint and remove trustees at will, the courts treat the organization as a partnership. Though this application of the trust is not unknown in England (see *Smith* v. *Anderson*, 15 Ch. D. 247), conditions peculiar to America have made for its extraordinary growth in the latter country. The device originated in Massachusetts, hence the term "Massachusetts trusts," due to the fact that the laws of that State did not allow corporations to deal in real estate Experience refined the forms of organization to permit their application to other enterprises, but until late years the device was not generally employed in other States. But when legislation during the beginning of this century sought to impose onerous burdens upon the doing of business in the corporate form, especially upon corporations of other States, the trust device was generally resorted to in order to avoid these burdens. The business trust thus became a familiar type of organization. It was expressly recognized by legislation in Oklahoma in 1919, and since then by a few other States Some State courts, however, have as yet failed to recognize the possibility of adapting the trust as a form of business organization.

Another adaptation of the trust for business purposes is the voting trust, a device whereby the stock of shareholders is deposited with a trustee for the purpose of controlling the policy of a corporation. The interests of the shareholders are commonly represented by transferable certificates Though in some States such trusts cannot be employed to control certain types of business, their legality is recognized provided that all shareholders shall be permitted to avail themselves of the trust agreement and provided that its purpose is to benefit all shares alike.

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(J. M. LA.)

TRUST COMPANY is a corporation engaged in winding up estates, administering trusts and performing agencies for individuals, partnerships, corporations, associations and institutions both public and private, under authority of law. The trust company may be engaged exclusively in trust business or it may perform commercial banking functions as well as those of a savings bank.

In all of its purely trust functions, the trust company acts as a fiduciary for its customers in that it acts for the benefit of someone other than itself. It cannot delegate the performance of its duties.

In the United States, trust powers are granted to corporations by governmental authority; they are not implied rights. National banking institutions receive their trust powers from the federal government. Other corporations receive their trust powers from state governments Power to engage in trust business in one state does not carry with it power to engage in trust business in other states of the United States Each corporation must meet the requirements of the governmental authority under which it wants to do business Each state has the authority to determine the conditions under which a corporation may conduct a trust business within its borders.

In addition to its trust charter, each trust company must obtain a licence to operate National banks receive their licences to operate from the board of governors of the federal reserve system State banks apply to the state banking authority for their licences

Other requirements are imposed on corporations before they can engage in trust business. The laws of the various states are not uniform. Some require a minimum capital and surplus which is fixed according to the population of the city in which the corporation is located, while others base the requirement on the volume of the trust business of the corporation. Some states further require that a deposit be made with the proper state authority to protect the trust property. In some states a deposit of securities of a fixed amount permits the handling of an unlimited volume of trust business

The trust company renders three kinds of service for three distinct groups of persons. The three services are: distribution of property; administration of property; and custody and agency functions with respect to property These three services may be rendered for individuals, for business firms, or for public institutions For convenience, most trust companies classify their services as personal trusts and corporate trusts.

Personal Trusts.—The trust company serves individuals in many ways but its chief function is that of executor or administrator of estates. When a person dies, leaving property and a will that is admitted to probate, he often nominates a trust company to wind up his estate. The court of competent jurisdiction usually appoints the trust company so named and it is known as the executor of the estate. If an executor is not named in the will, or if the person so named is not appointed by the court, the court appoints someone to act Such a person is known as an *administrator with a will* Should the person who dies leaving property not make a valid will, the court appoints an *administrator*. The trust institution so appointed is known as the *administrator of the estate*.

The principal duties of the executor or administrator are to obtain *letters testamentary* or *letters of administration* from the court giving the trust company authority to settle the estate, assemble the assets of the estate, take such steps as are necessary to protect the assets, pay all just claims, and distribute the remainder to the heirs

Personal Trusteeships.—The administration of personal trusteeships constitutes the second main function of personal trusts. A trust exists when one person has legal title to property and another person has the beneficial ownership. Personal trusts are of two kinds, testamentary trusts and living trusts A testamentary trust is created by a person who leaves a will which transfers his title to property to one person to hold for the benefit of a third person or persons. A living trust is created when a person during his lifetime conveys title to property to another person to be held for the benefit of himself or a third person. These living trusts may be revocable or irrevocable. The living trusts are of several kinds.

Guardianships.—Under court appointment, trust companies serve individuals as guardians of property. In some states a trust company may also act as guardian of a person Guardianships of property arise when the court appoints someone to manage the property for an incompetent person. Such appointee is known as a guardian, trustee or conservator The incompetent person may be mentally incapable of managing his own property or he may be a minor.

A guardianship differs from a trusteeship in that under the former, the title to the property remains in the minor or the incompetent whereas under the latter the title resides in the trustee. The administrator of estates under guardianship is controlled by the statutes and court decisions of the state Under trusteeships the trustee derives his powers and duties from the trust instrument creating the trust.

Agencies.—The third principal function performed by trust companies for individuals is that of agent Agencies are created when one person authorizes another to act for him. The principal retains title to his property and may terminate the agency at any time. It is automatically terminated on the death of either the principal or the agent. Agencies are of many kinds but may be grouped under five headings:

safekeeping, custodianships, management agencies, attorneyships-in-fact, and escrow agencies

Safekeeping is the simplest kind of agency and involves the receipt of property or claims to property, care in its protection, and delivery upon order of the owner. No responsibility other than due care and diligence in the physical protection and delivery of the identical property is imposed

Custodianships constitute the next step beyond safekeeping. The custodian, in addition to receiving, caring for and delivering property performs many other duties set forth in the agreement. The custodian is expected to relieve the principal of the details connected with ownership.

Management agencies represent the third step in activity and responsibility under agencies in that the exercise of judgment is involved. In addition to the duties of safekeeping and custodianship, the management agent may be expected to render a multitude of services in which it must exercise the same kind of care and judgment that it would for property held in a trust account.

Attorneyships-in-fact arise from a written authorization by the principal conveying to the agent authority to perform certain acts Attorneyships-in-fact accepted by trust institutions do not involve the practice of law. These agencies may cover any business transaction which the principal has a legal right to perform.

Escrow agencies constitute the fifth agency function of trust companies. In performing this service the escrow agent acts as a stakeholder for two or more persons engaged in a business transaction. The agent exercises no discretion and assumes no responsibility other than following the instructions agreed upon

Corporate Trusts.—Corporate trusteeships are one of the principal services rendered by trust companies As corporate trustee, a trust company serves as trustee under bond issues It takes title to property under deed of trust from corporations which wish to sell notes or bonds The trustee holds title for the benefit of the noteholders or bondholders. The trustee certifies that each bond or note is one of a series issued under trust deed It protects against an overissue but does not guarantee the value of the security. As agent, the trust company acts as transfer agent or registrar. As transfer agent, it acts for corporation stock and registered bonds It also acts as transfer agent for many forms of business paper such as warrants for stock rights, voting trust certificates, and receivership certificates. As registrar, trust companies guard against an overissue by checking the certificates against the number of shares authorized When certificates are issued the registrar checks the old and new certificates Another function of the trust company is that of depositaryship These services are governed by the depositary agreement. The trust company accepts the securities, accounts for their safety, and delivers them on demand. Because of the vast detail involved in connection with the payment of dividends on stocks, interest on bonds, and the payment of matured issues, corporations appoint trust companies as paying agents Trust companies also serve corporations as custodians, management agents, escrow agents and attorneys-in-fact

In addition to their services for corporations and individuals, trust companies act as fiscal agents for governmental bodies, and for social institutions such as clubs, schools, churches and fraternal institutions.

(H. F. W.)

Historical Development.—The first trust companies in the United States were not chartered as trust companies originally but as insurance companies, trust activities remained secondary until, with the growth of wealth, the fiduciary services became of greatest importance, whereas insurance and annuity business was secondary By 1822 several companies were placing chief emphasis upon the fiduciary business Their development before the Civil War was slow, and by 1850 there were some 50 trust companies scattered throughout the commercial states Besides performing trust functions, some of these early trust companies operated as savings banks and provided safe deposit facilities. The charters of trust companies around the middle of the 19th century included these functions specifically.

With the development of a national banking system and a national currency after 1863, trust companies grew in importance and number and developed into powerful financial institutions. In the 25 years following the Civil War great changes took place in the activities of trust companies Whereas state banks were decreased in number and in extent of their operations as a result of the National Banking act of 1863, trust companies began to grow in number and resources. The regulatory measures provided in their charters were regulatory in name only. Deposit banking and discounting activities became the chief functions of trust companies The old alliance with insurance and annuity business was completely dropped and fiduciary business began to occupy a rank of secondary importance.

After 1880, trust companies became commercial banks in reality even though not always in name As a result of the growth of trust companies, banks complained that they were being discriminated against and clamoured for state supervision of trust companies. The three chief complaints were that trust companies were not subject to taxation as were banks; that trust companies kept no reserves, but depended on the banks for cash and clearing service; and that trust companies were not subject to state supervision and regulation in their operations, which constituted a danger to sound banking After many heated controversies measures of relief were started. New York enacted a trust company reserve law in 1906, but the law was changed in 1908 and trust companies were brought under the same law as banks Other states followed suit. When the Federal Reserve act was passed in 1913 the same powers to act in a fiduciary capacity as were enjoyed by trust companies were extended to commercial banks The act also provided that trust companies could become members of the reserve system. Since then trust companies have become almost indistinguishable from commercial banks, though they place a heavier emphasis on fiduciary business than do most commercial banks By 1939 about one-third of the country's banking resources were in the hands of trust companies

(B. H.)

TRUSTEESHIP SYSTEM: *see* MANDATE; UNITED NATIONS.

TRUSTS. The term "trust" is a convenient though mostly inaccurate label popularly applied to any large business concern, or amalgamation or association of business concerns, which exercises some degree of monopolistic power over output and prices in the industry with which it is connected. The "trust," as it first appeared in America in the '80s, was a form of organization in which the shareholders of a number of enterprises agreed to assign the whole of their stock to a small board of trustees, receiving in exchange trust certificates representing the valuations of their properties This particular way of bringing a number of rival businesses under one direction has no particular significance nowadays, and it is but by historical accident that it has given its name to something much wider than itself, but the term has become established, and when a British official committee was appointed in 1918 to enquire into all forms of trade organization and combination it was officially designated "The Committee on Trusts." The subject of this article, then, is not "trusts" in the derivational sense, but the whole movement of which the "trust" proper was and still is one example That movement has two main aspects It entails, in the first place, a change in the size of the business unit, a change from a multitude of small separately controlled businesses to a few big businesses, and in the second place a change in the basic principle upon which industry is conducted, a change from competition as the ruling factor in the fixing of output and prices to deliberate control, fortified by monopoly, on the part of the manufacturing or commercial interests concerned.

From Competition to Combination.—The system under which goods are produced, distributed and bought is still commonly referred to as the "competitive system," but for the last half century and longer the economic order has been changing and the assumptions upon which it was held that, normally, supplies, prices, profits, and wages are determined by the free play of competition are no longer entirely valid For an account of the competitive system and the nature of the change from competition to combination the reader should see the article COMPETITION IN INDUSTRY, where the virtues and triumphs of competition are extolled, but it is shown that there are fields in which competition is detrimental to efficiency and obstructive to progress, and also that, when industrialists wake up to the fact that there is an easier way than competition to the ends they pursue, competition frequently gives place to combination.

FORMS OF COMBINATION

(1) **Gentlemen's Agreements.**—Industrial combination in the dual sense of the replacement of many small firms by a few large firms and the substitution of concerted control for competition takes a wide variety of shapes. In its simplest and most elusive form there is no outward sign of change but a few business rivals meet from time to time and reach an "understanding" in regard to prices, output, division of business, etc In effect, the competitors agree not to compete: that is all. Nothing is put on paper; a gentleman's word is as good as his bond. Such understandings are fairly common among local coal dealers, carriers, shopkeepers, etc, and are no less a figure in industrial diplomacy on the largest scale The reader should see the article GENTLEMEN'S AGREEMENTS.

(2) **The Trade Association.**—A more advanced kind of combination is that in which a large proportion of the manufacturers or traders in a particular line of business form a trade association.

Many such associations go no further than to compile and exchange statistical information. Others openly or secretly adopt

measures designed for the purpose of regulating the trade. In the latter instance, as in the "Gentlemen's Agreement," there is exemplified one only of the two aspects of combination: there is no change in the size of the business unit, but something has happened to the competitive principle by which the relations of the various firms are supposed to be governed. Associations for the regulation of trade are associations for the limitation of competition. This can be effected in a variety of ways, by fixing uniform prices, by apportioning and controlling output, by supervising tenders, by dividing up the market.

For an account of these bodies, which are to be found in almost every branch of industry in Great Britain and America, and indeed in all industrial countries, the reader should see the article TRADE ORGANIZATION. The economic effects of the limitations upon competition effected by these associations, and the social and political problems to which the possibilities of abuse of their powers give rise, will be discussed at a later point in the present article.

(3) **The Consolidation.**—It frequently happens that two or more previously independent business concerns are permanently *amalgamated into one* large concern under more or less completely centralized direction and control. The consolidation may be a coalition of equals, or it may be the result of a powerful concern buying up one or more smaller rivals; it may have been engineered by outstanding personalities within the industry, or it may be the result of operations promoted by outside financiers; the previously independent businesses may continue to operate to all outward appearance as though they were still independent, or some of them may disappear as separate entities, their goodwill and business passing to more efficient establishments within the amalgamation. According to their origin, scope, and manner of operation, distinguishing names have been given to these conglomerate bodies. The term "combine" is frequently used in Great Britain, generally to designate a merging of firms in the same line of business at the instance of some dominant concern or group among their number. The term "merger" is more usually used in the United States in much the same sense. The term "*Kartell*" is widely used to denote the specifically German type of joint selling organization (*See* CARTEL.) The term "trust," as already mentioned, has particular application to the former American plan of assigning the stock of the associated enterprises to a body of trustees. There is no need, for present purposes, to examine more closely these differences in financial structure and control. The terminology is largely arbitrary, and the distinctions often without real significance.

Consolidations may, however, logically be divided into two distinct classes. The "vertical" consolidation results from a merging of firms engaged in the production of a commodity at successive stages of manufacture; *e.g.*, coal and iron mining, pig iron, iron and steel, and ships. The "horizontal" consolidation, on the other hand, results from the merging of firms engaged in the same line of business at the same stage of production, *e.g.*, the firms engaged in the bleaching and dyeing industry or those engaged in the manufacture of cement.

A consolidation may attain such size and power that it represents within itself the greater part, locally, nationally, or maybe internationally, of the particular line of business in which it is engaged, and is able within limits to control the output of the industry and dictate the prices at which its particular type of goods shall be sold. The phenomenon and the problem are only formidable where the consolidation is on at least a national scale.

Multiple Directorships; Banking Control.—Among a miscellany of forms other than those already named, taken by the movement under discussion, two, which are of far greater import than might at first sight appear, call for specific mention. The first of these is the practice of one person holding directorships in a number of ostensibly competing firms or in firms engaged in mutual trade. Cases of persons holding a dozen directorships are common; and it is on record that as many as thirty-two directorships, including thirteen chairmanships and three positions of managing director, in businesses of the first order of magnitude concerned not only with manufacture but also with banking, shipping, railways, and telegraphs, have been simultaneously held by one person. The same phenomenon appears in more systematic guise where arrangements for the collaboration of erstwhile competing firms take the form known as "interlocking directorates" in which an interchange of shares is accompanied by arrangements whereby the directors of one concern sit upon the board of another. Where these conditions obtain, it is evident that the idea of competition in its old crude sense must be modified. The second is the control exercised over a large part of the industrial field by the great banks. It is not suggested that the details of prices, output, and marketing are matters with which the banks concern themselves, but their influence over the industrial and commercial policy of their clients is hardly in dispute, and that influence has its reflex upon the policy of its clients towards each other (*See* BANKING AND CREDIT.) Throughout any survey of tangible consolidations and trade associations these less tangible influences must be kept in mind if a comprehensive idea of the extent of trade combination is to be obtained.

National Characteristics.—The combination movement has accommodated itself in each country to national conditions and characteristics. In the United States, the size of the national market, and the singular uniformity in the goods required by American consumers, were both favourable to centralized large-scale production. The importance of rail transport costs as an element in total selling costs and the monopolistic position of certain main railroads gave added cause for collaboration among manufacturers with a view to collective bargaining with the railroad interests. These circumstances, together with a national zest for power and masterdom, conduced when time was ripe to a rapid growth of great industrial consolidations. In the United Kingdom, great consolidations wielding monopolistic and political power have not, in general, been so formidable as in America, nor have British associations of independent manufacturers developed so fully the range of activities displayed by such organizations in Germany. The movement toward industrial combination in the United Kingdom has been relatively more cautious and less spectacular than elsewhere. The reasons for this would appear to be partly the deep-rooted individualism of the British manufacturer and partly the greater difficulty of establishing monopolistic consolidations in a country where many of the principal industries are widely dispersed, where the raw materials of most of the great industries are drawn from world-wide sources, and where, for many decades, such shelter as monopoly might obtain from protective import duties was not available. None the less, combination has replaced or minimized competition over a great part of the industrial activity of the United Kingdom. In Germany, the local concentration of the coal and iron industries, the protective policy, the state-ownership of the Prussian railways, and the inter-relations of industry with government, all contributed to the emergence of a special type of trade combination in the form of a joint selling organization between independent concerns in the same line of business empowered to fix and maintain prices and to allot the participation of each independent producer in the aggregate output. For this German type of combination the reader should see the article CARTEL.

Industrial Occurrence.—It would be difficult to lay down any rule as to the industries which are most susceptible to combination or have travelled farthest along that road; but a few generalisations can be made. Industries engaged in supplying the need for a standard unvarying product—*e.g.*, steel bars and rails, sewing cotton, cement, salt, sugar, tobacco—invite combination more than do industries engaged in miscellaneous and varying production, such as general engineering and shipbuilding. Manufacturing enterprises requiring much capital for their establishment, or which can operate much more economically with expensive plants are, in general, more easily collected into large aggregates by the instrumentality of high finance and are more secure against sporadic competition than are industries which require little capital. Local proximity has been a factor of some importance in certain cases in facilitating centralized control; but improvements in transport and communication are minimizing this factor. Patents have formed the bed-rock of combinations in some industries *e.g.*, electrical, chemical, and shoe-machinery;

and natural monopoly has supported others. In general, manufacture lends itself to consolidation much more than agriculture; but combination plays an important part in the marketing of agricultural products For many years, retail distribution lagged behind manufacture as a subject for combination, but the last twenty years has seen an immense increase in the multiple shop or chain store Indeed, no array of purely economic factors will explain why combination has developed much further in some industries than in others; why, for example, soap, cocoa and sewing cotton should be represented in Great Britain by vast establishments, why shipbuilding and coal-mining should have stood so much aloof from the general tendency The present industrial spread of the movement would appear to have depended, as much as on anything else, on the chance emergence in certain industries, at the critical moment, of dominant personalities who have conceived great plans and carried them through. Where the right man with the necessary powers has been lacking at the propitious moment combination has had to wait

The growth and present existence of trusts in the United States has been very largely conditioned by legislation. The passing of the Sherman Act of 1890 necessitated the abandonment of the trust proper and led to the adoption of the method of complete amalgamation either by outright purchase or by the formation of holding companies This process of consolidation has proceeded very rapidly, with the result that a wide range of American industrial production has come to be under the dominion of giant concerns, some of which exercise considerable monopoly power Among concerns dominant in their respective industries are the United States Steel Corporation, the Aluminum Company of America, the Allied Chemical and Dye Corporation, the American Radiator Corporation, the Corn Products Refining Company, and the Eastman Kodak Company In the electrical, chemical, cement, oil seed, meat, shoe machinery, and non-ferrous metal industries, to name but a few, great consolidations play important parts. In the United Kingdom consolidations of such a size as to be capable of exercising some degree of monopolistic power also exist in the main branches of manufacture. In the cotton branch of the textile industry Messrs J & P Coats and The Fine Cotton Spinners' and Doublers' Association are of long standing; and two great post-war amalgamations are The Amalgamated Cotton Mills Trust and Crosses and Winkworths In the woollen and worsted industries combination has taken the form rather of association than consolidation, but Woolcombers Ltd is an amalgamation dating back some years, while since the World War large amalgamations have been formed in the worsted spinning and knitting wool spinning sections of the industry Outstanding in the bleaching, dyeing, printing and finishing industries are the Bradford Dyers' Association, the Bleachers' Association, the Calico Printers' Association, the British Cotton and Wool Dyers' Association and the English Velvet and Cord Dyers' Association In the chemical industry Brunner Mond and Company, the United Alkali Company, Nobel Industries and British Dyestuffs were amalgamated in 1926 into one great undertaking; Lever Brothers, the Salt Union, and Borax Consolidated, are each dominant in their respective branches of industry. In the coal industry, amalgamation has not proceeded far, except in South Wales, where there are two large groups of anthracite collieries, merged under Amalgamated Anthracite Collieries Ltd and United Anthracite Collieries Limited. In the iron and steel industry, combination by terminable association has been accompanied by great concentrations of capital, such as Dorman Long and Co., Bolckow, Vaughan & Co, Baldwin's Ltd, The Ebbw Vale Co and Guest, Keen and Nettlefolds The engineering and shipbuilding industries, again, present a network of terminable associations studded by large consolidations. Foremost among these are Vickers Ltd., Armstrong Whitworth & Co., Cammell Laird & Co. and John Brown & Co, but a score more could be quoted within almost the same range of importance. In other industries examples of dominant consolidations may be found, notably in matches, glass, bottles, electric lamps, machinery and tobacco.

International Combinations.—From combines of national range and consolidations of national magnitude it is a natural step to agreements and amalgamations on an international scale. It has been estimated that there were in existence before 1914 114 international associations, chiefly in the coal, ores, metal, transport, chemical, textile, pottery, paper and electrical industries The object of the majority of these organizations was the regulation of competition, and especially the exclusion of foreign competition from the respective home markets of the participants and the division and demarcation of sales territories, but some of them regulated prices, credit terms and selling practices generally among their members and in a few cases there were arrangements for the exchange of patents or knowledge of technical processes. The outbreak of war in 1914 broke up most of these international groups, but since 1918 some have been re-formed and others are in process of formation or re-formation Among these the International Rail Makers' Association is one of the earliest, having been first formed in 1884 by British, German and Belgian steel manufacturers for the purpose of dividing up export orders and securing the home market to the home manufacture. The association was re-constituted in 1926 under the name European Railmakers' Association. The pool formed by the French, German, Belgian and Luxembourg steel makers in 1926 provides for the allocation of output quotas among its members with penalties for exceeding the quota and compensations for keeping below it. Associations existed before the war to regulate the international relations of manufacturers engaged in the production of galvanized steel, tubes, pipes, rods, wire nails and enamel ware, and many of these have been or are being re-formed A copper syndicate comprising producers responsible, it is said, for some 90% of the world output and intended to control prices and reduce the number of middlemen was formed at the end of 1926 Potash, electric lamps, explosives, glass bottles and gas mantles are the subject of other agreements among the principal manufacturers in the various countries In addition to these international associations, agreements, cartels, or combines there were built up before the World War a number of giant consolidations of wide scope. In petroleum, the world trade is largely dominated by two enormous groups, the Standard Oil group and the Royal Dutch Shell group These, in collaboration, control something less than half the world's production, but a far greater proportion of international trade. In tobacco, the export trade of America and Great Britain is largely in the hands of the British-American Tobacco Company.

Relative Extent and Trend of Combination.—The degree to which combination has supplanted competition as the ruling factor of business operations must not be exaggerated. Even in the most powerfully organized industries competition plays its part with fitfully recurring intensity; while there are still numerous industries (*e.g.*, coal, shipbuilding, textile manufacturing, as well as a host of minor industries) in which the concerted control of output or prices or the concerted direction of industrial policy has made relatively little headway Under the influence of conditions during the World War, not only were numbers of listless associations galvanized into great activity and enterprise, but many new associations were formed Also, one effect of the excess profits tax was to encourage the buying up of unprofitable businesses by prosperous concerns, for such purchases were in effect paid for by moneys which would otherwise have gone in excess profits duty to the revenue For this and other reasons, the war period was one of unusual increase in the number of amalgamations Since the war, the impetus has been towards amalgamation rather than association; indeed trade associations have been through a difficult time, and several have dissolved The tendency is still toward large-scale amalgamation, and the economic and financial system appears to furnish little incentive for a great consolidation to dissolve into its constituent elements It is an old American aphorism that "you cannot unscramble eggs"

The Advantages of Combination.—Great possibilities of industrial and commercial improvement lie beyond the confines of free competition, and are only to be realized by combination in one or other of its several forms; by informal consultation and co-operation, by formal association, or by actual amalgamation. Only from the latter proceeds in full measure the advan-

tage that may follow from extending over a wide area the intelligence and control of technicians and administrators of outstanding ability such as only a large undertaking can afford to retain, and only the consolidation can order with plenary powers the policy of the industrial block over which it exercises authority, and can acquire control of the sources of raw material and an influential interest in the means of transport, but associations as well as consolidations can effect many improvements and economies along the whole line of manufacture and sale. By the consolidation, purchases of material and components can be made in gross instead of in detail, with the advantages of better selection, better terms and lower transport charges; middlemen can be side-stepped and, as already stated, the control over the sources of material can be acquired The association is not entirely powerless in these matters, for it can assist members to better buying by collecting and distributing information on the point As regards manufacture, it is possible under combination to arrange for a standardizing of parts and sizes throughout the industry, whereby production can be greatly cheapened and the parts of one maker made interchangeable with those of another Again it is possible to arrange that instead of every firm trying to cover the whole ground, each shall devote itself to some particular section, and install specialized equipment for its own section and for that only, in which case wasteful duplication can be avoided and specialized skill developed; or, where other conditions prevail, it is possible to bring equipment and inside organization throughout the industry to a uniformly high level Further, whereas under free competition the firms in one district may be working overtime while those in another district are on short time, it is possible through combination to maintain something like an equal distribution of work and to control orders so that the volume of work does not fluctuate so greatly from one period to another

The economies in the matter of distribution to be achieved by associations and combines need little demonstration. Critics of the competitive system have often pointed out the wastefulness of the "five milkmen in one street." The economic waste of numbers of rival travellers, each seeking to frustrate the efforts of the rest, and of competitive advertisements which cancel each other out, has long been a subject of comment. But only by some form of understanding or concerted arrangement of monopoly can such wastes of competition be eliminated Moreover, for a country carrying on a large export trade, representation in foreign markets is a matter of primary importance, and it has become increasingly apparent that independent manufacturers, if they combine for nothing else, must combine for the purpose of pushing their wares abroad if they wish to keep and extend their foreign connections

With these advantages that combination alone holds out goes another—the freer exchange of knowledge. Under competition, every one of a host of small manufacturers works out his own problems, evolves his own methods and processes, and "keeps what he knows to himself." When a combine or a consolidation is formed, this secrecy is ended, and anything worth imitating at one branch is available for all the others Associations do not always adopt the policy of "open doors" as between the members, but many of them go a long way in that direction, and the regular meetings conduce to a friendly atmosphere in which ideas are exchanged. The two essentials of the healthy rivalry which advances, as distinct from the jealous competition which obstructs, are a common basis of comparison and the pooling of data. With combination it is possible to arrange for a uniform system of records throughout an industry and for the circulation of cost-sheets showing what has been achieved by the most efficient firms. With such a sheet before him the less efficient member can see precisely where his methods are faulty and can set to work to improve them.

Possible Losses from Combination.—Against these possible gains on the score of productive and distributive efficiency must be set some possible losses. Where an industrial unit grows beyond the compass of one man's personal detailed direction, "system" must be introduced and system can degenerate into bureaucracy and red tape What is gained in power and knowledge at the centre may be lost in freedom and strength at the circumference, and the over-grown unit is in constant danger of becoming inefficient and reactionary. Again, under the shelter of monopoly a comfortable somnolence may descend upon the giant concern Since fear of change is a well-known characteristic of large administrations, the large business unit may become stagnant and antiquated, especially if its control falls increasingly into aged hands

Probably the most serious objection to combinations and consolidations is that they tend to establish rigidity in the prices of their products When, after a boom, optimism gives way to pessimism and, as a result, demand slackens greatly, most highly concentrated industries follow the policy of maintaining their selling prices at boom levels. The great holding company finds it feasible to follow this policy because it is in a strong financial position. Unfortunately, the result of maintaining selling prices in the face of weakening demand is to reduce sales volume, and such a reduction almost inevitably leads to the discharge of workers, a reduction of their buying power, and intensification of the forces leading to depression

However, popular opposition to trusts, combinations, and holding companies arises mainly from the belief that they will acquire monopolistic powers and will then raise the prices of their products far above the levels prevailing under free competition It is undoubtedly true that concentration of control in any industry brings in its train the danger of monopolistic power being used to exact monopolistic prices and conditions from the public

The problem for all industrial communities is therefore one of how to leave business concerns free to achieve the economies and other advantages of combination in so far as they are consistent with the general interest, and at the same time to provide means of curbing any tendency to use monopolistic power in a manner detrimental to the public and of penalizing those who do so use it.

Monopolistic Power.—Size is an important element in combination, but mere bigness is not disconcerting so long as competition remains effective as a curb upon the operations of the mammoth organization. The problems with which industrial communities are faced arise when the proportion of an entire industry covered by a great amalgamation is so large as to give it some degree of monopolistic power It has sometimes been laid down as a rough working rule that any consolidation or association which covers 80% of the output of an industry can dictate the prices at which the other 20% shall sell its competing products and so may be described as having an effective monopoly; but that formula cannot be applied indiscriminately, inasmuch as the limiting conditions of control vary greatly from industry to industry and in some industries very effective monopolies of merely local range may exist Confidence that the fear of competition can be relied upon to restrain tendencies to extortion on the part of even the most complete monopolies rests upon the belief that no association, combine, or consolidation, even though it has a monopoly, can for long put up prices above what is fair and reasonable, because, if it does, it will only "invite competition" - new people will come into the industry, competition will start afresh, and prices will fall But a powerful monopolistic firm or group can make it extremely difficult for any new entrant to get a footing It can monopolize raw materials, put pressure on merchants and retailers, or scare investors by hints of an under-selling campaign It can tie the distributing trade to it with deferred rebates and conditional commissions It can make conditions such that no one will enter the field against it except at great risk. It can in fact, if so inclined, build a stockade round its industrial territory. These are the instruments and devices by which a monopoly which is not complete and which is always in peril of a recrudescence of competition can maintain its dominance. For a fuller statement of the history, nature and significance of monopoly the reader should consult the article MONOPOLY. The practical outcome of the principles there expounded, as evinced in the case of the great consolidations and powerful associations, are dealt with in this article.

Industrial States.—It must be accepted that there exists a

tendency to form great consolidations representing whole branches of industry, and that such consolidations, could they be successfully organized, would have it in their power to effect great improvements in the lay-out and organization of the industry and to cut out much of the friction, waste, and overlapping which is often due to competition.

It has at the same time to be borne in mind that, as these consolidations came into being, the old accepted basis and operating principle of industry would undergo a radical change, being completely revolutionized. Industries would have become corporate bodies with monopolistic powers, in each of which a central intelligence would direct policy and ordain what supplies and prices should be. A consolidation representing the greater part of an industry, with command or influence over the sources of material and the channels of the distributing trade, would be a close corporation from which would-be intruders could be excluded.

It is clear that, if this stage was reached, governmental control of the industry would be inevitable, for no government can tolerate within its jurisdiction such a powerful rival. Were the leading industries all to become controlled by various powerful combinations the natural outcome would seem to be the formation of a corporative state such as that organized in Italy by Mussolini

Effects of Combinations: General.—It is in the nature of things not possible to prove conclusively the effect of combination upon the well being and prosperity of an industry or upon the volume of its output or the prices charged to customers. It is, obviously, possible to trace, in very many cases, the course of prices and profits before and after the forming of a particular consolidation or association, but from such surveys there is always lacking a knowledge of what prices and profits would have been had no combination been formed Further, it does not follow that an increased level of prices and profits, if proved, is of necessity an evil There have undoubtedly been, and will yet be, cases of industries working for long periods at less than their proper remuneration, and, from the social standpoint, it may be advantageous that an industry so placed should improve its position even at the expense of the rest The idea that the state of an industry under competitive conditions is an ideal standard from which to measure departures is not tenable in all cases

Effect upon Output.—The output of an industry depends upon the sales of its products, and these sales are largely conditioned by the prices at which the goods are sold. In general, and with very many qualifications and exceptions, the effect of combination upon output is a reflex of its effect upon price. So much are price and output recognized as interdependent that trade associations have a choice of two ways of "stabilizing" the industry, one being the fixing of prices and the other the regulating of output. Certain trade associations (*see* TRADE ORGANIZATION) attempted, for example, to regulate the output of the whole of their members by allotting to each a fixed percentage of the total production, whatever that total might be, with penalties for exceeding the quota and compensations for falling short of it.

It was held by the promoters of such "pooling" associations that the effect of the system is not to diminish output It is explained that, under the system, the total output is neither fixed nor even regulated: but is free to expand or contract in accordance with the total demand. It is difficult, however, to accept this view without some reservations. Since those who increase their output beyond the average are penalized, and those who fall below the average are rewarded, it would appear that the aggregate output must tend to be less than it would have been in the absence of any "pool." Yet such statements as "there has never been a time when we have failed to supply the utmost demand of the market" are doubtless made in good faith and have a certain truth What happens is that, under the influence of the penalties and rewards, prices rise, and though the whole demand at the increased price may be met, it is a demand depressed to some extent by the greater costliness of the article. This appears in every way likely to be the immediate effect of the pool system; but against it may be set the consideration that, in the long run, the gains of steady and equalized production in the various works composing the industry and the greater efficiency due to the removal of obstacles to the interchange of knowledge may accrue to the public in the shape of lower prices, whereupon sales may recover and output increase

Effect upon Quality.—It has been contended, and with some truth, that the fixing of a uniform price at which all establishments in a given branch of industry shall sell their products does not mean an end of competition but rather a change-over from competition in price to competition in quality Differences in price are more evident than differences in quality, and are apt to affect the judgment more The difference between £1 and 19/– in the price of an article is a plain matter of five per cent· the difference of five per cent in quality is less easily discernible. The immediate effect of the standard uniform price for various makes of the same article is undoubtedly to turn attention at once to differences other than price, and it may be accepted as usually the case that the establishment of uniform prices is followed by a tendency to improvement in designs and quality and hence in value.

Effect upon Evolution of Industry.—According to the competitive principle industrial evolution proceeds in part by the ill-endowed and ill-placed firm being "unable to compete" and, after a struggle more or less prolonged, going out of business. The ease and certainty with which this process of the "elimination of the unfit" accomplished itself in practice under the competitive system may easily be over-rated, but it certainly did occur. The risk of failure, of the total loss of all the capital sunk in the undertaking, was one of the accepted risks of industrial enterprise. Under combination other provisions are made for the flow of business from the less efficient to the more efficient units. In the case of trade associations working under a quota system, the less efficient members of the group are the more ready to let their business go to the more efficient in that they receive, from the pool, monetary compensation The least efficient may find it worth while to close down altogether and draw the compensation as long as the association continues, and the firms best equipped for efficient production may find it well worth their while to do more than their quota and pay the penalty.

This transference of work from the less to the more efficient firms does in fact take place to a considerable extent, and it cannot be doubted that as a result production is carried on to greater advantage, but it is not so clear that much of the advantage accrues to the general public, since the greater part of the gains of increased efficiency go in the form of compensation to the less competent producers Similarly with amalgamations It may be essential to the attainment of an effective monopoly that all the firms in a line of industry, inefficient and unprofitable, shall be brought within the amalgamation. But the inefficient concern will not sell out at a knock-down price; the fact that its non-existence is needed by the amalgamation gives it a new value. Many a trust and combine, therefore, has had to acquire properties already overdue for dissolution and has had to choose whether to keep them in being or close them down. It will be observed that in both types of combination the cost of providing for the elimination of the units that have shown themselves least fit in the industrial struggle falls not upon the owners of the derelict business but upon the more efficient survivors. Questions as to what shall happen in an industry to the least profitable concerns the capacity of which exceeds foreseeable demand are among the most difficult of all that confront attempts to "rationalize" such industries and proved to be the main obstacle to rationalization in the coal and cotton industries of Great Britain.

Limitations of Powers.—What are the limiting conditions within which combinations can wield their monopoly powers? It is clear that the distance to which a combination can go in the direction of extorting monopoly prices depends on the elasticity of the demand for the goods it handles, and in particular upon whether there is some other article, not very inferior, upon which the consumer can fall back in the event of prices being raised against him. In so far as its goods are sold to manufacturers in other industries, the undue exercise of monopoly power is likely to produce a corresponding degree of combination among its customers, resulting in prices being a matter of negotiation, bargaining, and agreement between parties of the same order of strength. Where the combination is of no more than national range, foreign

competition or the fear of such competition may act, in the absence of high import duties, as a check upon any tendency to abuse of monopoly power in some branches of manufacture, but the safeguard of foreign competition is apt to be rendered inoperative by international agreement or consolidation just when its influence is making itself most felt

It is evident that a combination representing an entire branch of industry, and charged with the best present and future interests of that industry, will not seek to raise prices to a level which will cause the volume of trade to shrink, the plant to be idle, and net earnings to fall. Another reason why it will be loath to run up prices is that the existence of unduly high prices furnishes a strong inducement for potential rivals to enter the field. Last, but by no means least, the maintenance of prices believed by the public to be materially above the competitive level is almost certain to bring about a demand either for governmental control or for the destruction of the combination.

Effect upon Prices.—One of the most important trade associations in Great Britain, the National Light Castings Association, declared in its original rules, "The object the Association has in view is that of raising and keeping up the price of the buyer . ." Most associations, however, would repudiate the suggestion that they aimed at raising prices, and would describe their policy as being directed towards "preventing price-cutting," "securing fair and reasonable prices," "providing a fair return on capital and energy," or, most probably, "stabilizing prices." Clearly, regularity of output, with continuity of returns, is a desirable condition for any industry, a condition much preferable to one of violent alternations of good times and bad Steadiness of prices has certain advantages for the consumer. Contractors and buyers of semi-manufactures and components find it satisfactory to be able to depend, in sending out estimates or in planning ahead their own developments, on a reasonable stability in the price they will have to pay for their wares. Again, in so far as the stabilization of prices is accompanied by the standardization of prices, *i.e.*, the charging of uniform prices or prices regulated in accordance with a known scale to all purchasers, there is some advantage in each contractor or retailer knowing that his rival is buying on the same terms as himself In a few industries, associations have done much to prevent prices falling, at times of slack demand, to ruinous levels, and there can be no doubt that, during the war-scarcity and post-war boom periods, the prices of goods controlled by associations were not in general allowed to rise to the heights reached by goods not so controlled While, as has just been pointed out, such price stabilization is, in some respects, socially beneficial, its net results are usually inimical both to the industry itself and to the nation at large The combination which maintains prices in the face of shrinking demand thereby insures a curtailment in the volume of its sales and production, and thus makes it inevitable that employees will be discharged. This policy of price maintenance, encouraged both by custom and monopoly, is then one of the prime causes of cyclical unemployment.

The effect of actual amalgamations of business concerns upon the trend of the prices of their products depends upon a multitude of factors—the circumstances of the businesses before the amalgamation, the thoroughness with which the economies of combination are carried out, and the extent of the monopoly power possessed by the amalgamation. At the beginning of the 20th century when the trust problem was much discussed, many students of the subject felt that it would not be long until all industries would be controlled by monopolies which would ruthlessly force up prices to exorbitant levels. Forty years later, it was found that industries were rare in which combinations had succeeded in establishing any effective control over prices. Just as some combination had seemed to gain virtual control of an industry, a virile rival had appeared to offer new competition When an association had forced up the price of one product, a lower-priced substitute had swept the market and nullified all the efforts of the monopolists. Only the public utilities, protected by exclusive franchises, had been able to exercise any considerable degree of monopoly controls, and they had been subjected to rigorous governmental regulation.

(J. H.; W. I. K.)

LEGAL POSITION OF MONOPOLISTIC COMBINATIONS

Great Britain.—The legal position of monopolistic combinations is determined (unless authorized by special statute) by their status at the common law. This status is decided, in general, by applying, in a given case, the common law doctrine of restraint of trade Contracts or agreements in restraint of trade are in principle unenforceable, though they are not actually illegal unless they involve an illegal act Nevertheless a contract which is technically in restraint of trade has long been regarded by the courts as valid and enforceable when it involves a particular restraint which is not larger than the protection of the party with whom the contract was made reasonably requires The doctrine of the unenforceability of contracts in constraint of trade is part of the larger legal doctrine of "public policy," which is interpreted in economic matters as equivalent to freedom of trade, or disapproval of measures in restraint of trade. In recent years however, the courts have shown a perception of the fact that free competition is not necessarily in the interests of the community, and that, on the contrary, competition may be accompanied or followed by serious disadvantages There has consequently been a tendency for the law relating to combinations to be stated with modifications Such modifications have become so general, in fact, that it is the exception, rather than the rule, that an alleged illegal combination will be held invalid as involving an unreasonable restraint of trade Numerous types of restraint practiced by combinations have been held, under common law, to be reasonable and not contrary to public policy. Included have been such characteristic agreements as those restricting competition, fixing prices, maintaining resale prices, establishing exclusive dealer arrangements, and granting deferred rebates. The post-World War difficulties of British industry and trade encouraged an increasingly tolerant attitude by the Government toward combines. This attitude has resulted in encouragement and even dictation of combinations in certain basic industries In some industries definite forms of combination have been legalized by specific legislation of Parliament In other instances encouragement has been given by means of administrative policies, but no specific pattern of combination has been established by statute. Agriculture and herring fishing are among those industries which belong to the former group; the iron and steel and chemical industries typify the latter

Canada.—Canadian policy has been embodied in a series of laws enacted since 1889 In that year, certain sections of the Criminal Code were drawn to cover instances of conspiracy in restraint of trade. These sections, amended in 1899 and 1900, provide penalties against those who combine or agree with others to limit unduly facilities for the production or distribution of, restrict unduly production or enhance the price of, restrict unduly competition in the production or distribution of, or restrain or injure trade in articles of trade or commerce. An amendment enacted in 1935 prohibits rebate or discount discriminations, by dealers, as between purchasers buying under similar conditions, and makes it an offence for dealers to engage in area price discrimination or to sell at unreasonably low prices in order to destroy competition The Criminal Code safeguards are supplemented by the Combines Investigation Act. This law, enacted in 1910 and frequently amended since, imposes heavy penalties upon every person or corporation "who is a party . to or knowingly assists in the formation or operation of a combine. . ." "Combine" is broadly defined to include any combination, obtained by merger, lease, agreement, or other method specified, which has operated or is likely to operate to the detriment of the public by limiting facilities for production or distribution; restraining production, fixing common prices or resale prices; enhancing prices; preventing or lessening competition; substantially controlling production or distribution; or otherwise restraining or injuring trade or commerce The Dominion Trade and Industry Commission administers the law and investigates unfair trade practices.

United States.—Under the common law of the United States as under English common law agreements in restraint of trade are not enforceable In 1890 there was passed the Sherman Anti-Trust Act which prohibited under severe penalties "every contract, combination in the form of trust or otherwise, or con-

spiracy, in restraint of trade or commerce among the several States, or with foreign nations" and declares it to be an offence to "monopolize, or attempt to monopolize, or combine or conspire, . . . to monopolize any part of the trade or commerce among the several States or with foreign nations." Much difficulty arose over the interpretation of the act, partly because of its abstract terminology and partly because of uncertainty as to whether it invalidated all, or merely unreasonable, restraints of trade. Successive Supreme Court decisions made the position increasingly clear, but in general in the direction of a more liberal interpretation of the statute. From the 1912 decision in the case of the United States Steel Corporation it appeared that the legality of a combination depended on the proportion of the industry it represented, and a 1911 decision made contracts not illegal unless in unreasonable restraint of trade. As a result of these decisions it was felt that the Sherman Act needed strengthening and, on the other hand, it had become evident that some power of dispensation was required to modify the cruder effects of the act. Consequently, in 1914, two further acts were passed, the Clayton Act, and the Federal Trade Commission Act. The Clayton Act legalizes certain activities of trade associations which were declared illegal under the Sherman Act. It makes it illegal for a company to acquire shares in another company if this leads to "a real diminution of the competition between companies" or "tends to establish a monopoly"; it prohibits price discrimination between different purchasers which aims at lessening competition or creating monopoly; and the giving of discounts or rebates on condition that the buyer shall not use or deal in the goods of competitors; and it contains provisions against the holding of posts simultaneously in different companies by directors and employees.

The Federal Trade Commission Act established a commission, to which was assigned two main tasks: to investigate and report on the organization and conduct of corporations charged with violations of the anti-trust laws and to prevent unfair competition. The commission was authorized, after a hearing, to issue orders against continuation of unfair competitive practices. It could appeal to a circuit court for enforcement of such an order.

Legislation since 1914 has authorized combinations in several industries, including shipping, export trade, marine insurance, railroad transportation, and agriculture. The Recovery Act of 1933, while in effect, exempted from anti-trust law any practices of industry groups authorized by "codes of fair competition." Also, the Sherman Act was amended in 1937 to permit contracts for maintaining resale prices of branded commodities. The price-discrimination clause of the Clayton Act, on the other hand, was strengthened in 1936.

British Attitude to Anti-Trust Laws.—As seen by British eyes legislation of the Sherman and Clayton kind is not easily made effective without the doing of more harm than good. The Committee on Trusts, appointed in Feb. 1918, turned its attention rather to what might be called "policing" action than to repression. It sought for ways in which combinations might be controlled or supervised to safeguard the public interest from the abuse of monopoly power while being left free to achieve all those economies and improvements which combination alone can furnish.

Public ownership, public control, public competition, profit limitation and profit taxation were passed under review. In all these schemes three main difficulties were encountered: first, that of defining a monopolistic concern; second, that of distinguishing rightful rewards of enterprise and efficiency from the exactions of monopoly; and, third, that of determining the datum on which rate of profit can be calculated. These suggestions were one by one rejected as limited in scope, difficult of application, or hazardous in reaction, and the committee turned its attention in other directions. It was thought that if fuller publicity in regard to the conduct and earnings of business concerns generally, and of the working and effects of combinations in particular, could be secured, the desired object would be in great measure achieved. It was also thought that some machinery should be provided whereby suspected or alleged abuses could be penalized.

Accordingly, the conclusion was reached that there should be established a department of state charged with the duty of informing itself as to the nature, extent and development of combinations of all kinds in so far as they tend to the restraint of trade and the creation of monopolies, and of making preliminary inquiry into complaints made in regard to them, also that a tribunal should be set up to which the department could apply for powers to obtain particular information, and would refer for full investigation cases in which combinations appeared to act injuriously to the public interest. The requisite publicity would thereby be secured in two ways: the relevant facts as to offences proved before the tribunal would be made public, and the department would present annually to parliament a report upon the nature, extent and development of combinations. Publicity thus secured would not only be in itself a considerable safeguard against the abuse of monopolistic power, but it would serve to reveal actions and developments for which publicity alone was not a sufficient safeguard, and against which further action should be taken, whether in the form of nationalization, public competition or the control of prices and profits. These conclusions formed in substance the recommendations of the committee, but such recommendations did not result in legislation of the suggested type.

The fact that the recommendations of the Committee on Trusts have not been adopted in British legislation is not surprising, considering the fundamental change in the attitude of the people since the World War—and especially during the second decade after the war—toward trade and industrial combinations. The former emphasis upon competition between individual units of business has been supplanted to an important degree by an attitude of approval of concerted or co-operative action by means of combination. This attitude toward business combination has been evident among British statesmen as well as business leaders.

This basic shift in the British attitude toward "trusts"—paralleled by a similar change in many other countries—had its roots in the economic conditions growing out of the World War. Readjustment of industry and trade to peace-time conditions was rendered difficult by deflation of prices, excessive plant capacity, heavy taxation and mounting restrictions on international trade. The position of British industries was especially difficult because her economy relied so heavily upon foreign trade and markets, both of which were greatly affected by the post-war policies aimed at the achievement of national self-sufficiency.

A committee of the Government—the Committee on Industry and Trade—made an intensive study of the British economic position from 1925 to 1929 and submitted a final report in the latter year. Statements of this committee indicate clearly the basis for the development of sentiment for co-ordination and combination in business. The committee was of the opinion "that the first step towards putting British industries in a position to compete successfully in overseas markets is to subject their organization and equipment to a thorough process of reconditioning." In a supplementary statement to the final report, a number of the members of the committee stated that the last quarter of a century had witnessed "a mighty transformation from individualistic to co-operative methods of action" and that "it is in proportion as the principle of co-operative action and control is accepted that we find economic success achieved, both at home and abroad."

Pursuant to this type of thought, the Government has encouraged informal combination arrangements established by industry groups and, by such acts as the Cotton Industry Reorganization Act, the Sugar Industry Reorganization Act, the Livestock Industry Act, and others of similar character, has provided for definite forms of combination.

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(J. H.; T. J. A.)

TRUTH. The concept of truth belongs to the fundamental philosophical problems—in fact, one may describe it as the central question of all theoretical philosophy. The first step in philosophic reflection consists in asking the question concerning the nature and criteria of truth. The world of being is no longer accepted as a simple datum, but a "reason" for it is required; a "principle" is sought which will enable human cognition to distinguish "genuine" being from "non-genuine" being, "reality" from "appearance," truth from error. The same change of attitude occurs also in regard to *values*. Here, too, cognition is not satisfied with the values accepted on the testimony of tradition, custom or authority, but inquires into the *meaning* of the difference between "good" and "evil," and seeks universally valid, "objective" norms to justify this distinction. In this two-fold significance, the problem of truth was first raised in Greek philosophy. From it evolved the various fields of philosophy within Greek thought. Logic as also ethics and physics have their common root in the problem of truth. For they are all founded on the presupposition that both the *immediate* view of reality, as presented to us in perception, and the immediate purposes pursued by instinctive impulse and desire, are not finally valid. This immediacy is transcended in the theoretical as well as in the practical sense: it is "questioned" and "called to account." This account implies that from now on, in the sphere of thinking, as in that of willing, individual contents are distinguished as having positive or negative value, the latter being rejected as "invalid," the former retained as "valid." This fundamental distinction forms the pervading theme of Greek philosophy.

The individual systems differ only in the means by which they try to solve it, by which they try to obtain a clear definition of the difference between "True" and "False."

In theoretical respects, the first step is made when the certainty of immediate sense perception is shaken and is opposed by another, "critical" authority. It is not the senses which decide about truth and falsehood, about being and non-being; the decision rests with reason, pure thought. The beginnings of this view can be traced to the older Ionian philosophy of nature, but it reached its proper development only in the classical systems of the great pre-Socratics. Parmenides and Heraclitus, Pythagoreanism and Atomism reject unanimously the view of the world as perceived through the senses and oppose to it another view which is based on thought—the power of the "Logos." According to Heraclitus, the senses alone are "bad witnesses": they can be used for a knowledge of reality only when they are judged by the soul as to their value and truth. The senses individualize and separate; as long as we follow them exclusively, each perceiving mind has its own world in which it remains enclosed. Thought, however, is "common to all": by means of it, alone, we reach a universally valid, "objective" view of the cosmos. "It is a duty to follow that which is common; but although the Logos is common to all, the majority live as though they had an insight of their own" (Heraclitus, *Fragment* 2 [Diels]; cf. *Fragments* 72, 89, 113–114). "Wisdom resides in One, in the recognition of the reason which pervades all and everything" (*fr.* 41). According to Parmenides, the road to truth consists in not allowing oneself to be misled by well-worn habit into trusting sense perception: "no, by reason decide the controversial test, the question of Being and Non-Being" (Parmenides, *Fragment* 1, *cf.* 35 *sqq.*). The true power of conviction (πίστις ἀληθής) does not reside in the senses but in pure thought: "for thinking and being are the same." Similarly, the Pythagoreans see the true *essence* of reality in number, because number is to them the principle of all truth. "For nothing of delusion (ψεῦδος) does the nature of number admit; but delusion occurs only in the realm of the unlimited, the unreasonable, and of that which is not determined by the Logos" (Philolaos, *Fragment* 11). Democritus distinguishes two forms of cognition: the genuine and the spurious one. The spurious one comprises sight, hearing, taste, smell and touch—in short, the whole world of sense qualities, which exist only "according to custom";—the genuine one gives us an insight into the veritable, the "true" reality, which belongs only to the atoms and empty space (Democritus, *Fragment* 11).

The completion of this trend of thought is reached in Plato. According to the platonic doctrine of ideas the sensible world, as a world of becoming, can possess no veritable being or truth. It is a world of mere "opinion" (δόξα), a world of "appearance," whereas truth and knowledge refer only to objects of pure thought which are not subject to change. This "rational" conception of truth, however, was not without its countercurrents in Greek philosophy. The *Sophists* deny the possibility of a universal truth valid for all thinking subjects. According to the proposition of Protagoras that "man is the measure of all things," truth is relative and subjective: "for each, his perception is true" (*cf.* Plato's *Theaetus*). Out of this opposition, there develops in later Greek philosophy the controversy between the "dogmatic" and the "sceptical" schools. For the former, there is a universally valid "criterion" of truth, which gives to certain concepts and principles absolute certainty.

According to the *Stoics* this criterion consists in "cataleptic presentation" (φαντασία καταληπτική). It forms a spontaneous achievement of thought, a type of assent (συγκατάθεσις), which must be added to the sensible impression in order to make it *known*. A doubt with reference to the "cataleptic presentation" is not possible: we possess full evidence that the object is reproduced in it as it is in itself. In opposition to this the Greek Sceptics deny that there is any such criterion of "evidence." All supposed "truth" is mere probability. For the absolute objects, the "things in themselves," are entirely unknown to us (ἄδηλα); accessible to our judgment are merely the appearances of things, which, however, take entirely different shapes according to the differences of the perceiving subjects and the conditions of the perception itself. The definiteness of reason, of the "Logos," is thus abandoned: concerning any subject there are innumerable assertions each of which may claim to be equally valid. (*See* Herbertz, *Das Wahrheitsproblem in der griechischen Philosophie*, 1913.)

Mediaeval scholasticism, in its definition of the concept of truth, refers throughout to Greek philosophy, especially to Aristotle. According to it, truth consists essentially in the agreement of thinking and being, in the *adaequatio intellectus et rei* (Thomas Aquinas, *De veritate* 1, 2). But this definition bears now a new content. For the problem of truth belongs no longer exclusively to the realm of logic, to the sphere of pure *cognition*, but refers essentially to the question of *religious certainty*. The opposition between "sensibility" and "thought" is now replaced by the opposition between "faith" and "knowledge." Religious faith seeks support in the intellect (*fides quarens intellectum*), although it cannot find in it a sufficient foundation but stands in need of another, superior source of certainty. Thus the problem arises as to how both principles of certainty, how "natural intellect" and "revelation" stand to one another. Scholasticism, at times, supposes a relation of mere *subordination;* at times, it asserts a complete separation between them. In the later nominalism this idea of separation is predominant. There arises the doctrine of "twofold truth," according to which a definite sentence may be true from the standpoint of knowledge and false from the standpoint of faith. The problem of truth and of logical and religious certainty

had been conceived most profoundly by Augustine. "Do not turn outward; go back into yourself; in the inner life of man resides the truth." The inner life gives us, as a first indubitable starting point, the certainty of the thinking, feeling and willing subject: the certainty of our own Being and Knowing and Willing. This certainty cannot be attacked by doubt because doubt itself is an act of thought and must, therefore, presuppose the latter. "Whoever knows himself as doubting, knows something true and is certain of that which he knows; he is thus certain of truth. Therefore, whoever doubts whether there is a truth, has thus in himself a truth about which no doubt is possible. Therefore, he who doubts at all, cannot doubt truth as sucn." (Augustinus, *De vera religione*, cap. 39.) However, this *immanent* truth as exhibited in the thinking consciousness, is not the only one, nor a sufficient one for the foundation of religious cognition. For the Being to which religious cognition refers, lies, as an *infinite* Being, beyond the limits of human consciousness. For a knowledge of the Divine mere *ratio* must be "transcended" by another power of the mind. Entering into the inner life of the subject and going beyond this inner life are thus the two phases which disclose the realm of truth as a whole. If there were only a truth of finite and contingent things, we could stop with the finite, empirical consciousness as the bearer of this truth. However, since there is a region of eternal truths (*veritates aeternae*)—Augustine cites the truths of religion and of pure mathematics—there must be an infinite intellect which thinks them and in which they subsist. Human thought does not create these truths; it is only able to receive them in so far as it is enlightened by a higher power. In every cognition of a necessary and eternal truth, our reason is only seemingly self-active and autonomous. In order to apprehend such a truth, it must be enlightened by the divine intellect. The divine Logos is the "hidden sun" which alone makes truth visible for us.

The intimate connection of the problem of truth with the problem of God, which is characteristic of mediaeval epistemology, continues for a long time also in *modern philosophy*. The after-effects of the Augustinian doctrine are obvious in Nicolaus Cusanus and Marsilius Ficinus. (*See* FICINO, MARSILIO.) (*Cf.* Ernst Cassirer, *Individuum und Kosmos in der Philosophie der Renaissance*, 1927.) But also Descartes and Malebranche, Cudworth and the Cambridge Platonists show clearly traces of this. On the other hand, however, there develops a more and more pronounced tendency to emancipate the problem of truth from all entanglements with theological questions and to give it logical independence. Modern rationalism, as represented especially by Herbert of Cherbury's *De veritate* (1624), maintains the pure self-determination, the unconditioned autonomy of thought. Human reason decides according to its own, universally valid, innate principles about truth and error. Its fundamental concepts and axioms are absolutely binding. There can be no conflict between faith and knowledge because any truth of faith needs the test of reason to attain to and be determined in its certainty. In Descartes, Spinoza and Leibniz, the clear and distinct cognition (*clara et distincta perceptio*) is set forth as the criterion of truth. Those judgments alone may claim universal assent which are founded on clear and distinct ideas and which allow us to recognize the connection of these ideas with the same certainty that obtains in the propositions of mathematics. (*See* RATIONALISM.)

Accordingly, the characteristic trait of truth, the *norma veritatis*, is no longer placed in the agreement of a presentation or cognition in us with an external "transcendent" object, but in the agreement with definite principles of reason itself. Every idea is called true which can be derived from them in a strictly deductive manner, by the method of purely logical or mathematical inference. When this proof has been given for a certain idea, there can be no doubt that the objective reality must conform with the idea; for this agreement forms, itself, a necessary axiom of reason. Thus, Spinoza, for instance, expounds in his *Treatise on the improvement of the understanding* that that which makes a thought a true thought, must lie entirely within it; that the real cause of truth is to be sought, therefore, not in an external object, but exclusively in the intellect itself. The mathematical idea of the sphere, for instance, is "true" even if there is no entity to be found in intuition and empirical perception which corresponds to the definition of the sphere in all respects and with perfect accuracy; and after this ideal conception of the sphere, we determine the reality of "nature" as it is grasped and "clearly and distinctly" recognized through geometry and mechanics. With particular clarity this conception of truth appears in Leibniz's *Meditationes de cognitione, veritate et ideis* (1684). Against the nominalistic view of Hobbes, that truth consists only in the correct connection of certain linguistic signs (*veritas non in re, sed in dicto consistit*), Leibniz emphasises that the correctness of the connection between the signs must be based on a relation between the ideas themselves. Truth, therefore, always depends on the relations which subsist between the pure ideas.

The process in which the assumption of one idea necessarily implies another, gives birth to the systematic coherence of knowledge—and this *nexus* according to the principle of sufficient reason makes up the fundamental character of all truth. Even the truth of phenomena consists only in the fact that they obey certain laws which correspond to the ideal truths of pure logic and pure mathematics. A different form is given to the problem of truth in the English philosophy of the 17th and 18th centuries. In Locke the "intuitive" truth of mathematical ideas is contrasted with the empirical certainty of the existence of things, which can never be inferred by pure logic, but rests on the testimony of sense perception. Empirical truth, in this sense, belongs only to the simple ideas which are given to us immediately through sensation or reflection. What we can predicate, on the other hand, about the connection of these simple ideas, about their coexistence, their regular recurrence, etc., has no truth in the strict sense of the word, no demonstrative certainty, but rests on mere probability. With Berkeley and Hume, this view is developed further and stated more radically with reference to the empirical knowledge of nature. The order of nature is not founded on principles which can be understood in themselves as necessary and unconditionally valid, but it represents a purely empirical regularity with which we become acquainted through *habit* and *custom;* the knowledge of this order can, therefore, never claim to be more than probable.

With Kant, the battle between the rationalistic and the empirical conceptions of truth is decided in such a way that the laws of pure understanding are recognized as necessary and universal, as valid *a priori*, but that, on the other hand, these laws themselves can retain their validity only within the bounds of experience. The traditional definition of truth—namely, that it is the "agreement of knowledge with its object"—involves, as Kant expounds in the *Critique of Pure Reason* (p. 82), a logical circle. For the problem of knowledge consists in determining just what the "relation of a presentation to its object" means, and how we can ascertain this relation. The concept of an "object of knowledge" is only the concept of a "Something in general=X," "because, apart from our knowledge, we have nothing which we could set over against it as corresponding to it." "It is clear, however, that because we have only to do with the manifold of our presentations and because that X which corresponds to them, in so far as it is to be something distinct from our presentations, is for us nothing, the unity made necessary by the object can be nothing other than the formal unity of consciousness in the synthesis of the manifold of presentations. Then we say: we know the object, when we have effected synthetical unity in the manifold of intuition." (*Kritik der reinen Vernunft*, 1st ed., p. 104 *seq.*) The "transcendental" truth, the truth of the object, rests thus on the "formal" truth; for only the forms of pure intuition and understanding make a connection of the phenomena possible; this connection, however, and nothing else, is meant when we attribute to a phenomenon objective significance, objective validity. However, since, on the other hand, the concepts of the synthesis *a priori*, although not originating in experience, all refer, nevertheless, to experience as the condition of its possibility, one may say that the possibility of experience is that which alone gives objective reality to all our cognitions. Cognition *a priori* has, therefore, *truth* (agreement with the object) only because it contains nothing further than what is necessary for the synthetic unity

of experience. (*Kritik der reinen Vernunft*, and ed. p 195 ff.) In this sense, Kant declares that with regard to theoretical cognition of nature, experience supplies the rule, and that it is the "source of truth" (*Krit. d. r. Vern.* p. 375); but in contradistinction to the empiricism of Locke and Hume, experience is here to be understood not as a "mere rhapsody of perceptions," but a synthetical unity according to laws. In this point, Kant sees the decisive contrast between his "formal" idealism and the speculative idealism represented, for instance, by Berkeley. "The thesis of all true idealists, from the Eleatic school down to Bishop Berkeley, is contained in this formula: 'All cognition through sense and experience is sheer illusion, and only in the ideas of pure understanding and reason is truth.' The principle which governs and determines my idealism throughout, is, on the contrary: 'All cognition of things merely out of pure understanding or pure reason, is sheer illusion, and only in experience is truth' " (*Prolegomena*, Appendix).

Also in the epistemology of the 19th and the beginning of the 20th century, the problem of truth is the central problem It is especially the battle between pure "formalism" or "logicism" on the one hand, and "pragmatism" on the other, which gives to this epistemology its stamp. In the sense of "logicism," the concept of truth is determined especially by Bernhard Bolzano (1781–1848). Bolzano demands that the logical definition of truth must be set forth without any regard for the individual minds for whom the truth is valid, and without any intermingling of psychological determinations. Truth is entirely independent of the thought of an individual mind. This view is expressed in Bolzano's concept of a "truth in itself." "I understand by a truth in itself any proposition which predicates something as it is, whereby I leave undetermined whether this proposition has really been thought and expressed by anybody or not. Be it the one or the other, the proposition shall always receive from me the name of a truth in itself if only . . . the object with which it deals, really possesses what it attributes to it. Thus, the quantity of flowers, for instance, which a certain tree standing in a definite place had last spring, is an indicable number even if nobody knows it; a proposition, therefore, which indicates this number, has for me the name of an objective truth even if nobody is cognizant of it."

This formal determination of truth, which abstracts from any reference to actual thinking, is opposed by pragmatism (*q v*). For pragmatism, the concept of truth can be understood only if it is referred to the *activity* of thought, and if this activity is not considered merely in the abstract but is treated as a vital expression of a living individual. "True" is the term applied to those representations which hold good in the course of one's experience, *i.e.*, which prove practically useful. This "power to work" is the real characteristic and criterion of truth. It is, accordingly, not so much an abstract-logical, but rather a *biological* conception: the truth of a judgment is decided not by the agreement with a reality existing in itself, but by its practical efficiency. As a consequence, there results that *relativity* of truth which had already been urged by the Greek Sophists, especially by Protagoras. Truth is never absolute and universally valid: it is always true only for a definite biological species, inasmuch as the advantage of certain beliefs depends upon what is conducive to the species. (For a *criticism* of pragmatism, *see* Cassirer, *Substance and Function*.) In an entirely different manner and with a different tendency Rickert tries to base the conception of truth not so much upon theoretical as upon "practical reason." According to Rickert's doctrine, we must start our quest for this concept not from the idea of what *is*, but from the idea of what *ought to be*, not from "ontology," but from the *theory of values*. The concept of reality finally presents itself as a concept of values; for we apply the name "real" to that which, in demanding recognition from every thinking mind, is valid as a *norm* for all thought. Only by regression to a superindividual command, to a "transcendent ought," can the meaning of truth be clarified and understood. All cognition, inasmuch as it proceeds by judgments, *i.e.*, by assent and dissent, implies an act of taking sides. Such an attitude, however, is possible only towards a value. Insight into this "primacy of the ought" is necessary for a satisfactory solution of the problem of truth. (Rickert, *Der Gegenstand der Erkenntnis*, 1904.) In general, the treatment of the problem of truth in the epistemology of the 19th and 20th centuries, as compared with that of the 18th century, shows a change in point of view. The opposition of "experience" and "thought," of "empiricism" and "rationalism," has been replaced by the opposition of the "theoretical" and the "practical," "intellectualism" and "voluntarism."

(E. Ck.)

TRUTNOV or TRAUTENAU, a town of Bohemia, is situated at the foot of the Riesengebirge, on the Upa. Founded by German colonists in the 13th century, it developed a flourishing linen industry which was helped by the bleaching suitabilities of the mountain streams. Pop. (1930) 15,923, mostly Germans. The town was ceded to Germany in 1938 by the Pact of Munich.

TRUXTUN, THOMAS (1755–1822), U.S. naval officer, was born at Jamaica, Long Island, N.Y., Feb 17, 1755, and, at the age of 12, went to sea in the London trade. During the Falkland Island war scare (1770–71), he was impressed for a short space in the British navy. At the outbreak of the American Revolution he was engaged in importing powder, but turned early to privateering From 1777 to the close of the war, he commanded letters-of-marque bringing supplies from France and the West Indies, and won a number of hard-fought engagements with enemy vessels. He engaged in the China trade during the peace years, and was appointed a captain in the new U.S. navy by President Washington in 1794. He superintended the building of the frigate "Constellation" at Baltimore, and commanded her during most of the quasi-war with France. Truxtun won naval renown, on Feb. 19, 1799, when he took the French frigate "Insurgente" in a spectacular fight off Antigua, and added to his reputation a year later when he defeated the French frigate "Vengeance," and drove her into Curaçao His resignation from the command of a fleet, planned to combat the Barbary pirates in 1802, was interpreted by the secretary of the navy as a resignation from the navy itself. Highly incensed and cherishing the supposed slight, Truxtun refused overtures from the navy department during the War of 1812. He engaged successfully in Pennsylvania politics until his death in Philadelphia on May 5, 1822.

See *Quasi-War with France*, and *Barbary Wars* (1935–1942); John Frost, *The Pictorial History of the American Navy* (1854).

(W. B. Ck)

TRYON, DWIGHT WILLIAM (1849–1925), U.S. artist, was born at Hartford, Conn , Aug. 13, 1849. At the age of 25 he left his position as a clerk in a Hartford publishing house to devote himself entirely to art, and two years afterwards went to Paris, where he became a pupil of the École des Beaux Arts, under J. de la Chevreuse, Charles Daubigny and A. Guillemet. He first exhibited at the Salon in 1881. In 1882–86 he was director of the Hartford School of Art, and in 1886 became professor of art at Smith college. He became a National Academician (1891), and won numerous medals and prizes at important exhibitions, among his pictures being "Daybreak," "Moonlight" and "Early Spring, New England." He died at South Dartmouth, Mass., July 1, 1925.

TRYON, SIR GEORGE (1832–1893), British admiral, a younger son of Thomas Tryon, of Bulwick Park, Northamptonshire, was born on Jan. 4, 1832. He entered the navy in 1848, and served on various stations and in the Abyssinian expedition of 1867. In 1889 Tryon was promoted vice-admiral; and in August 1891 was appointed to command the Mediterranean fleet, which under him—following the example of his old chief, Sir Geoffrey Hornby—became an evolutionary and, in that sense, experimental squadron. On June 22, 1893, the fleet being off Tripoli on the coast of Syria, in two columns, Tryon made the signal to invert the course, the ships turning inwards in succession. By a fatal error, the psychological cause of which has never been explained, he ignored the patent fact that the two columns were so near each other that the manoeuvre, as ordered, must entail the most serious risk, if not certainty, of collision. And, in fact, the two leading ships did come into collision, with the result that the "Victoria," Tryon's flagship, was cut open and sank in a few minutes. Tryon and 358 officers and men were drowned.

TRYON, WILLIAM (1720–1788), American colonial governor, was born at Norbury Park, Surrey, England, in 1729. In 1764 he succeeded Arthur Dobbs as governor of North Caro-

lina. By refusing to allow meetings of the Colonial Assembly he prevented North Carolina from sending representatives to the Stamp Act Congress in 1765. With the support of the law-abiding element he suppressed with severity the Regulator uprising of 1768–71, caused partly by excessive taxation. In July, 1771, he was transferred to New York, where he acted as governor, nominally at least, until 1780 On his return from a trip to England in 1775 he found the colony in rebellion and was compelled to take refuge on the sloop-of-war "Halifax" in New York harbour. He was restored to power when the British took possession of New York city in September, 1776, though his actual authority did not extend beyond the British lines. In 1777 he became commander of a corps of Loyalists, and in 1779 invaded Connecticut and burned Danbury, Fairfield, and Norwalk. In 1780 he returned to England, and on Jan 27, 1788 died at his London home.

See M. D. Haywood, *Governor William Tryon and his Administration in the Province of North Carolina* (1903).

TRYPANOSOMES, single-celled parasitic animals belonging to the class *flagellata*, chiefly found in the blood of vertebrates; some cause dangerous maladies, *e g*, sleeping sickness in man, and nagana, or tsetse disease in ruminants, in Africa. For further particulars *see* PROTOZOA.

TSAI-DAM (ZAIDAM), a basin area in Central Asia, between the eastern Kuenlun mountains on the south and the Altyntagh and Nan-shan mountains on the north, in the north part of the Chinese province of Kuku-Nor. Its altitude is about 8,200 ft. above sea, and it has many brackish pools and swamps with bare hills around them, there being little vegetation, save on the mountain slopes around. The name Tsai-dam is widely applied to dry lake bottoms in the Mongolian region

See E Trinkler, *Tibet* (Mitteilungen Geogr. Ges München, bd. 50, 1921–22)

TSANA, lake, Africa: *see* TANA.

TSANKOFF, ALEXANDRE (1879–), Bulgarian statesman, was born in 1879 in the town of Oriatovo, on the Danube. He got his secondary education at Roussé and studied law at Sofia university. After specializing in political economy in Germany where he was sent by the university he became professor of economics at Sofia university. A social-democrat in his student years, Tsankoff long remained outside active politics In 1922 he became leader of a small group called the National Concord (Naroden Sgovor), drawn from the intelligentzia of the various political parties and the mass of ex-officers, which aimed at combining the dispersed national forces for a struggle against the semi-dictatorship of Stamboliski. To him fell the premiership of the coalition Government, representing all the political parties, except the communists, that took power on June 9th, 1923, after a military *coup d'état*, in the preparation of which Tsankoff's National Concord had its share. Prof Tsankoff remained prime minister till the end of 1925 when he was replaced by Andrea Liaptcheff (*q v*) another leader of the Democratic Union. His tenure of office coincided with one of the most tragic periods in modern Bulgaria's history. The disturbance that broke out after the overthrow of Stamboliski's régime took thousands of human lives. The principal moments in it are the communist rising of Sept. 1923 and the communist outrage at Sveta Nedelia in April 1925 Tsankoff was minister of public instruction, 1930–31.

TSARITSYN: *see* STALINGRAD.

TSARSKOYE SELO: *see* DYETSKOYE SELO

TSCHAIKOVSKY, NIKOLAI VASSILIEVICH (1850–1926), Russian revolutionary and politician, born at Viatka, studied chemistry at the university of St Petersburg under Mendelyeev and Butlerov, and published in the *Bulletin of the Academy of Sciences*, an original work on chemistry. But pure science did not satisfy the ardent youth, who strove for practical activity. Herbert Spencer and Auguste Comte were Tschaikovsky's spiritual guides. The 19 year old student became the soul of the "circle," which soon took his name. "The circle of Tschaikovsky" laid the foundation of the Russian Narodniki (populist) movement and for many years directed its channels. Persecutions by the authorities changed the character of the movement; from purely cultural it became political, and from the original circle it soon created the revolutionary-terroristic "Narodovolzy."

Tschaikovsky fought desperately against the new tendencies, and after a strong moral crisis left Russia with a few followers for America, where he founded in the wild steppes of Kansas a colony of people "seeking God in themselves." He organized this commune of "Godmen" in the belief that only people enlightened from within could conquer social evils and form a perfect society. Nikolai Vassilievich remained true to this conviction and his Christian faith to the end of his days. The Kansas experiment did not succeed and after two years Tschaikovsky returned to Europe "to fight for his ideals among men."

He could not return to his country; long years of exile began. He worked in the "Red Cross of the Narodnaya Volia," in the "Fund of the Free Russian Press" and went to the United States to collect funds and to make propaganda for the Russian movement for freedom. In 1900 during a secret voyage to Russia he was arrested, but set free after trial. He devoted himself to the organisation of the co-operative movement in Russia. The war and revolution found the "first Russian Narodnik" at work in relieving the sufferings of the Russian people: he helped with the food supply of the Northern front, and fed the populations of Lettonia, Poland and Latvia ruined by the war In the revolution of 1917 he fought to the last the Bolshevist currents in the councils of workers and soldiers deputies, finally resigned and gave himself entirely to the White fight against the Bolshevist government. He was elected a member of an All-Russian directory in Ufa, and later became president of the Northern Government on the Archangel front. Afterwards he was a member of the "political consultation" in Paris, and of the South-Russia government in Ekaterinodar and the Crimea. Exile again, once more emigration. The White front was broken, the White fight lost. After the fall of the Crimean front Tschaikovsky organised in Paris a secret "centre of action," for a fight against the Bolsheviks inside Russia. Until 1923 efforts were made to organise in Russia "a new revolution" but for lack of funds the "centre of action" ceased its existence

TSCHAIKOVSKY, PETER ILICH (1840–1893), Russian composer, born at Votkinsk, in the province of Viatka, on May 7, 1840, was the son of a mining engineer, who shortly after the boy's birth removed to St. Petersburg (Leningrad) to become director of the Technological institute there. While studying in the school of jurisprudence, and later, while holding office in the ministry of justice, Tschaikovsky picked up a smattering of musical knowledge, but he was never suspected at first of possessing any special musical talent, of which there had been no previous traces in his family. Nevertheless, the seriousness of his musical aspirations revealed itself in due course and led him to enter the newly founded Conservatorium of St. Petersburg under Zaremba, where he was induced by Anton Rubinstein, its principal, to take up music as a profession.

With the former he fared better than the latter who, though worshipped by Tschaikovsky, seems never to have appreciated the gifts and promise of his young pupil who was destined none the less completely to eclipse his own fame. Very different was the attitude of Nicholas Rubinstein (Anton's brother) who showed his belief in the young musician in the most practical manner by inviting him to become, in 1866, practically the first chief of the recently founded Moscow Conservatorium, since Serov, whom he succeeded, never took up his appointment.

In Moscow, while engaged at the Conservatorium, Tschaikovsky wrote among other things his first opera *The Vojevode*, which was, however, a failure when produced in 1869. In the meantime he had met in St. Petersburg Balakirev, Stassov, Rimsky-Korsakov and other representatives of the then "advanced" school in Russian music, who exercised a stimulating influence on him, although neither then nor later was he ever wholly in sympathy with their ideals.

Also at this period he fell desperately in love for a time with the opera singer Désirée Artôt who, however, shattered his hopes by marrying someone else He found consolation in his art, and his third opera *The Opritchnik*, was one of many works composed at this time, others including the pianoforte concerto in B flat

minor, the third symphony and another opera *Vakoula the Smith*. The *Oprischnik* was produced at St. Petersburg in 1874 and *Vakoula the Smith* in 1876, but neither had any success.

A happier fate attended the B flat minor piano concerto, which though severely condemned in the first instance by Nicholas Rubinstein (to whom it was originally dedicated) as clumsy and unplayable, as a mere duel between the piano and orchestra, and so on, was afterwards taken up with enthusiasm by Hans von Bülow (to whom the composer transferred the dedication) and performed by him everywhere with the greatest success. At the same time it is only fair to add that Tschaikovsky, though much hurt by Nicholas Rubinstein's strictures, considerably modified the work on the strength of his criticisms and that Rubinstein in turn ultimately recognized the merits of the concerto and played it constantly. To the period of the late '70s belong the E flat quartet, the ballet *The Swan Lake*, and the "Francesca da Rimini" fantasia among other compositions, while during this period also, namely in 1877, Tschaikovsky first began to work on the opera of *Eugen Onegin*, destined to become the most popular of all his stage works and first heard at the Moscow Conservatorium in March 1879.

Meanwhile the more personal side of the composer's career had been given a romantic touch by his acquaintance with his life-long benefactress Nadezhda Filaretovna von Meck (1831–1894) and his deplorable fiasco of a marriage. In 1876 he had aroused the interest of Mme. von Meck, the widow of a wealthy railway engineer and contractor. She had a large fortune and she began by helping the composer financially in the shape of commissions for work, but in 1877 this took the more substantial shape of an annual allowance of £600. The strangest feature of their association consisted in the fact that, by agreement, they never met, though they corresponded with one another continually. In 1890 Mme. von Meck, imagining herself—apparently a pure delusion—to be ruined, discontinued the allowance; and though Tschaikovsky was then no longer really in need of it, he was deeply wounded by the manner in which she had made the announcement, and to the end of his days never entirely recovered from the shock which his abnormally sensitive nature had received from the termination of their relations.

Not less distressing was the episode of his marriage. Tschaikovsky married Antonina Ivanovna Milyukova on July 6, 1877, but the union proved an impossible one through no fault of hers but simply through his own abnormality of temperament; and it resulted in separation in October.

Tschaikovsky, who was deeply affected, went abroad with his brother to recover and was restored in due course to a more satisfactory state, but such happiness as he was to enjoy throughout the remainder of his career was qualified in an ever increasing degree by the tendency to melancholy and morbid introspection which, from the first, had been a conspicuous characteristic of his disposition.

Nor can it be said that he did not have many causes for discomfort and disillusionment in the ill luck and indifferent appreciation which attended in so many instances the performances of his works. But he continued to produce none the less with unchecked ardour and the fourth symphony may be named among the other works which he composed during his period of recuperation abroad.

Later, after his return to Russia, came the Italian Capriccio and the "1812" overture among other things. In 1879 he wrote his *Maid of Orleans* (produced in 1880) and his first suite for orchestra. In 1881 died Nicholas Rubinstein, to whose memory he dedicated the pianoforte trio in A minor. To the next five years belong the *Manfred* symphonic poem and the *Hamlet* overture fantasia, the operas *Maseppa* and *Charodaïka*, the "Mozartiana" suite and the big fifth symphony, of which even the last-named, though reckoned nowadays among his finest achievements, failed to elicit any great enthusiasm at first. Nor were the opera *The Queen of Spades* (which later vied with *Eugen Onegin* in popularity) or the delightful ballet *The Lake of Swans, The Sleeping Beauty* and *Casse-noisette* any more favourably received when first produced, so far at least as the critics were concerned. Better fortune, however, attended the *Casse-noisette* music in suite form which soon found unlimited favour and quickly established itself as one of the most popular pieces of its class ever written. (Incidentally, it may be noted that Tschaikovsky himself had the poorest opinion of this music when he was actually writing it.)

But though, after the time honoured experience of genius, Tschaikovsky gained full appreciation so tardily in his own country, in foreign countries his claims were much more readily recognized. In 1887 the first of several concert tours took him to Leipzig, Berlin, Prague, Hamburg, Paris and London, and won many warm friends for his music in every instance, not least so in London where he conducted the Serenade for strings and the Variations from the third suite at a Philharmonic concert.

Later, in 1891, he paid a visit to America, where he conducted six concerts—four in New York, one in Baltimore and one in Philadelphia—and again he was everywhere received with unbounded enthusiasm, the works performed being the Coronation March, the third suite, two sacred choruses, the B flat minor piano concerto and the Serenade for strings.

In 1893 Tschaikovsky sketched his sixth symphony, becoming more and more absorbed in his task as the work proceeded and more and more firmly convinced that it was the greatest thing he had ever done, a judgment subsequently confirmed in full measure by the world at large; for this was the symphony afterwards known as the "Pathetic," and under that title destined to enjoy such world-wide fame and popularity as perhaps no similar work had ever known before. Yet even this symphony had a cold and indifferent reception on the occasion of its actual first performance (on Oct. 28, 1893) at St. Petersburg, though in this instance the verdict was speedily reversed, both in Russia and elsewhere.

But the composer was not fated to witness and enjoy its triumphs. For within ten days of its production the world was shocked by the news of his wholly unexpected death—from an attack of cholera, caused by the drinking of unfiltered water—on Nov. 6, 1893.

As to the precise value of Tschaikovsky's music and the place which it is likely ultimately to take critical opinion has been sharply divided, but with a prevailing tendency to accord far less importance to his work than some consider its due. Almost inevitably the enormous popularity enjoyed by so many of his works at the hands of the general public has strengthened this tendency and the impartial student may well wonder if, even when the worst has been allowed, the process of critical belittlement which has been witnessed during recent years in the case of Tschaikovsky, has not gone far beyond the requirements of the case.

While his work as a whole may be unequal, there is in the finest of his orchestral compositions, which represent him at his best, a breadth and scope, a wealth of inspiration and imagination, and a command of his materials which may well secure for them a far greater measure of favour at the hands of posterity than is anticipated by some of his critics. How, indeed, the title of a great master can be denied to the composer of such things as the fifth and sixth symphonies, the "Francesca da Rimini" fantasia, the B flat minor piano concerto, and the pianoforte trio, it is indeed hard to understand. Tschaikovsky's operas are admittedly on a lower plane than the best of his orchestral writing, though containing many delightful pages, and much the same applies to the songs, albeit these also include many examples—he wrote over 100 in all—of rare beauty and charm.

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(H. A. Sc.)

TSCHAKSTE, JAN (1859–1927), first president of the republic of Latvia, was born in Courland, Sept. 14, 1859. He was educated at the Mitau gymnasium, studied law at the University of Moscow, and was for some years in the public prosecutor's depart-

ment of the Courland Government. Leaving the public service in 1888, he started practice as a barrister in Mitau and began to edit the paper *Tēvija* (Fatherland). In 1902 he served on a committee appointed by the local administration to enquire into agricultural conditions in Courland, and from time to time was employed on various Imperial Government committees. In 1906 he was elected a member of the first Russian Duma. The German invasion of Courland, July 1915, obliged him to leave Mitau. He went to Petrograd (Leningrad) where he founded a central relief committee for war refugees. In 1916 he went to Stockholm to promote the cause of Lettish independence and published there in German his book, *Die Letten und ihre Latvija.*

In 1918 Tschakste was elected chairman of the People's Council and was later head of the delegation sent to Paris and London to secure the recognition of the republic of Latvia. He was president of the Latvian National Council and in 1920 he was president of the Latvian Constituent Assembly, and also became professor of international law at the University of Riga. On Nov. 14, 1922, he was unanimously elected president of Latvia by the first Latvian Saemia (parliament), and on Nov. 6, 1925, was re-elected for a further period of three years, but he died on March 14, 1927, before the completion of his term of office, after a long and painful illness. His activities as a statesman have been dealt with in special publications and, since his death, a memorial fund has been started.

TSCHUDI, GILES or AEGIDIUS (1505–1572), Swiss historian, a zealous Catholic, who became the chief magistrate or *landammann* of Glarus in 1558, and in 1559 was ennobled by the emperor Ferdinand, to whom he had been sent as ambassador. He is best known as the historian of the Swiss Confederation. His great work is the *Chronicon helveticum*, or *Eidgenössche Kronik*, dealing with the period from 1000 to 1470. In spite of its many inaccuracies, falsifications and acceptance of baseless legends (comp., *e.g.*, the article, TELL, WILLIAM) this work is one of great interest and merit, and was long considered the leading authority on its subject. It enshrines the text of many ancient documents that would otherwise have been lost.

Tschudi's chief works were not published until long after his death. The *Beschreibung Galliae Comatae* appeared under Gallati's editorship in 1758, and is mainly devoted to a topographical, historical and antiquarian description of ancient Helvetia and Rhaetia, the latter part being an early work on Rhaetia revised and greatly enlarged. This book was designed practically as an introduction to his magnum opus, the *Chronicon helveticum* above mentioned, which was published by J. R. Iselin in two stately folios (1734–1736). *See* Lives by I. Fuchs (1805) and C. Vogel (1856).

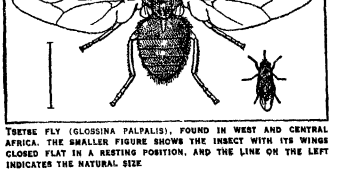
TSĒNG KUO-FAN (1811–1872), Chinese statesman and general, was born in 1811 in the province of Hunan, where he took in succession the three degrees of Chinese scholarship. In 1843 he was appointed chief literary examiner in the province of Szechuen, and six years later was made junior vice-president of the board of rites. The Taiping rebels were overrunning Hunan, and Tsēng was ordered to assist the governor of the province in raising a volunteer force, and on his own initiative he built a fleet of war junks, with which he attacked the rebels. His lieutenants recovered the capital, Chang-sha, and destroyed the rebel fleet. Following up these victories of his subordinates, Tsēng recaptured Wuchang and Hanyang, near Hankow, and was rewarded for his success by being appointed vice-president of the board of war. The rebels retook Wuchang and burnt the protecting fleet. Tsēng, however, succeeded in clearing the country round the Poyang lake, and subsequently in ridding the province of Kiangsu of the enemy. In 1857 he took supreme command in Cheh-kiang. Subsequently the rebels were driven westwards and Tsēng then cleared the province of Ngan-hui of rebel bands.

In 1860 he was appointed viceroy of the two Kiang provinces and Imperial war commissioner. At this time, and for some time previously, he had been fortunate in having the active support of Tso Tsung-t'ang, who at a later period recovered Kashgar for the emperor, and of Li Hung-Chang. In 1862 he became assistant grand secretary of State. At this time the Imperial forces, assisted by the "Ever-victorious Army," had checked the progress of the rebellion, and Tsēng was able to carry out a scheme which he had long formulated of besieging Nanking, the rebel headquarters. While Gordon, with the help of Li Hung-Chang, was clearing the cities on the lower waters of the Yangtse-kiang, Tsēng drew closer his besieging lines around the doomed city. In July 1864 the city fell into his hands, and he was rewarded with the rank and title of marquis.

After the suppression of the Taipings the Nienfei rebellion, closely related to the former movement, broke out in Shantung, and Tsēng was sent to quell it. He failed, and was relieved of his command by Li Hung-Chang, who succeeded him in the viceroyalty of Chihli. Tsēng died in 1872.

Tsēng was a voluminous writer. His papers addressed to the throne and his literary disquisitions are held in high esteem by the scholars of China, who treasure as a memorial of a great and uncorrupt statesman the edition of his collected works in 156 books, which was edited by Li Hung-Chang in 1876. (R. K. D.)

TSETSE FLY, the name given to any one of the twenty species of *Glossina*, a genus of African blood-sucking flies of the family Muscidae, order Diptera (*q.v.*). In appearance they are brownish insects banded or mottled with darker markings: they are somewhat larger than the housefly and have a prominent proboscis projecting horizontally in front of the head. Their habit of resting with the wings closed flat, one over the other, on the back enables them to be distinguished from other blood-sucking flies. The female insect does not lay eggs but brings forth at intervals a single fully-grown larva which is deposited on the ground, where it speedily conceals itself in some shady place and turns to a pupa. The flies abound where there is bush or forest, often frequenting the margins of rivers, lakes and islands; they are not found continuously but are restricted to areas known as fly belts. Both sexes are active blood suckers and are most troublesome during the hotter parts of the day, attacking both man and domestic animals. They are of great economic significance because they act as carriers of the pathogenic organisms (trypanosomes) which are responsible for fatal diseases in man and animals. When a tsetse fly alights on an infected subject and sucks its blood, numbers of the trypanosomes may be taken in at the same time. These tiny organisms require to undergo a developmental phase within the fly and when it is completed, are ready to pass into the blood of any man or animal upon which the fly happens to feed. In this manner the tsetse fly *Glossina palpalis* transmits *Trypanosoma gambiense*, the causal agent of sleeping sickness from man to man by means of its piercing mouth-parts, and in a similar fashion *Glossina morsitans* transmits *Trypanosoma rhodesiense*, which is responsible for the more local or Rhodesian form of that disease. This same species of tsetse fly is also the principal carrier of *Trypanosoma brucei*, which causes nagana disease among domestic animals. Five other kinds of tsetse fly have been proved experimentally to be capable



TSETSE FLY (GLOSSINA PALPALIS), FOUND IN WEST AND CENTRAL AFRICA. THE SMALLER FIGURE SHOWS THE INSECT WITH ITS WINGS CLOSED FLAT IN A RESTING POSITION, AND THE LINE ON THE LEFT INDICATES THE NATURAL SIZE

of transmitting trypanosomes, and it is probable that a number of species are natural carriers of the diseases mentioned.

The development of communications has probably been responsible for the spread of sleeping sickness from West Africa to eastern Central Africa where the population had acquired no immunity In the five years 1901–06 it is stated that over 200,000 natives died of the complaint in Uganda, where it was previously unknown, and the local tsetse flies until then were believed to have been uninfected with the trypanosome. The island population of Lake Victoria Nyanza suffered most seriously from this outbreak. Among the various methods which have been tried to control the fly, the clearing of vegetation around villages, so as to make such localities unsuitable for the insect, is now receiving attention. No feasible methods of luring or poisoning the insect are known, while the destruction of the concealed pupae presents great difficulties if carried out on a sufficiently extensive scale. The utilization of natural parasites has received some attention but at present offers little prospects of success. It has been proved experimentally that monkeys can be infected with the sleeping sickness trypanosome, and certain wild game, including antelopes, are regarded as functioning as "natural reservoirs" for trypanosomes although they themselves apparently suffer little ill effects.

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TSHI, a group of Negro peoples of the Gold Coast (*q.v.*). The chief of these are the Ashanti and Fanti.

TSIMSHIAN, an American Indian linguistic stock on Nass and Skeena rivers and Milbank sound, British Columbia. They are typical north Pacific coast tribes, forming, with the Tlingit, the Haida and certain Athabascans of the adjacent interior, a matrilineal sub-culture group. The four Tsimshian phratries, Raven, Wolf, Eagle and Grizzly Bear, are distributed through the three tribes composing the stock, namely Tsimshian proper, Niska and Gitksan. Population, originally estimated, 7,000; 1906, 3,700.

TSINAN: *see* CHINAN.

TSINGTAO, a port on a large inlet named Kiaochow bay, on the south side of the base of the Shantung peninsula, China. The bay was occupied by Germany after the murder of two missionaries in Shantung in 1897, and negotiations followed, resulting in a lease of land to Germany for 99 years. The area leased was about 117 sq.mi., and all points within 32 mi. of any point on the bay were held not to be affected by Chinese ordinances without German consent. A free port was created in 1899, and a branch of the imperial maritime customs was established there for collection of duties on shipments to and from the interior, in accordance with the general tariff. Tsingtao, on the bay, became the port and chief centre, and the German government created educational and agricultural institutions in the leased territory, and fortified the port Japanese forces took the place in 1914, and held it till 1922, when it was returned to China under the Washington agreement. The port is connected with Tsinan, the capital of the province of Shantung, by rail. The port fell early in 1938 into Japanese hands after the Chinese had destroyed the textile mills. Area of municipality, 289 sq.mi.; pop. (1940) 590,374.

The Siege of Tsingtao.—The first part which Japan took upon herself to play in World War I was the reduction of the German stronghold of Tsingtao, on the bay of Kiaochow. This fortress served at the outset of the war as the only base of operations in eastern Asia for the German marauders menacing the Allied trade routes. It was imperative to make von Spee's raiders homeless, and the military and naval operations against the redoubtable base, which was under the command of Capt. Meyer-Waldeck and garrisoned by some 13,000 men, of whom 5,599 were German regulars, were started with the utmost dispatch. On Aug. 27, 1914, the blockade of Kiaochow bay was declared by the Japanese navy, and Lungkow, 150 mi. N. of Tsingtao, was chosen as the point for landing troops.

On Sept. 2, 1914, the Japanese division, under the orders of Lieut.-Gen. Kamio, commenced landing at Lungkow. Despite the terrible weather conditions, the vanguards arrived on the 12th at the small town of Tsimo, where they encountered the enemy for the first time. The second Japanese contingent began to land at Laoshan bay, within the leased zone, on Sept. 18 and soon established touch with the first army. The Japanese forces under Gen. Kamio thus amounted to about 22,980 officers and men, and they succeeded in some 10 days in wresting from the Germans several of their advanced positions. On Sept. 24 there arrived at the arena of campaign the British force, commanded by Gen. Barnardiston, consisting of 910 officers and men of the 2nd South Wales Borderers and 450 of the 36th Sikhs. After the noncombatants had been permitted to leave the fortress, the general attack of the position was commenced on Oct. 31, the Japanese blockading fleet off the harbour assisting by a continuous bombardment. On the morning of Nov. 7 white flags were descried on the forts of Moltke, Bismarck and Iltis, to the pleasant surprise of the attacking army, which had expected a protracted siege. After the fall of the stronghold it was ascertained that all enemy ships, including the Austrian cruiser "Kaiserin Elisabeth," had been sunk in the port of Tsingtao. The Japanese army lost during the campaign 1,968 killed or wounded, and the Japanese navy, a cruiser, a destroyer and a torpedo boat. The port of Kiaochow was reopened for trade by the Japanese on Dec. 28, 1914. (*See* WORLD WAR I: *Bibliography.*)

TSINLINGSHAN, a range of mountains which forms the southern wall of the Wei-ho valley and extends eastwards into the plain of north China (Honan). It forms a boundary in geology climate and human relations between the region of loess in the north and the basin of the Yangtze to the south. The Tapaling or Tapashan is a range diverging from it south-eastwards, with the valley of the Han between them. These mountains are often held to be structurally a continuation of the Kuenlun system and, like the Kuenlun, show folding of rocks up to the Upper Carboniferous age, with granites and gneiss in many places, especially in the north. The reduction in height from the great mountains of the Kuenlun system on the west to the Tsinlingshan on the east is very marked, though the latter reach 10,983 ft. and its average height is surprisingly great. The break between the Kuenlun system and these mountains is a part of the great break seen all along the east side of the Tibetan plateau. The north face is very steep, and loess reaches up to some 3,300 ft. above sea level at places along it. The top of the range is broad, with sharp heights. The south face has rounded heights and wild, deep-cut valleys. In spite of its size and height the range is essentially one mass, and not a complex of chains such as we find, for example, in the Alps. The Chinese were interested in and occupied the Han valley in distant antiquity, but until a way was worked out across the Tsinlingshan, these had to pass south-eastwards up the Tankiang, a long detour if the ultimate goal were Han-chung-fu, or, perhaps, Chengtu in Szechwan.

TSUSHIMA, an island belonging to Japan, situated about midway between Korea and the island of Iki, so that the two islands were used as places of call in former times by vessels plying between Japan and Korea. Tsushima lies about 34° 20′ N., 129° 20′ E. It has an area of 271 sq.mi and a population (1950) of 60,376. It is divided at the waist by a deep sound (Asaji-ura), and the southern section has two hills, Yatachi-yama and Shira-dake, 2,106 ft. and 1,680 ft. high, respectively, while the northern section has Ibeshi-yama and Mi-take, whose heights are 1,128 ft. and 1,598 ft. The chief town is Izuhara. The Mongol armada visited the island in the 13th century and committed great depredations. In 1861 an attempt was made by Russia to obtain a footing on the island. The name of the battle of Tsushima is given to the great naval engagement of May 27–28, 1905, in which the Russian fleet under Admiral Rozhestvenski was defeated by the Japanese under Admiral Togo.

TSWANA, otherwise BATSWANA or BECHUANA, a Sotho people of southern Africa. *See* BECHUANALAND.

TUAM, a market town and episcopal city of County Galway, Ire., 20 mi. N.N.E. of Galway on the Great Southern railway. Pop. (1951) 4,010. It is the seat of a Roman Catholic archbishopric and of a Protestant bishopric. The cross of Tuam, re-erected in modern times, bears inscriptions in memory of Tur-

logh O'Conor, king of Ireland, and O'Hoisin, successively (1128) abbot of St. Jarlath's Abbey and archbishop (1152) of Tuam, when the see was raised. St. Jarlath's Roman Catholic college is a seminary founded in 1814 for the education of priests.

TUAN CHI-JUI (1864–1936), Chinese politician, was born in Anhwei. He succeeded Yuan Shih-kai as viceroy of the Hukuang Province, and was one of the signatories to the memorial of Jan. 1911, urging the Emperor to abdicate. He was acting Premier from May to July 1913, Minister of War in 1914, and Premier in April 1916. In Oct. 1918 he resigned, and, after an ill-advised coup on behalf of the Anfui Club, played no great part in affairs till Nov. 24, 1924, when he succeeded Tsao Kun as President.

TUAPSE, a town on the Black Sea in the Krasnodar territory of the Russian S.F.S.R., in 44° 10′ N., 38° 59′ E., linked by a branch line with Armavir on the Rostov-Baku railway. It has oil refineries working on oil from the Groznyi district, to which it is connected by a pipe line. Population 34,000 in 1933.

TUAREG, also **TAWAREK** (sing. *Targi*), the name given by Arabs to the western and central Saharan Berber peoples in the desert from Tuat to Timbuktu and from Fezzan to Zinder, an area of about 1,500,000 sq.mi. The Tuareg resort to the centres from which the trade routes radiate, Timbuktu, Ghat, Ghadames, Murzuk and Tuat. Their general colour is reddish yellow Their hair is long, black and silky, beards black and thin, eyes generally black; noses small, hands delicate, and bodies muscular. They are tall and graceful.

The aristocratic section is called *Tmajogh;* Arabs call them *muleth themun* (veiled people). The men wear the veil day and night, the women never. The Tuareg, at any rate the noble class, are among the purest of the Berber stocks but have become largely Arabised. The script is known as T'ifinagh, consists of 40 to 50 symbols They dress generally in a black tunic (some wear white); trousers of white cotton, and wear a cloth called *litkam* or *tagilmus,* the end of which is drawn over the face, leaving visible only the eyes and the tip of the nose. These cloths are dark blue or white. To this difference of colour is due the terms "black" and "white" Tuaregs.

Socially the Tuareg are divided into six classes, viz.: *Imajeghan* or nobles; *Marabout* or priests; *Imghad* or serfs; *Irejanaten* or mixed people, issue of noble and Imghad; *Ikelan* negro slaves and *Buzu* outdoor slaves. The nobles are all pure blooded and provide the tribal chiefs. They do no manual work. Among the Imghad serfdom is hereditary, and they are bound collectively to a noble tribe or group of tribes. The Tuareg weapons are a straight two-edged sword about 4 ft. long, a dagger bound to the left forearm and spears and leathern shields.

See Heinrich Barth, *Travels in Central Africa* (1858); W. J. Harding King, *A Search for the Masked Tuaregs* (London, 1903); M. Benhazera, *Six Mois chez les Touareg du Ahaggar* (Algiers, 1908); Lieut C Jean, *Les Touareg du sud-est* (Paris, 1909); E. Doutté, *Magie et religion dans l'Afrique du nord* (Algiers, 1909); E. F. Gautier, *Le Sahara* (1923); F. R. Rodd, *People of the Veil* (1926).

TUAT, a word sometimes applied generally to all the oases in the western part of the Algerian Sahara, *i.e.,* between 2° W. and 2½° E. 26° and 30° N., sometimes restricted to a particular group which borders the east side of Wad Messaud between 26½° and 27½° N. According to the first usage Tuat includes the oases of Gurara in the north and Tidikelt in the south with the important centre of Insalah. The three groups are spoken of collectively by the French as the Tuat archipelago. The district is comparatively fertile, and produces dates and some cereals and vegetables The wadi Saura (known in its lower course as the Messaud), formed by the junction of the wadis Zusfana and Ghir, marks the north-western boundary of the oases. The inhabitants live in *ksurs* or fortified villages, grouped in districts. The Tuat group forms part of the Southern Territories of Algeria; Gurara and Tuat are attached to the territory of Ain Sefra and to the native commune of Timimun. Tidikelt to the Oasis territory and to the native commune of Wargla. The pop. is (1936) 57,815, of which Gurara and Tuat have 40,576 and Tidikelt 17,239 The principal ksurs are in Gurara, Timimun (pop. [1936] 5,394). Deldoul (2,694); at Tuat, Timmi (2,079). Kaouïa-Kounta (2,536); at Tidikelt, In Salah (13), In-Ghar (1,370). The district commands the routes southwards to Timbuktu and the Sudan.

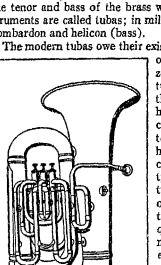
The oases appear to have been inhabited from a very early period. The Arabs took possession in the 10th century and imposed Islam upon the people. The treaty of 1845 between Morocco and France left the question of the possession of Tuat, Gurara and Tidikelt unsettled. In 1890 a French scientific mission, under Flamand, was despatched to the oasis of Tidikelt. The French were attacked by the natives (Dec 28, 1899), whom they defeated. This was the beginning of a campaign which ended in March 1901 in the complete occupation of the oases and of the Zusfana-Saura line of communication. The French were not, however, left in peaceable possession. Attacks by the nomad tribes, were made on the line of communications, and during 1903 the French troops suffered serious losses To punish the tribes the town of Figig was bombarded (June 8, 1903). From 1904, the methods of governor Jonnart and of General Lyautey brought about rapid pacification. In 1905, the extension of the railway from South Oran to Colomb Bechar, which had been occupied in Nov. 1903, definitely stabilised French domination in that region.

Major A. G. Laing visited the Tuat territory in 1825, but his papers were lost. The next European to visit Tuat was Gerhard Rohlfs, who described his explorations in *Tagebuch seiner Reise durch Marokko nach Tuat, 1864* (Gotha, 1865) and *Reise durch Marokko . . . Exploration der Oasen von Tafilet, Tuat und Tidikelt . . .* (Bremen, 1868). E. F. Gautier, *Sahara algérien* (Paris, 1908), Id *La conquête du Sahara,* Paris, 1910; Id *Le Sahara,* Paris, 1923, G. B. M Flamand. *Recherches géologiques et géographiques sur le haut-pays de l'Oranie et sur le Sahara,* Lyon, 1911. Augustin Bernard and N. Lacroix, *La pénétration saharienne,* Alger, 1906; *Les territoires du Sud de l'Algérie* 3 vol., Alger, 1922.

TUATARA, the lizard-like *Sphenodon* of New Zealand, which forms a distinct order of reptiles. *See* REPTILES.

TUBA, in music, the tubas—bombardon, helicon, euphonium —are a family of valved instruments of powerful tone forming the tenor and bass of the brass wind. In the orchestra these instruments are called tubas; in military bands euphonium (tenor), bombardon and helicon (bass).

The modern tubas owe their existence to the invention of valves or pistons by two Prussians, Stölzel and Blümel, in 1815. The tubas are often confounded with the baritone and bass of the saxhorns, being like them the outcome of the application of valves to the bugle family. There is, however, a radical difference in construction between the two types. Given the same length of tubing, the fundamental octave of the tubas is an octave lower than that of the saxhorns, the quality of tone being besides immeasurably superior. This difference is entirely due to the proportions of the truncated cones of the bore and consequently of the column of air within. By increasing the calibre of the bore in proportion to the length of the tube it was found that the fundamental note or first sound of the harmonic series was easily obtained in a full rich quality, and by means of the valves, with this one note as a basis, a valuable pedal octave, absent in the saxhorns, is obtained.



THE TUBA, THE DEEPEST TONED INSTRUMENT OF THE BRASS WIND FAMILY

The modern tuba finds its prototype in the Roman tuba. Compared with the other military service instruments of the Romans, the buccina and cornu, the tuba was straight and was used to sound the charge and retreat, and lead the soldiers in action.

TUBE. This term generally refers to a hollow cylinder or pipe for conveying liquids or gases. In botany it denotes the narrow basal portion of a gamopetalous corolla or a gamosepalous calyx.

For a discussion of the manufacture of metal tubing, *see* the article on IRON AND STEEL.

The manufacture and application of glass tubing is discussed under GLASS MANUFACTURE. Tubes for boilers (*i e*, fire tubing and water tubing), are treated under BOILERS and STEAM GENERATION. The term as used in the textile industry (*i e*, tube yarns), is found in articles related to textiles.

The application of the term to subsurface transit is found in the article RAILWAYS, TUBE. The article PNEUMATIC CONVEYING treats the use of tubes in postal and similar services. Under TYRE various types of inner tubes for vehicles are described The Coolidge tube and tubes used for X-ray treatment and radiotherapy are discussed under articles related to these subjects. The tubes used in lighting are discussed under LIGHTING AND ARTIFICIAL ILLUMINATION. For Estuary tubes *see* AQUEDUCTS.

Perhaps the most common use of the word in recent years has been in connection with vacuum tubes used in the radio These are discussed under THERMIONICS and ELECTRON TUBE.

Many special tubes applying to different fields of science and industry are found under various headings in their related fields. One device, however, which deserves mention here is the Knowles Grid-Glow tube or relay. This is a device for controlling electrical power which is so sensitive that it can be operated by the mere approach of the human hand. Superficially the Knowles Grid-Glow tube resembles the radio tube for it has the anode, the cathode and grid. However, it has no filament; the connection of the anode and cathode are the reverse of the radio tube; the grid is merely a piece of heavy wire and the tube is filled with neon, argon, or some other gas. The ordinary relay is a device which is operated by a small current which controls a much larger one. The relays commonly used in electrical engineering have an amplifying power of about 10,000, which means that they can control a current 10,000 times greater than the current controlling them. A Knowles Grid-Glow tube has an amplifying power of the order of 100,000,000 and it is probably the most sensitive thing of the kind ever devised. The energy required to operate it is about one one-thousand-millionth ($\frac{1}{1,000,000,000}$) of a watt This small amount of energy is sufficient to start a current of 25 milliamperes flowing through the tube. This current is sufficient to close or open a switch of 25 amperes and this in turn to control almost any operation. It is possible by use of this relay to turn on the lights of the city, start a railway train, or manoeuvre a battleship. The tube is the invention of Knowles of the Westinghouse Electric and Manufacturing Co.

TUBE RAILWAYS: *see* RAILWAYS, TUBE.

TUBERCULIN. In 1890 Robert Koch found a specific substance produced in artificial culture media durnng the growth of tubercle bacilli (*Mycobacterium tuberculosis*) which he called tuberculin. It caused an inflammatory reaction when injected into animals or people previously infected with the tubercle bacillus but not in uninfected individuals. His original preparation, called old tuberculin (OT), was made by concentrating the whole germ-free culture liquid to one-tenth the original volume and filtering off the bacilli. This tuberculin has been used for the diagnosis of tuberculosis. An enormous variety of other tuberculin preparations have been proposed.

Many attempts have been made to isolate the active fraction, which proved to be protein. One of the purest products isolated is the purified protein derivative (PPD) which was used extensively for diagnosis after 1934 in the U.S. and other countries. This product was isolated from filtrates of heated human tubercle bacillus cultures grown upon a synthetic nonprotein medium It consists of the purified proteins of tuberculin, free from the germ and all other substances. It is so potent that only 0.00002 mg. is required to give a positive reaction in 94% to 96% of all individuals with active tuberculous infection. If no reaction occurs with this dose in 48 hr. a second test with 0.005 mg. is usually given to detect those infected with less virulent strains, such as BCG. A patient giving a negative reaction to this dose is considered uninfected. A very few individuals fail to react in spite of known infection. Larger doses are not used because there are indications that they give nonspecific or primary toxic reactions. A single dose of 0.0001 mg. is frequently used.

Tuberculin Test.—One of the most popular methods of administering tuberculin is known as the Mantoux test. A small amount of tuberculin (0.1 cc.) is injected intracutaneously, usually on the flexor surface of the arm, and if the subject reacts positively, swelling and redness develop at the site of injection within 24 hr. Other methods of testing, generally considered less accurate, have been used, such as the scratch technique, the patch test, the ophthalmic method, and subcutaneous injection.

The specificity of the reaction is very great For example. practically 100%of guinea pigs artificially infected with tubercle bacilli, or individuals vaccinated with the attenuated tubercle bacilli (BCG), react to tuberculin On the other hand, in a population group in Dutch Guiana where there was no infection with tubercle bacilli only negative reactions to tuberculin were found.

The extent of tuberculosis infection in any locality can be determined approximately by finding the percentage of reactors to tuberculin. In this way it has been determined that the rate of infection varies greatly in different parts of the world, in different sections of the same country and even in different groups within a city, and that such rates are correlated with the intensity of exposure, which usually reflects the prevailing economic and sanitary conditions. A positive reaction, however, merely indicates infection with the tubercle bacillus. Such infection in most cases does not give rise to active disease, as determined by the X-ray film. The test is a help to the doctor in determining the source and time of an infection, and in distinguishing between tuberculosis and other pulmonary diseases. A negative reaction usually excludes a diagnosis of tuberculosis.

Tuberculin Therapy.—Tuberculin was also used therapeutically by Koch. It is used very much less in pulmonary tuberculosis than formerly, but is frequently employed in the treatment of tuberculosis of the eye and other forms of nonpulmonary tuberculosis. In these cases a series of injections of increasing dosages, beginning with a 1:100,000 dilution of old tuberculin, aiming at desensitization, is given.

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TUBERCULOSIS. Tuberculosis is an infectious disease of man and animals caused by the tubercle bacillus (*Mycobacterium tuberculosis*), which belongs to the acid-fast group of bacteria (*Mycobacteria*), and of which several types exist, including the human, bovine and avian. The principal form of the disease in man is pulmonary tuberculosis.

Prevalence and Mortality.—Tuberculosis is world-wide in its distribution and the chief cause of mortality in many parts of the earth. The death rate is especially high in densely populated countries with poor hygiene It declined steadily in the 20th century in all industrialized nations, except for periods of war and national catastrophe. In the U.S. the rate (all forms of tuberculosis) dropped from 194 per 100,000 population in 1900 to 36 in 1947, and in England and Wales from 191 for the period 1896–1900 to 53 in 1946.

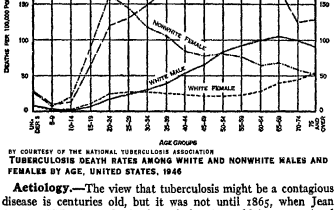
Tuberculosis was the chief cause of death in the U.S. until 1909 and seventh in 1947, being exceeded in that year by heart diseases, cancer, intracranial lesions of vascular origin, accidents, nephritis and pneumonia. In 1947 in the U.S. 48,064 deaths from tuberculosis were recorded.

It is calculated that in general the prevalence is approximately nine times the mortality, but both prevalence and mortality vary considerably in different circumstances. In general, tuberculosis rates are higher in urban than in rural communities, because of crowding, greater opportunity for infection and the frequent hygienically less favourable position of large parts of some cities.

However, with economic improvement, better sanitation, more widespread education and particularly with the establishment of public health practice, including specific measures for tuberculosis control, many cities have lower tuberculosis rates than adjacent rural areas. In the U.S. the chief factor influencing the mortality rate is the relative proportion of Negro inhabitants. The over-all mortality rate from tuberculosis is three times as high in Negroes as in whites. In New York city, with an estimated population of 7,835,293, the tuberculosis mortality rate was 40 in 1947, but in central Harlem, with a predominantly Negro population, the rate was 157, while in adjoining Westchester county, a district with relatively few Negro inhabitants, the rate was only 25.

Economic conditions have a notable effect on the rate. The well-to-do and professional classes exhibit a low rate, while unskilled labourers have a high rate. A study by J. S. Whitney based on death rates in the U.S. in 1930 revealed a rate for unskilled labourers seven times as high as that among professional men. Sex and age are equally important.

The chart shows how mortality varied with sex, age and race in the U.S. in 1946.



BY COURTESY OF THE NATIONAL TUBERCULOSIS ASSOCIATION

TUBERCULOSIS DEATH RATES AMONG WHITE AND NONWHITE MALES AND FEMALES BY AGE, UNITED STATES, 1946

Aetiology.—The view that tuberculosis might be a contagious disease is centuries old, but it was not until 1865, when Jean Antoine Villemin in Paris showed that it could be transmitted from tuberculous to healthy animals by inoculation, that it was proved to be due to an infecting agent. The actual cause, the tubercle bacillus, was discovered by Robert Koch in Germany in 1882. The bacillus is the best-known member of the family of acid-fast bacteria, distinguished by their capacity to resist destaining by such reagents as acids, alkalies and alcohol when once stained with aniline dyes like fuchsin. As compared with other bacteria it grows slowly in artificial culture media. Once isolated it may be grown readily in large quantities on simple media of well-defined chemical structure, containing glycerol, nitrogen in the form of ammonia or the amino group, and inorganic salts. It is relatively resistant to the usual disinfecting agents, and withstands drying for long periods. It is killed quickly by sunlight and ultra-violet light from artificial sources.

The bacillus is a rod from one-half micron to four microns in length which reproduces, as microcultures by Morton C. Kahn showed, by a complex division into minute particles from which new bacilli arise. It does not pass through porcelain filters, although claims for the existence of filterable forms have been made. Colony growth on solid culture media is of two types, "rough" and "smooth," which exhibit differences in virulence.

Advantage has been taken of its capacity to grow on media of known composition, to make exact studies of its chemical composition. In the bodies of bacilli grown on such media, lipids, carbohydrates and proteins occur in approximately equal proportion. The lipids of the bacillus were shown by R. J. Anderson to be distinctive for acid-fast bacteria, and one of them, a phosphatide containing a specific fatty acid, phthioic acid, was shown by Florence Sabin and associates to stimulate in animal tissue the histologic changes characteristic of tuberculosis. Certain waxy constituents of the bacillus were shown by Anderson and his co-workers to play a role in the phenomenon of acid-fastness. The proteins are extremely important, for they include the specific substance tuberculin, which is a valuable diagnostic agent and which is believed to be responsible for many of the toxic manifestations of tuberculosis in the body. The physicochemical studies of Florence Seibert showed that proteins of different tuberculin potency occur in the filtrate from cultures of tubercle bacilli, and that extremely minute amounts of certain of the proteins will elicit a tuberculin reaction. (*See* TUBERCULIN.)

Mode of Transmission.—Tuberculosis is transmitted to healthy bodies by way of the respiratory and alimentary tracts, and rarely by direct inoculation through the skin. Most tuberculosis is acquired by inhalation of bacilli from the sputum of persons with ulcerative pulmonary tuberculosis. Investigation has shown that the minute droplets may be discharged by cough or sneeze, and droplets of such size, sometimes containing hundreds of tubercle bacilli, may float in the air for many minutes or even hours. Experimental evidence indicates also that bacilli in thoroughly dried and ground sputum may be inhaled and prove infective. Specific procedures, including sterilization of the air by ultra-violet light and treatment of clothes, bedding and floors with an oily preparation to reduce dust, are used by hospitals to reduce the hazard of inhalation.

The principal source of primary infection by way of the alimentary tract is contaminated milk. Secondary, endogenous infection of the alimentary tract, from swallowing sputum discharged from tuberculous ulcerations in the lungs or bronchi, is frequent in advanced pulmonary tuberculosis. In milk from cattle with infected udders, bacilli may be numerous, and the practice of pooling milk from several dairies may distribute tubercle bacilli widely in a city's milk supply if pasteurization is not practised. The bacillus concerned is the bovine type.

Pathology.—The anatomic unit of tuberculosis is a highly characteristic pathological formation known as the tubercle. When tubercle bacilli lodge in tissues the first reaction is an outpouring of polymorphonuclear leucocytes which surround and engulf the bacilli. This phase of reaction is over within a few hours, and is succeeded by a stage of infiltration of large mononuclear phagocytic cells which enlarge, with production of abundant cytoplasm, and engulf the polymorphonuclear leucocytes and their content of tubercle bacilli. The enlarged mononuclear cells, because of an early fancied resemblance to epithelial cells, have long been known as "epithelioid" cells. The latter tend to assume a radial arrangement around the site of infection, and among them appear large cells, designated by the name of an early describer as "Langhans' giant cells." These differ from the usual giant cells of foreign-body reaction in tissue in a distinctive arrangement of their nuclei. The giant cells arise from epithelioid cells as a result of fusion or incomplete division of the latter. In the normal course of development of the mass of epithelioid cells a specific type of necrosis of the central portion occurs, which is designated as "caseation" necrosis because of its cheese-like appearance when seen in large tuberculous masses. In time fibroblasts appear at the periphery of such an epithelioid mass. The complete structure, with a caseous centre, a zone of radially arranged epithelioid cells and a periphery of young mononuclear cells and fibroblasts, still microscopic in size, is known as an epithelioid tubercle. Most of the visible manifestations of tuberculosis, from barely visible nodules to large tuberculous masses, are fundamentally conglomerations of such tubercles, in which caseation necrosis progresses. Under certain circumstances large caseous masses tend to soften, and if such softened areas discharge their content into a segment of the bronchial tree, a cavity results. In typical pulmonary tuberculosis, concomitantly but varying in degree according to individual circumstances, exudation occurs into the pulmonary alveoli, and frequently into the pleural space.

In time reparative processes occur, with evolution of a chronic lesion characterized by localized destruction and scarring, with surrounding exudation.

The principal site of tuberculosis is the lung. Ordinarily pulmonary tuberculosis is a chronic disease, although many of the manifestations that enter into its complex character are acute, and rapidly progressive pneumonic forms, almost entirely exudative in character, occur. The typical lung of chronic advanced tuberculosis is characterized by cavity formation and scarring in the upper part, tuberculous consolidation with smaller cavities in the zone immediately below, and scattered shotlike tubercles in the lower regions. Ulceration, the result of the softening process described above, is the immediate cause of the chain of events leading to progressive tuberculosis. When this occurs, semiliquid material containing tubercle bacilli is poured into the bronchial tree and aspirated into adjacent bronchi, with the production of new tuberculosis, called "bronchogenic" from its mode of origin. As the disease progresses, new cavities develop and the process is repeated. At the same time reparative processes are under way, and scarring may be extensive.

Pulmonary Tuberculosis; Clinical Features.—Approximately 90% of all clinically recognized tuberculosis is pulmonary. The disease is insidious in onset and early course, and may reach a moderately advanced stage before identifying symptoms are manifest. The chances for cure are immeasurably better when the disease is discovered in an early rather than advanced stage. Control, therefore, depends largely on early diagnosis.

Several classifications of pulmonary tuberculosis are in use. That recommended by the National Tuberculosis association in the U.S. is widely employed. It distinguishes primary and reinfection types of the disease, and minimal, moderately advanced and far advanced stages. Primary tuberculosis (first infection) was formerly most frequent in children. In contrast to the reinfection type of tuberculosis in adults, first infection tuberculosis in children occurs in any part of the lung, and the draining lymph nodes soon become involved. The course in children is usually benign, and healing occurs in both the primary lung focus and regional lymph nodes, with scarring and calcification, leaving two or more nodules which are often readily visualized in chest X-ray films, and are easily found on post-mortem examination. The healed lesion is commonly designated as a primary complex; its development was traced with great care by the Austrian pathologist Anton Ghon. Severe forms of primary tuberculosis sometimes occur in children, with rapid pneumonic progression, or with invasion of the blood stream and death from miliary tuberculosis or meningitis.

With improved measures for tuberculosis control primary infection is less frequent in children. First infection with tubercle bacilli may take place in later life, when in its localization and character, it commonly resembles reinfection-type tuberculosis in adults more closely than it does primary tuberculosis in children.

Reinfection-type tuberculosis represents disease from repeated infection with tubercle bacilli. The bacilli concerned may come from fresh infection from a new source (exogenous infection) or from an already existing focus in the body (endogenous infection). Reinfection-type tuberculosis, in generally accepted classifications, is subdivided on the basis of its anatomical extent and the presence or absence of gross cavity formation, into minimal, moderately advanced and far advanced stages. Its onset is often difficult to detect. Fatigue, afternoon and evening fever, weight loss and cough are the usual symptoms. With advance of the disease these symptoms become more severe, and others may occur, the most striking of which is haemorrhage from the lungs (haemoptysis). Pleurisy with effusion of fluid into the pleural space is common.

Diagnosis is made by a combination of methods. Discovery of the tubercle bacillus in the sputum establishes it beyond question. In early stages this may not be possible, for tubercle bacilli do not appear in the sputum until ulceration of the lesion has occurred. Prior to the development of X-ray techniques chief reliance was placed on physical examination, with emphasis on differences in density of the lung, evident on percussion, and the detection of characteristic *râles* on auscultation with the stethoscope. X-ray evidence of infiltration of the lung is highly important in establishing the diagnosis. Early tuberculosis of minimal extent is usually found in the upper part of one lung, either above or below the clavicle.

Sputum is examined by a special staining technique used to detect acid-fast bacteria, either by direct smear of a selected portion of the expectorated material, or by concentration methods in which a large amount of sputum is reduced to a small volume by chemical treatment and centrifugalization. In cases where the presence of tubercle bacilli is suspected, but the amount of sputum is too small for examination, the contents of the stomach, containing small accumulations of swallowed sputum, may be aspirated and examined. When the number of bacilli is too small for detection by staining methods, they may be found by culture methods or inoculation of guinea pigs.

Pulmonary tuberculosis is treated by rest, good nutrition and hygiene and by certain specific measures, of which various methods for the collapse and enforced rest of the affected lung are particularly important. All methods require treatment over many months. Treatment is best carried out in a tuberculosis hospital. The chief methods of collapse treatment are artificial pneumothorax and thoracoplasty. In the former, air is allowed to enter between the two pleural surfaces and the lung collapses. It is often necessary to sever adhesions between the pleural surfaces in order to make this treatment effective (pneumonolysis). After cure the lung is allowed to re-expand. In thoracoplasty the upper portion of the rib cage is removed by surgery, periosteum being left to regenerate bone, so that a new and very much smaller rib cage is ultimately left. The lung is confined to a small space and the affected part permanently immobilized. Other operative procedures, including pneumonectomy (removal of one lung) and lobectomy (removal of a lobe of a lung), are also employed.

Many drugs have been used in the treatment of tuberculosis, most of them without success. Some value was found in drugs of the sulphone series, including promin, promizole and diasone, but these proved too toxic for general use. In 1944 streptomycin, first employed in the therapy of tuberculosis by H. C. Hinshaw and W. H. Feldman, was found to exert a favourable effect, particularly on miliary tuberculosis, tuberculous meningitis, tuberculous sinuses, tuberculous laryngitis and bronchial tuberculosis. Other drugs, including para-amino-salicylic acid, are used effectively as adjuncts to streptomycin. (*See* also HEART AND LUNG, SURGERY OF.)

Nonpulmonary Tuberculosis.—Approximately one-tenth of clinically recognizable tuberculosis is nonpulmonary. The organs chiefly affected are the lymph nodes, bones and joints, serous surfaces, genital organs, kidneys, adrenal glands and skin. Lesions in these organs are usually caseous and there is a tendency for tuberculous abscesses and sinuses to develop. Tuberculosis of the intestines is common, but is usually a complication of pulmonary tuberculosis. Generalized tuberculosis of the lymph nodes (scrofula) was at one time one of the most frequent manifestations of tuberculosis, but with improved hygiene has become rare. Tuberculosis of the bones and joints is a grave disease requiring immobilization for arrest and usually leaving permanent damage to function when healing occurs. Tuberculosis may destroy the adrenal glands, in which case Addison's disease (*q.v.*) results. In countries where bovine tuberculosis is not well controlled, nonpulmonary tuberculosis caused by infection with bovine-type tubercle bacilli is frequent. In the treatment of nonpulmonary tuberculosis, rest of the affected part is secured, in so far as possible. When practical, as in the case of tuberculosis of a single kidney, surgical measures are employed.

Generalization of tuberculous infection, with dissemination through the blood stream, is a not-rare complication of nonpulmonary tuberculosis. Miliary tuberculosis is a highly fatal form, in which small nodules, likened by early investigators to millet seeds (and hence the term "miliary"), are scattered throughout the body. They represent individual implantations of tubercle bacilli discharged into the blood stream from a tuberculous focus which invades a vein wall, and are conspicuous in the lungs, in which they give rise to a characteristic X-ray picture. Tuberculous meningitis, the most severe of all forms of tuberculosis, is a frequent complication of miliary tuberculosis; at times it occurs

without grossly evident miliary tuberculosis.

Resistance and Immunity.—Resistance and immunity in tuberculosis may be natural or acquired. Certain animals, like the monkey and guinea pig, are highly susceptible to the disease; others, like the cat, dog and horse, are relatively resistant. Some animals are susceptible to invasion by one type of tubercle bacillus and not by others. The rabbit succumbs to infection by bovine and avian strains of bacilli, but is resistant to the human type. Man is virtually immune to the avian type, but suffers from progressive disease caused by human- and bovine-type bacilli.

Heredity and constitution play an important part in determining the outcome of tuberculous infection. Before the discovery of the tubercle bacillus heredity was believed the chief determinant in man. That heredity is a vital factor in resistance has been proved experimentally by several investigators. In a long series of investigations from 1932 to 1949, M. B. Lurie showed that inbred strains of rabbits of different genetic constitution varied considerably in their resistance to tuberculosis and in the character assumed by the disease.

Racial variation in resistance to tuberculosis has also long been recognized. In 1908 S. Lyle Cummins called attention to the high rate of tuberculosis in Sudanese troops in Egypt; his subsequent studies indicated great susceptibility in "primitive" peoples in general. Negroes are more severely affected by the disease than whites, and different white stocks appear to vary in resistance. The significance of the higher death rate for Negroes in the U.S. is complicated by the generally unequal environmental conditions of the two races. Pathological studies disclose differences in the character of the disease in the two races, however; more extensive caseation necrosis and more frequent nonpulmonary tuberculosis is evident in the Negro.

Studies of populations in periods of deprivation show a correlation between nutritional deficiencies, particularly in proteins and vitamins, and increase in tuberculosis. Certain diseases, notably silicosis, depress resistance to tuberculosis.

Enhancement of resistance by infection itself is easily demonstrated experimentally. Animals inoculated with tubercle bacilli of low virulence reveal much greater resistance to subsequent infection with virulent tubercle bacilli than do normal animals. Advantage is taken of this fact in vaccination against tuberculosis. Animals, including man, when infected with tubercle bacilli, in addition to manifesting increased resistance to further infection from without, develop a remarkable hypersensitivity to a protein substance derived from tubercle bacilli (*see* TUBERCULIN). The virtually invariable development of hypersensitivity to tuberculin following infection of man and cattle with tubercle bacilli, regardless of the severity of infection, makes tuberculin valuable in detecting tuberculous infection and determining its prevalence in human groups and herds of cattle

Prevention and Control.—Specific measures for the control of tuberculosis were inaugurated by Sir Robert W. Philip in Edinburgh, Scot., in 1887, by establishment of a tuberculosis dispensary in which patients convalescing from tuberculosis could be watched carefully and persons from households with a tuberculosis patient could be observed to detect evidence of developing disease. At the same time, through regular home visiting by dispensary personnel, efforts were made to improve the standard of living of the families under supervision, while the dispensary itself acted as a centre for the dissemination of knowledge concerning tuberculosis. In 1889 in New York, Hermann M. Biggs, with his colleagues T. M. Prudden and H. P. Loomis, developed a similar plan based on the contagiousness of tuberculosis and need for protection of the public. Ultimately the Biggs program, including compulsory reporting of the disease to the department of health, was adopted *in toto* by the New York city department of health, and public health measures for the prevention of tuberculosis became recognized as a governmental obligation. In the development of a sense of public responsibility in the control of tuberculosis, voluntary agencies played a great part. In the U.S. the National Tuberculosis association, founded in 1904, in Great Britain the National Association for the Prevention of Tuberculosis and in Canada the Canadian Tuberculosis association created a public understanding of tuberculosis that was reflected in steadily increasing official tuberculosis control. Voluntary organizations throughout the world were similarly effective. The National Tuberculosis association is financed by the sale of Christmas seals, a device originated in Denmark in 1903 by Einar Holbøll. By mid-20th century the association, made up of about 3,000 co-ordinated state, county and city units, was raising more than $20,000,000 annually by this means.

Local official tuberculosis control at the state level was practised in the U.S. long before a federal division for tuberculosis was organized. Many states developed strong programs with clinics, case-finding programs and state hospitals. In 1944 a tuberculosis control division was established in the bureau of state services of the U.S. public health service to aid state health departments in developing adequate programs, and to bring about other "measures for the prevention, treatment and control of tuberculosis." In Great Britain national law requires that local county and borough authorities have a tuberculosis scheme. In the general plan the tuberculosis dispensary is the central unit. Coordinated with the dispensary, which is organized to serve a community population of 150,000 to 200,000 persons, are a series of institutions, including hospitals for special types of tuberculosis, training colonies and village settlements. On the staff of each county council and county borough council are tuberculosis officers, charged with operation of the tuberculosis scheme. The system of control was improved markedly during World War II, after an alarming rise in the incidence of the disease in early years of the conflict. On recommendation of the medical research council a program was adopted calling for mass radiography of civilians for case-finding purposes, energetic follow-up of home contacts of tuberculous patients, financial assistance for patients undergoing treatment, increased measures for after-care and rehabilitation following sanatorium treatment, and, finally, nation-wide extension of the program of pasteurization of milk.

Sanatoria, in the notable decline of tuberculosis, played a highly effective role, not only in providing medical care, but in isolating tuberculous patients who would otherwise be sources of infection. In the early years of the 20th century most of the sanatoria in the U.S. were private; by mid-century the great majority of such institutions were under state, county or municipal control, and of hospital rather than sanatorium character. In 1900 there were only 4,500 beds for tuberculous patients in the U.S.; by 1940 there were approximately 100,000. The provision of beds for tuberculosis in the proportion of two and a half for every death annually from the disease, was a recognized requirement of public-health practice.

With improved understanding of the means for combating tuberculosis, progressive health departments, ably assisted by voluntary agencies, incorporated extensive case-finding programs in their general procedure for tuberculosis control. Two methods came into use. In the older, an effort is made to ensure examination of all persons in the same household or in close association with a person known to have tuberculosis. This is based on the fact that tuberculosis is contagious, and the persons most likely to become tuberculous are those in intimate contact with the disease. In the later method large groups or whole communities are X-rayed by one of several inexpensive and rapid methods. In World War II, mass X-ray examination was used on an enormous scale to detect cases of tuberculosis in prospective recruits and draftees.

In determining the prevalence of tuberculosis in a population, tuberculin is an important agent. Any person infected with tuberculosis develops a specific inflammatory reaction when tuberculin is injected into the skin or placed in prolonged contact with the skin in an ointment. Actually only a fraction of those infected develop the disease, but possible future cases are thus recognized, and when large groups are examined the results furnish a measure of the extent of infection in a community. In guarding the health of previously uninfected persons exposed to the disease, such as members of the household of a tuberculous patient or nurses caring for patients in a hospital, the tuberculin test furnishes the earliest evidence of infection.

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...berculosis of bovine origin became rare, but in countries
...t such measures, bovine-type bacillus infection of children
...still frequent.

Preventive inoculation against tuberculosis, in which live but attenuated tubercle bacilli are used as a vaccine, was introduced in France in 1921 by Albert Calmette and Camille Guérin. The strain designated BCG (Bacillus-Calmette Guérin) was one of bovine origin, which became attenuated while growing on culture media containing bile. After its introduction by Calmette, large numbers of children were vaccinated in France, central Europe and the Balkans. The method was adopted in the Scandinavian countries and South America and after 1930 the vaccine was used there on an extensive scale. The procedure met with little favour in the U.S. until after 1940, when studies by J. D. Aronson and C. E. Palmer and S. R. Rosenthal were accepted as indicating definite value. In the meantime its use had become compulsory in exposed groups in Denmark, Norway and Sweden.

Rehabilitation of Tuberculous Patients.—When patients return to normal life after arrest of their disease in a tuberculosis hospital, relapse frequently occurs. Other patients never achieve a true arrest of the disease, but develop a tolerance so that they can undertake a certain amount of activity without symptoms or acceleration of the progression of their disease. A sheltered post-hospital environment, where work can be carried out under medical supervision and gradually increased until normal activity can be resumed safely, is as important for many patients as hospital care. Likewise, for those who cannot arrest their disease and who may be a menace to society because of the persistence of tubercle bacilli in their sputum, but who retain the capacity for some degree of productive work, it is desirable to have an environment as nearly satisfactory as possible, with the medical supervision necessary to guard against undue strain and maintain proper facilities for medical treatment when it is needed. The need in each respect was met by an increasing number of organizations for vocational training, part-time employment and custodial care with graded activity. The Altro workshops in New York city, manufacturing washable garments, and the Potts Memorial institute in Livingston, N.Y., with a successful print shop, became examples of sheltered workshops in which convalescing tuberculous patients could work within the limits of their strength and gradually increase their capacity for employment. The Papworth Village settlement near Cambridge, Eng., achieved world-wide fame for its provision of suitable living and working conditions and medical care for patients for whom cure could not be expected. This settlement established quarters for single persons and families, and provided for a wide variety of occupations. In such a colony a patient with chronic tuberculosis, without toxic manifestations and able to do a limited amount of work, could approach closely to a normal existence.

Tuberculosis in Animals, Birds, Fish and Reptiles.—Tuberculosis is occasionally encountered in wild animals and birds in their native state; it is much more frequent when they are in captivity. Presumably the greater exposure and opportunity for infection in captivity account for the difference. Among domestic animals and birds, tuberculosis is an important disease in cattle, swine and domestic fowl. Cattle are infected by the bovine type of bacillus and relatively infrequently by the avian, swine frequently by both and occasionally by the human type, and domestic fowl only by avian bacilli.

In cattle the mesenteric and other lymph nodes and the liver, spleen, serous cavities and other organs are involved; tuberculosis of the udder is frequent and is serious because it leads to heavy contamination of milk with tubercle bacilli. In the U.S. bovine tuberculosis by mid-20th century was a vanishing disease. Less than 0.5% of the nation's herds included reactors to tuberculin. The slaughter of infected cattle, detected by the tuberculin reaction, had become a universally accepted procedure, and the avoidance of tuberculous infection from dairy products was made doubly sure by the general pasteurization of milk. In the British Isles and much of the rest of the world, however, bovine tuberculosis was still a common disease responsible for widespread infection of children. In Great Britain Frederick Heaf estimated in 1947, that 1,600 deaths resulted annually from drinking tuberculous milk, that 40% of the country's cattle reacted to tuberculin and that 0.5% of the dairy cattle yielded milk containing tubercle bacilli. Vigorous promotion of the campaign to pasteurize milk was under way, however. Adequate programs of control on the model of that practised in the U.S., including slaughter of infected cattle and pasteurization of milk, were expensive and still to be developed in most parts of the world.

The control of tuberculosis in swine had not been so successful as in cattle. Cattle infect each other, as do humans, and in both species removal of sources of infection halts the spread of disease. Swine, however, are susceptible to avian-type tubercle-bacillus infection, as well as bovine. It is difficult to keep swine and poultry entirely separate, and birds other than domestic poultry are likely to establish sources of infection. Tuberculosis in domestic poultry is also difficult to control. Intestinal ulceration is the rule, and droppings may be heavily contaminated. The most practical procedure is to market birds at an early age and thereby limit opportunities for infection. Claims that the avian tubercle bacillus occasionally infects man have been made, but the evidence has not been convincing. Avian tuberculosis is a source of serious economic loss, but is not, like bovine tuberculosis, a significant source of human disease.

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TUBEROSE. The cultivated tuberose (*Polianthes tuberosa*) of the family Amaryllidaceae is a plant distantly allied to the American agaves, but has not been found wild. The tuberose rootstock sends up a stem 3 ft. in height, with numerous lanceolate leaves and terminal racemes of waxy white, funnel-shaped, very fragrant flowers. Each flower is about 1¾ in. long, with a long tube and a six-parted limb. The ovary is three-celled, and the ovoid fruit is crowned by the persistent flower. The plant is largely grown in the United States and at the Cape of Good Hope for export to England, as it is found that imported tubers succeed better than those grown in the United Kingdom. The double-flowered form is that principally grown.

TÜBINGEN, a town of Germany, in the *Land* of Württemberg, on the banks of the Neckar, at its junction with the Ammer and Steinlach, 22 mi. S of Stuttgart by road. Pop. (1939) 32,002. Tübingen is mentioned as a strong fortress in 1078, and was ruled from 1248 by counts palatine. In 1342 it was purchased by the count of Wurttemberg, whose descendants afterward acquired the title of duke.

The town was captured by the Swabian league in 1519, by Turenne in 1647, and again in 1688 by the French, who destroyed the walls.

The most conspicuous building is the old ducal castle of Hohentübingen, built in 1507–35 on a hill overlooking the town, and now containing the university library and the observatory. The quaint old *Stiftskirche* (1469–83) is a Gothic building containing the tombs of the rulers of Württemberg; the town-hall dates from 1435 and was restored in 1872. Tübingen's chief claim to attention lies in its famous university, founded in 1477 by Duke Eberhard of Württemberg. Melanchthon was a lecturer here (1512–18). The university adopted the reformed faith in 1534, but in 1817 a Roman Catholic theological faculty was added to the other faculties. The leading faculty was long that of theology. The university was attended in 1937 by about 1,500 students and had a teaching staff of 200. In the neighbourhood is the former Cistercian monastery of Bebenhausen, founded in 1185.

TUBUAI (or AUSTRAL) ISLANDS: *see* PACIFIC ISLANDS

TUBULIDENTATA, an order of mammals, including only the African aardvarks (*q.v.*), and formerly united with the Xenarthra and Pholidota (*q.v.*) as the order Edentata, under which heading these groups are treated.

TUBUPHONE, a musical instrument resembling the Glockenspiel (*q.v.*), with metal tubes replacing the steel bars of the latter.

TUCKER, ABRAHAM (1705–1774), English moralist, was born in London, of a Somerset family, on Sept. 2, 1705, son of a wealthy city merchant. He studied at Merton college, Oxford, and in 1727 settled down as a country gentleman at Betchworth castle, near Dorking. His chief work was *The Light of Nature Pursued* (7 vols. 1,765 pp.), which was completed but not all of it published when he died on the 20th of November, 1774.

In some important points Tucker anticipates the utilitarianism afterwards systematized by Paley. "Every man's own satisfaction" Tucker holds to be the ultimate end of action; and satisfaction or pleasure is one and the same in kind, however much it may vary in degree. This universal motive is further connected, as by Paley, through the will of God, with the "general good, the root where out all our rules of conduct and sentiments of honour are to branch."

The *Light of Nature* was republished with a biographical sketch by Tucker's grandson, Sir H. P. St. John Mildmay (1805), 7 vols. (other editions 1834, 1836, etc.), and an abridged edition by W. Hazlitt appeared in 1807. *See* James Mackintosh, *Dissertation on the Progress of Ethical Philosophy* (Edinburgh, 1832); and specially Sir Leslie Stephen, *English Thought in the 18th Century*, iii, 119–130.

TUCSON, a city in southeastern Arizona, U.S., lying in the broad valley of the Santa Cruz river. It is about 2,400 ft above sea level and is sheltered by mountains 5,000–9,000 ft. high. The population in 1950 was 45,064 (corporate limits only and not including semitransient visitors). Tucson has many irrigated farms in its vicinity and is the centre of one of the oldest agricultural districts of the state. Its climate is dry, mild and equable and attracts many winter visitors. It is an industrial and transportation centre, on the main line of the Southern Pacific railway, and is also the northern terminus of the Southern Pacific of Mexico railway, which gives direct service to Guadalajara and Mexico City.

It is also on the main line of the American Airlines and Frontier Air Lines. The Southern Pacific has its division headquarters and repair shops in the city.

The University of Arizona (1885; nonsectarian, coeducational) occupies a campus of 75 ac. in the northeastern part of the city. Its attendance increased from 201 in 1909 to 6,000 in the winter of 1950–51.

Connected with the university is the state museum, which houses extensive archaeological and natural history collections. At Tucson is also the southwest experiment station of the U.S. bureau of mines.

In 1900 Tucson became the see of the Roman Catholic bishop and the church maintains a cathedral, St. Joseph's Academy and San Xavier Mission for Indians.

The city has an excellent Carnegie library.

In the immediate vicinity lie ruined villages of the ancient Pueblo peoples. In history Tucson is first heard of in 1699 as an Indian rancheria or settlement. In 1763 it was a *visita* of the Jesuit mission of San Xavier del Bac, founded between 1720 and 1732, 9 mi. south of Tucson. It was made a presidio or military outpost in 1776, and, although a few Spaniards may have lived there before, the founding of Tucson as a Spanish town dates from this time. It was never afterward abandoned during the Indian Wars. The first decade of the 19th century was the apex of its prosperity under Spanish rule, and its population was between 2,000 and 3,000 people. By 1848 this number had dwindled to 760. Tucson lay within the territory acquired by the United States by the Gadsen Purchase in 1853. It was occupied by the United States in 1856, and with the arrival of American troops and traders a new era of prosperity began. In the '60s and '70s the place witnessed considerable commercial activity, it being a general pack-train centre. In 1860 the *Weekly Arizonian*, the first newspaper in the state, was established there. Fort Lowell, 7 mi. northeast of the city, was built in 1873 for protection against the Apache Indians; it was abandoned in 1891. Tucson was occupied by the Confederates in Feb. 1862, and by the Union forces in May. It was the territorial capital from 1867 to 1877. The Southern Pacific railway arrived from the west in 1880, and in 1910 the connection with the Mexican railways was made.

Tucson was chartered as a city in 1883.

TUCUMÁN, a northern province of Argentina, bounded N. by Salta, E. by Santiago del Estero, S. and W. by Catamarca. Area, 8,696 sq.mi. Pop. (1914 census), 332,933; 1947 estimate, 587,604.

The Sierra de Aconquija is on the western frontier of the province and there is also broken country in the north, but in the east the country is flat, alluvial and very fertile. The only large river is the Salí, a tributary of the Río Dulce, which receives a large number of small streams from the Sierra de Aconquija and flows through Santiago del Estero to the Mar Chiquita in Córdoba.

Tucumán's main industry is the production of sugar and alcohol. Other products include rice, corn and livestock.

The capital of the province is Tucumán (*q.v.*).

TUCUMÁN OF SAN MIGUEL DE TUCUMÁN, a city of Argentina, capital of the province of Tucumán, on the right bank of the Salí river, 718 mi by rail N.W of Buenos Aires, in lat. 20° 50′ S., long. 65° 15′ W. Pop. (1947 est.) 170,000. The climate is warm. A summer maximum of 104° F. has been recorded, and frosts occur in occasional winters. The rainfall, which occurs almost wholly between September and April is moderate, about 38 in. per year.

Tucumán is laid out in regular squares, and retains many of its old characteristics, low buildings enclosing large courts (patios), with large rooms, thick walls and tile roofs. Several railway lines provide direct communication to Buenos Aires and other parts of Argentina.

Tucumán was founded in 1565 by Diego Villarroel at the confluence of the Salí and Monteros rivers, but frequent inundations led to a removal to its present site in 1585. In 1680 it succeeded Santiago del Estero as the capital of the province of Tucumán, then under the government of the Spanish viceroy at Lima. The province of Tucumán then extended from Jujuy south to Córdoba. In 1776 the viceroyalty of La Plata was created and Tucumán was transferred to its jurisdiction. In 1816 a convention of delegates from the La Plata provinces met in Tucumán and signed (July 9) an act of independence, which formally dissolved all ties with the mother country.

TUDELA, a town of northern Spain, in the province of Navarre, on the Saragossa-Logroño and Tudela-Tarazona railways, and on the right bank of the river Ebro, which is here joined by its tributary the Queiles. Pop. (1940), 12,873 (mun., 13,134). Tudela, the Roman *Tutela*, was taken from the Moors by Alphonso I of Aragon in 1114

The town was an episcopal see from 1783 to 1851. The

Ebro is here crossed by an ancient bridge of 19 arches. The Romanesque collegiate church, Santa Maria, founded in 1135 and consecrated in 1188, is one of the most perfect in northern Spain. There are many sawmills in the town, and an active timber trade.

TUDOR (FAMILY). The house of Tudor, which gave five sovereigns to England, is derived by all the Welsh genealogists from Ednyfed Vychan of Tregarneedd in Anglesey, who is named in 1232 as steward of Llywelyn, prince of North Wales, and, seven years later, as an arbitrator in a convention to which Davydd, the son of Llywelyn, was a party. His descendant, Tudor Vychan ap Gronw of Trecastell, had four sons, of whom the eldest, Gronw Vychan, was in favour with the Black Prince and with Richard II. He was forester of Snowdon and steward of the bishop of Bangor's lordship in Anglesey. He died in 1382, an infant son being heir to his lands in Penmynydd, whose sister carried them to her husband Gwylym ap Gmffydd of Penrhyn

Gronw's brothers Gwylym and Rhys served Richard II. as captains of archers. Their youngest brother, Meredydd ap Tudor, escheator of Anglesey in 1392 and, like Gronw, an officer of the household of the bishop of Bangor, is said to have slain a man and fled to the wild country about Snowdon. He was the father of the handsome Owen ap Meredydd, commonly called Owen Tudor, a squire who appeared at the court of the infant king Henry VI, and attracted the admiration of the queen mother. About 1428 or 1429, it must have been common knowledge that Owen Tudor and Queen Catherine were living as man and wife. There is no direct evidence for their marriage. An act had but lately been passed for making it a grave offence to marry with the queen dowager without the royal consent: this act is said to have been afterwards cut out from the statute book. Richard III denounced his rival Richmond as the son of a bastard, but it must be remembered that Richard was ready to foul the memory of his own mother in order to say the same of the young Edward V. But no one yet has found time or place of Owen Tudor's marriage with Catherine of France.

Five children were born to them, the sons being Edmund and Jasper and another son who became a monk. In 1436, a date which suggests that Bedford had been Owen's protector, the influence of Gloucester was uppermost. In that year the queen dowager was received within Bermondsey Abbey, where she died in the following January. Her children were taken from her, and Owen Tudor "the which dwelled with the said queen" was ordered to come into the king's presence. He had already seen the inside of Newgate gaol, and he would not obey without a safe conduct. When he had the safe conduct sent him he came up from Daventry and went at once to sanctuary at Westminster, whence even the temptations of the tavern would not draw him. Allowed to go back to Wales, he was retaken and lodged again in Newgate. He broke prison again and returned to his native Wales. When Henry VI. came of full age he made some provision for his stepfather, who fought on the Lancastrian side. At Mortimer's Cross (Feb. 4, 1461) Owen fell into the hands of the Yorkists, who beheaded him in Hereford market place.

His eldest son, Edmund of Hadham (b. *c.* 1430), was knighted in 1449, and in 1453 he was summoned as earl of Richmond. He was declared of legitimate birth, and in 1455 he married Lady Margaret, daughter of John Beaufort, duke of Somerset. His only child, afterwards Henry VII., was born three months after his death.

Edmund's younger brother, Jasper Tudor, survived him many years. Jasper was knighted in 1449 and, about the date of Edmund's patent, was created earl of Pembroke. He bore the royal arms of France and England, differenced with a blue border charged with the royal martlets of the Confessor's fabulous shield, and the same was formerly to be seen upon his Garter stall-plate of 1459. He fought at St. Albans in 1455 for the king who had advanced him, and two years later we find him strengthening the defences of Tenby. In 1460 he seized Denbigh, where the queen joined him after Northampton. He shared the defeat at Mortimer's Cross and left the country in 1462. In 1465 he made a last descent upon Wales, to be driven off by William Herbert, who was rewarded with his earldom of Pembroke, already forfeited by attainder. He came back again with Warwick in 1470 and was hurrying to join the queen when Tewkesbury was fought and lost. After many adventures he carried off his young nephew Richmond to Brittany The two came back together in 1485. After Bosworth, Jasper was created duke of Bedford and restored to his earldom, the earl-marshalship being given him in 1492. He lived to fight at Stoke in 1487 against Lincoln and Simnel his puppet and to be one of the leaders of the host that landed in France in 1492. He died in 1495 leaving no issue by his wife Catherine, the widow of the second duke of Buckingham and a daughter of Richard Widvile, Earl Rivers. But his bastard daughter Ellen is said to have been mother of Stephen Gardiner, bishop of Winchester.

TUDOR PERIOD, in architecture and the decorative arts, a loose term covering the final phase of Perpendicular Gothic and the earlier phases of Elizabethan or even Jacobean work, from which it is usually differentiated by the fact that those examples in which the Gothic influence predominates are termed Tudor, while those in which classic influence is more noticeable are known as Elizabethan or Jacobean. Since the Gothic tradition persisted in various parts of England and especially in Oxford and Cambridge until late in the 17th century, it is difficult to assign date limits to the Tudor style. In ecclesiastical architecture the Tudor period saw the climax of Perpendicular development. (*See* PERPENDICULAR PERIOD.) The characteristics in exterior secular work are: large groups of rectangular windows; rich oriel or bay windows; interesting and sometimes fantastic chimney treatments; complex roofs with many gables; much brickwork, frequently in patterns and lavish half-timber (*q.v.*). In interior secular work this period saw an extraordinary development of wood panelling which was frequently used to cover all four sides of a room, and often enriched with linen fold (*q.v.*) decoration and occasional naïve travesties of classic forms and the lavish use of moulded plaster-work for ceilings, cornices and walls. Examples of the style are: the older portions of Hampton Court palace (1515–25); Layer Marney (1522–25); Moreton Old Hall, Cheshire (1550); Compton Wnyates (*c.* 1520), Burton Agnes (1602–10); Ford's hospital, Coventry (begun 1529), at Oxford, Corpus Christi college (1516), the Founder's tower (1492–1505) and the hall (1541) at Magdalen, the tower of the old examination schools (*c.* 1620) and the chapel of Oriel (1637); at Cambridge, Queens' college (*c.* 1450), the two earliest courts of S. John's (between 1511 and 1602), and the King's gateway and Great Court at Trinity (built between 1518 and 1605). (T. F. H.)

TUFF (Ital. *tufo*), a rock formed by induration of volcanic ash or dust. The loose fragmental ejecta of volcanoes are classified by size into (1) volcanic dust, less than 0.5 mm.; (2) ash, from 0.5 mm. to 4 mm.; (3) lapilli, from 4 mm. to 32 mm.; (4) bombs and blocks, larger than 32 mm. Bombs are plastic while blocks are solid when erupted. By compaction and cementation, volcanic dust yields dust tuff and ash yields tuff. If lapilli predominate over the finer constituents, a lapilli tuff results Rocks composed chiefly of bombs are termed agglomerates and those consisting mainly of angular blocks are classed as volcanic breccias.

Among the products of explosive eruptions, some form by expulsion of liquid magma as clots and spray. These are referred to as essential or juvenile ejecta. Other fragments are discharged in a solid state, being torn from the crater walls, from the tops of cones or the roofs of the underlying reservoirs. These are termed accessory ejecta. Still other ejecta are described as accidental, since they include pieces of any kind of rock torn from the subvolcanic basement. Many of these are intensely baked or wholly recrystallized, such as the limestone blocks periodically blown out by Vesuvius. Indeed the pipes of many extinct volcanoes are almost completely filled with accidental debris made up of comminuted sandstone and shale, as in the Navajo region of New Mexico. It is the violent expansion of water vapour released from deep-seated bodies of magma that blasts these pipes through the overlying formations.

Tuffs may also be grouped as vitric, crystal or lithic, according as they are composed principally of glass, crystal chips or the debris of pre-existing rocks. During some explosions, like that of Krakatoa in 1883, the ejecta consist mainly of pumice (that

is, of extremely porous, glassy fragments light enough to float on water) and of finely divided glass dust that may be drifted by winds around the world. Volcanoes fed by siliceous magma, such as rhyolite, dacite and trachyte, tend to produce the most voluminous and extensive deposits of this kind. However, some of the world's largest deposits of vitric tuff are produced by eruptions through a large number of narrow fissures rather than from volcanic cones. Foaming magma wells to the surface as an emulsion of hot gases and incandescent particles, and the material spreads swiftly even over gentle gradients as glowing avalanches. Such eruptions occurred in 1912 in the Valley of Ten Thousand Smokes, Alaska. After coming to rest, the ejecta may be firmly compacted by adhesion of the hot glass fragments, and so form streaky, welded tuffs like those covering vast areas in New Zealand, Guatemala, Peru and Yellowstone National park, U.S.

Even fluid basaltic magma, such as that of Kilauea and Mauna Loa, may be inflated by expanding gas and tossed out as delicate glass threads and blebs, known respectively as Pele's hair and Pele's tears. But the chief fragmental products of basaltic volcanoes are the dark, porous, glassy lapilli and bombs which, from their superficial resemblance to the residues of burning coal, are spoken of as cinders. If the lapilli and bombs are sufficiently plastic when discharged, they assume rounded and ropy forms, partly in response to rotation during flight. More viscous clots fall to earth as subangular lumps with cracked, glassy skins that resemble bread crusts.

During other eruptions, the volume of ejected crystals exceeds that of glassy material, as at La Soufrière, West Indies, in 1902. Light crystals of leucite may accumulate by flotation close to the top of the conduit of Vesuvius during intervals of quiet, to be hurled out when activity revives; or clusters of heavy olivine and augite crystals may be expelled from lower levels. If the temperature of eruption is low, the explosions simulate steam blasts and none but angular, lithic fragments of old rock are expelled, as at Bandai-san, Japan, in 1888.

Fine ash and dust may aggregate into pellets or mud balls by falling through an eruption-cloud in which water vapour is condensing. Somewhat similar accretionary lapilli develop by the action of rain and wind on newly fallen ash.

In response to the dictates of gravity, the coarser and heavier volcanic ejecta tend to fall close to the source, while the finer and lighter particles are carried afar. Hence, in extensive deposits, tuff may vary greatly not only in texture but also in chemical and mineralogical composition. The ejecta of Quizapu, Chile, in 1932, provide an excellent illustration.

Some ejecta fall directly into lakes or into the sea; others, having been deposited on land, are later washed into bodies of water and are there mixed with normal sediment. The ashy clays and sands thus produced may subsequently be converted to tuffaceous shales and sandstones. When explosions take place underground, by contact of lava with ground water or wet sediments, the fragmental material may be forced violently into the surrounding rocks, forming instrusive tuffs or peperites.

There has probably been no geological period entirely free from volcanic eruptions. Tuffs therefore range in age from Archaean to Recent. Usually, the older ones have lost all original textures and are thoroughly recrystallized. Many old basaltic tuffs are now represented by green chlorite and hornblende schists, and many rhyolitic tuffs by sericite schists.

From A.D. 1500, the world's volcanoes have discharged about 80 cu.mi. of fragmental ejecta, as against 16 cu mi. of lava. The most voluminous explosions are generally associated with gas-rich magmas of volcanoes in mountain belts on the continents and adjacent islands, and follow long periods of quiescence. Among the most violent explosions of recent times are those of Tamboro, East Indies, in 1815; Coseguina, Nicaragua, in 1835; Krakatoa, Netherlands Indies, in 1883; and Katmai, Alaska, in 1912. Respectively, these volcanoes erupted approximately 8, 12, 5 and 6 cu.mi. of fragmental material. (H. Ws.)

TU FU (杜甫, A.D. 713–770), a Chinese poet and painter of the T'ang dynasty, considered by some Chinese critics as the supreme poet. Tu Fu was born in Tu Ling in the Shensi province, and is therefore often called Tu Shao-Ling (杜少陵), although his father was a native of Hsiangyang in Hupeh. His family belonged to the military and literary class. At 15, his essays and fantastic verses won great admiration. After ten years of wandering, he went to the capital, Changan (長安), for his literary examinations. Although his written papers were excellent he was not given a degree, as his views were unorthodox. He then became a wanderer, and on the "Lute Terrace" in Ching Hsien, he met his much admired friend Li Po, whom he immortalized in verse

In 749 the emperor (玄宗) invited all great scholars for examination. Tu Fu presented himself, but waited for four years until he managed to please the emperor with his three great *fu* (三大禮賦, a prose poem of irregular lines). He was given a post in the Chih Hsien library which he held for four years, he was then promoted to another post at Fêng-hsien. In 758, when the rebellion of An Lu-Shan (安祿山), which drove the emperor Ming Huang from the throne, broke out, he was exiled and went to live with a relative at White Water village (鄜州).

When a new emperor ascended the Dragon throne, Tu Fu went to pay his respects to him, but on the way he was captured by brigands, beaten, and made prisoner for a year. He escaped, and, emaciated and clad in rags, he reached the emperor. He was appointed to the post of censor, but fell into disgrace and was delegated to a minor post as governor of a small town in Shensi. This position he did not accept, and joined his family at Kansu. They were struggling for existence, and the poet supported them by digging up roots for food and by selling firewood. Several of his children, however, died of hunger. After six months in office in Hua Chou, he retired to Chêngtu in Szechwan, living in a house of grass roots. Here he wrote some of his most beautiful lyrics.

In 768 he took up nomadic life once more. He was caught by floods and compelled to go into a ruined temple at Hu Huang without food. After ten days' starvation he was given a feast by the local officials, and died (770) of over-eating.

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(Y. K.)

TUGELA, the largest river in Natal, its basin being about 8,000 sq.m. in extent. It rises on Mont aux Sources, in the Drakensberg, at over 10,000 ft. above sea-level. After a mile or two it plunges over the great escarpment forming the most rugged and picturesque scenery, and then flows as a dignified stream in a broad, open valley to a point a few miles below Colenso, about 60 m. eastward from the source. Here the valley becomes steeper and narrower, owing to rejuvenation. This character persists until within a few miles of its mouth, the river being sometimes 2,000 ft. below the neighbouring plateau. The Tugela is quite unnavigable. Its volume has great seasonal fluctuations, being easily fordable in many places in winter, and often quite impassable during summer rains. The Tugela receives as tributaries on its right bank the Little Tugela, rising near Cathkin Peak, and the Bushman and Mooi rivers, which both originate near Giant's castle. On its left bank it receives the Klip river, which flows past Ladysmith, the Sunday's river from the Biggarsberg, and the Buffalo river, which rises near Majuba and flows not far from Isandhlwana, at which place, and also at Rorke's Drift, on the Buffalo, memorable actions were fought in the Zulu War. The boundary between Natal proper and Zululand follows the Tugela from its mouth to the confluence with the Buffalo river, and then runs up the latter to its junction with the Blood river, so called on account of the defeat of Dingaan's impi by the Boers in 1838.

TUGGURT (Touggourt), capital of the region of the Wadi Ghir, Algerian Sahara, 127 mi. S. of Biskra, with which it is connected by a railway. It is the chief town of a "mixed" commune and of a territory of 284,940 inhabitants (1948). It has itself 14,719. Just within the northern of two gates is the market place and

the chief mosque. The surrounding oasis contains about 200,000 date palms. Temacine, with a holy lake, seat of a branch house of the extensive Moslem religious brotherhood of the Tijani, is nearby. From the city a road 75 mi. long leads across the desert northeast to El Wad (*q.v.*).

TUGUEGARAO, a municipality and capital of the province of Cagayan, Luzon, Philippine Islands, on the Cagayan river, about 60 mi. from its mouth, and near the southern boundary of the province. Pop. (1939) 27,643, of whom 13,862 were males and 65 were white. The river is navigable to Tuguegarao for vessels of light draught. The surrounding region is the most productive of tobacco in the archipelago. Ibanag is the principal vernacular, but Ilocano and Tagalog are also used. Of the inhabitants aged 6 to 19 inclusive, 36·6% attended school in 1939, and 58·2% of the population 10 years old and over was literate. (C. S. L.)

TUKE, the name of an English family, several generations of which were celebrated for their efforts in the cause of philanthropy.

WILLIAM TUKE (1732–1822) was born at York on March 24, 1732. His name is connected with the humane treatment of the insane, for whose care he projected in 1792 the Retreat at York, under the management of the Society of Friends, which became famous as an institution in which a bold attempt was made to manage lunatics without the excessive restraints then regarded as essential. His son HENRY TUKE (1755–1814) co-operated with his father in his reforms.

Henry's son SAMUEL TUKE (1784–1857) continued the work begun by his grandfather, and published a *Description of the Retreat near York*, etc. (York, 1813). He also published *Practical Hints on the Construction and Economy of Pauper Lunatic Asylums* (1815). He died at York on Oct. 14, 1857.

Samuel's son JAMES HACK TUKE (1819–1896) is chiefly remembered for his philanthropic work in Ireland, which resulted from a visit to Connaught in 1847, where he witnessed much distress. Letters descriptive of the state of things he saw when he was distributing relief in 1880, were published in *The Times*, and in his pamphlet, *Irish Distress and its Remedies* (1880), he pointed out that Irish distress was due to economic rather than political difficulties, and advocated state-aided land purchase, peasant proprietorship, light railways, government help for the fishing and local industries, and family emigration for the poorest peasants. From 1882 to 1884 he superintended the emigration of poor families to the United States and the Colonies. To his reports on the distribution of seed potatoes in 1885, and his letters to *The Times*, which were reprinted under the title *The Condition of Donegal* (1889), were due in a great measure the bill passed for the construction of light railways in 1889 and the Irish Land Act which established the Congested Districts Board in 1891. He died on Jan 13, 1896.

See *Report of the Select Committee of the House of Commons* (1815–16); DR. Conolly, *Treatment of the Insane without Mechanical Restraints* (1856); DR. Hack Tuke, *Chapters in the History of the Insane in the British Isles* (1882).

DANIEL HACK TUKE (1827–1895), younger brother of James Hack Tuke, abandoned a solicitor's career to undertake work at the York Retreat. After studying medicine in London, he graduated M.D. at Heidelberg in 1853. In 1858, in collaboration with J. C. Bucknill, he published a *Manual of Psychological Medicine*, which was for many years regarded as a standard work on lunacy. In 1853 he visited a number of foreign asylums, and later returning to York he became visiting physician to the York Retreat and the York Dispensary. In 1859 he retired, but he resumed practice in London in 1875 as a specialist in mental diseases. In 1880 he became joint editor of the *Journal of Mental Science*. He died on March 5, 1895.

Among his works were *Illustrations of the Influence of the Mind on the Body* (1872); *Insanity in Ancient and Modern Life* (1878); *History of the Insane in the British Isles* (1882); *Sleepwalking and Hypnotism* (1884); *Past and Present Provision for the Insane Poor in Yorkshire* (1889); *Dictionary of Psychological Medicine* (1892).

TUKHACHEVSKY, MIKHAIL NICOLAEVICH (1893–1937), Russian soldier, was born in the government of Smolensk. He was educated in the corps of cadets and the Alexandrovsky military school, out of which he passed in July 1914. In Feb. 1915 he was taken prisoner by the Germans, but escaped back to Russia in 1917, and in June 1918 received the command of an army. He commanded successively the I., VIII. and V Armies and then the Caucasian front. After the successful conclusion of operations against Denikin, Tukhachevsky was given the command of the Western front. After the Civil War he became chief of the military academy, and in April 1924 was appointed assistant chief-of-staff. In 1936 he was one of the Soviet representatives at the funeral of King George V. On June 11, 1937, after a secret trial for espionage and high treason, he, together with seven other generals, was shot.

TUKULOR, a tall, long-headed, well-proportioned and muscular people with long faces and fine features, incorporating Serer, Wolof, Mandinga, Soninke and Fulani elements in Senegal and the French Sudan. They call themselves *Futankobe* or *Futanke;* the Wolofs call them *Tokoror* or dwellers in the Tekrur or Senegalese Futa, or Tukolor, the name adopted for them by the French. Their language resembles Fulani and is related to Wolof and Serer. The Tukulor organized a theocratic elective monarchy, with a religious chief (*Almamy*), a functionary whose office was abolished in 1881. Their present organization is by territorial groups. The Tukulor are fanatical Muslims. The people are skilled cultivators and cattle-raisers, and are very brave

See Dr. Lasnet, *Une mission au Sénégal* (1900); Delafosse, *Haut Sénégal Niger* (1912).

TULA, (1) a region of the Russian S.F.S.R., surrounded by those of Smolensk, Moscow, Ryazan and Orel, and not coinciding with the pre-1917 province of the same name. Area 12,317 sq.mi. Pop. (1939) 2,049,950 (urban 711,240; rural 1,338,710), mainly Great Russians. It consists of plateau land (950 to 1,020 ft), deeply entrenched by the Don and its tributaries, the Upa and Sosna. About 9% is forested, the northern region having coniferous trees, and the south small and scattered patches of birch, ash and oak. The south is in the steppe black earth region, where agriculture gives a good guarantee to the peasant, but the north is poorer grey forest soil. There is little good pasture and dairying is not much developed, though sheep, working and milch cattle, horses, pigs and goats are bred to some extent. The climate is extreme, with five months' winter frost, an average July temperature of 66° F and 16–18 in. of rain per annum.

The chief crops are rye (48·2%), and oats (28·3%). Buckwheat, potatoes, wheat, millet, grass, hemp and sugar beet are grown, while along the Oka in the northwest of the region, apples, cucumbers, cabbages and onions are cultivated. Peat working is not profitable and the electric stations at Aleksin and Epifan use the local coal. This is mined along the railway extending eastwards from Aleksin on the Oka through Tula to the region of Ryazan. The better agricultural conditions lessen the rôle of koustar (peasant) industries, which consist mainly of the manufacture of small metal goods, especially samovars and wooden wares.

(2) Tula is also the name of the chief town of the above region, situated in the broad but low, marshy and unhealthy valley of the Upa, in 54° 12′ N. 37° 37′ E. Pop. (1939) 272,002. Tsar Boris Godunov founded the first Russian gun factory here in 1595, and in 1632 a Dutchman, Winius, established an iron factory. The factories were rebuilt on a larger scale in 1705 and 1714 and towards the end of the 18th century a marked expansion of the industry took place. The making of rifles is still the main occupation of the town, other industries being the manufacture of samovars (tea urns), sugar refining, smelting, the making of cutlery, leather and sewn goods and flour-milling. The town is first mentioned in 1147, but its former site seems to have been higher up the Tulitsa, an affluent of the Upa. Its wooden fort was replaced in 1514–21 by a stone *kreml* or citadel, which still exists.

TULARAEMIA, a specific infectious disease caused by the *Bacterium tularense*. It occurs in rabbits and squirrels throughout the West and South of the United States and causes considerable loss of life among them. In many ways it is quite similar to a plague. The first authentic human case was reported in 1913

in Utah. Since then it has become increasingly important owing to its more general recognition and also to its undoubted increase in frequency. It is transmitted to man either by an intermediate host, as the louse or flea, or by direct handling of infected animals. It usually begins as a small swollen, ulcerated spot on the skin which is followed by enlargement of the neighbouring glands. This is soon followed by a chill and a high fever which has a tendency to remit daily. There is sometimes a generalized skin rash with general involvement of the glandular system. Occasionally there is a dull typhoid state. The average course is about two weeks. The death rate is rather low but numerous fatalities have been reported. The disease is of particular importance because of its rapid spread to new territories indicating that it will probably occur more frequently in the future.

TULCEA, the capital of the department of Tulcea, Rumania, picturesquely situated on the right bank of the Danube, 42 mi. from its mouth at Sulina. Pop. (1930) 20,108, including many Russians, Turks, Greeks and Jews. A railway to Cerna Voda is projected. There is a large water-borne trade in cereals.

TULIP, a genus (*Tulipa*) of bulbous herbs belonging to the lily family (Liliaceae). The species are found wild along the northern shores of the Mediterranean, in the Levant, Armenia, Caucasus, northern Africa, Iran, and sporadically across north and central Asia to Japan. The cup-shaped flowers have six regular segments in two rows, as many free stamens, and a three-celled ovary with a sessile stigma, which ripens into a leathery many-seeded capsule. The species are numerous, and are distinguished one from another by the scales of the bulb being woolly or smooth on the inner surface, by the character of the flower stalks, by the filaments being hairy or otherwise, and by other characters. Owing to the great beauty of the flowers they have long been favourites in European and American gardens, and have been crossed and recrossed till it has become almost impossible to refer the plants to their original types.

The early flowering "Van Thol" tulips, the segments of which are mostly scarlet with yellow edges, are probably derived from *T. suaveolens*, a native of the Caspian region. *T. gesneriana*, a native of Armenia and central Russia, is the origin of most of the later flowering varieties. *T. oculussolis* and *T. clusiana* are lovely species, natives of southern Europe and *T. sylvestris*, with elegant yellow flowers, is a doubtful native of England. Owing to the exertions of Russian naturalists, a large number of new species were discovered in Turkistan and introduced into Europe. Some of these are very beautiful, and render it probable that by intercrossing with the older species still further difficulties will be presented in the way of identification. These difficulties are further enhanced by the fact that, quite apart from any crossbreeding, the plants, when subjected to cultivation, vary so greatly in the course of two or three years from the original species from which they are directly descended that their parentage is scarcely recognizable. This innate power of variation has enabled the florist to obtain, and ultimately to "fix," many remarkable varieties. Millions of bulbs are cultivated in Holland for export every year; many are also grown in the Channel Islands, especially Guernsey, in the fen district of England, around Belfast, Ireland, and in the United States. Tulips were introduced into the Low Countries from Constantinople and the Levant in the 16th century; about 1637 they became the subject of an extraordinary speculation known as "tulipomania" in which prices for single roots rose to as much as 2,600 guilders. Thousands became bankrupt when the bubble burst.

Tulips, which have sprung from *Tulipa gesneriana*, are arranged in separate classes. Of these the most important are early, breeder, cottage and Darwin tulips. There are, in addition, various secondary groups, named bizarres, byblomens, parrots, Rembrandts and striped tulips, according to their colour and marking. Tulips are readily raised from seeds, and the seedlings when they first flower (after about 7 years' cultivation) are of one colour—that is, they are self-coloured. Judged by the florists' rules, they are either good or bad in form, and pure or stained (white or yellow) at the base; the badly formed and stained flowers are thrown away, while the good and pure are grown on, these being known as "breeder" tulips.

The breeder bulbs and their offsets may grow on for years producing only self-coloured flowers, but after a time, which is varied and indefinite, some of the progeny "break," that is, produce flowers with the variegation which is so much prized. The flower is then said to be "rectified"; it is a *bizarre* when it has a yellow ground marked with purple or red, a *byblomen* when it has a white ground marked with violet or purple, or a *rose* when it has a white ground marked with rose colour.

Tulips flourish in any good garden soil that has been deeply dug or trenched and manured the previous season. To secure perfect drainage and greater warmth a fair quantity of sand or grit should be present. Fresh manure should be avoided, but the remains from an old hotbed or mushroom bed may be incorporated. The best time to plant is in October and November, the bulbs being buried about 4–5 in. deep and somewhat farther apart. The best effects are produced in formal beds by planting the same variety in each, to insure the plants being of the same height and in flower simultaneously.

Propagation.—Tulips are usually increased by offsets, which most varieties produce in fairly large numbers. These are taken off and sown in drills, like seed. They are usually strong enough to flower the third year from this sowing. Some varieties produce offsets sparingly and must be increased by seed—a slow and uncertain method. New varieties are raised from seed. (The colour variation in the flowers of seedlings is discussed above.) Seeds are sown in boxes or cold frames, in light sandy soil, and the young plants are allowed to remain undisturbed until the second year. They are then lifted and treated like offsets, being sown thinly in beds out of doors. They usually flower in about the seventh year. The soil in which tulips are propagated should be sandy, free working and thoroughly drained. A warm sheltered position is a necessity.

Forcing.—The early flowering varieties should be potted as early in September as practicable, later batches for succession being potted during October. Pots 5 and 6 in. in diameter are the most convenient for the early-flowering kinds, but seven-inch pots give the better results for the "Darwin" section of the May-flowering kinds which are now used for gentle forcing. Five or six bulbs are put in each pot and the tops should be covered with half an inch of soil and half an inch left for water. The soil should be a light and fairly rich compost, comprising about 2 parts loam, 1 part decayed manure or horse droppings that have been thoroughly sweetened, 1 part leaf mould and half a part of sand. Pot firmly, and plunge the pots in several inches of ashes out of doors, to protect the bulbs from frost, but it must be remembered that all garden tulips require a thorough winter chilling to bloom the next spring. As soon as growth commences at the top and a fair amount of roots are formed they may be introduced into the cool greenhouse, in batches according to the need and amount of stock available.

For market a slightly different method is adopted. The bulbs are placed in long shallow boxes, plunged in soil or ashes in semi-darkness, and are afterwards transferred to benches in the forcing houses where they flower. Bulbs which have been forced are of no further value for that particular purpose. If planted in borders and shrubberies, however, they will continue to bear fairly good blossoms in the open air for several seasons.

Varieties.—Many thousands of varieties are offered by dealers. The most generally useful fall into the following groups:

Early Single (or *Double*) *Flowering Kinds* are the most useful for bedding and pot culture.

Late Single Flowering Kinds.—These are all tall-growing hardy kinds suitable for growing in herbaceous borders where they can be left undisturbed; or for producing massed colour effects in flower beds. They include (a) "Cottage" or May-flowering tulips, so named because they were discovered in the gardens of old cottages, mansions, abbeys and monasteries throughout England, Scotland, Ireland, Belgium and France; (b) "Darwin" tulips which are a distinct race, having a wide range of large self-coloured flowers, but no yellows. The so-called black tulip belongs here.

Parrot Tulips.—This late flowering group is supposed to be derived from the curious green and yellow striped *T. viridiflora*. The flowers are mostly heavy and drooping, petals brightly coloured, the edges being curiously notched and wavy.

TULIPTREE (*Liriodendron tulipifera*), a North American forest tree closely allied to the magnolia (*q.v.*), called also yellow-poplar and whitewood, native from Rhode Island and Vermont west to Michigan and south to Florida and Louisiana. It is one of the handsomest trees of eastern North America, with a straight trunk sometimes 190 ft. high and 10 ft. in diameter, deeply furrowed bark, and large smooth two- to four-lobed leaves, truncate or broadly notched at the apex. The conspicuous tulip-like flowers, about 2 in. deep, yellowish-green on the outside and orange-coloured within, are followed by dry cone-shaped clusters of terminally winged samaras. At maturity these disintegrate and reveal the supporting, erect, now-naked axis which often persists on the branchlets through the winter. From Virginia to the lower Ohio valley and southward, where the tuliptree attains its maximum size and abundance, it is a valuable timber tree, furnishing the light, fine-grained lumber known as yellowpoplar, white-wood or tulipwood. In 1940 the total cut of yellowpoplar lumber in the United States amounted to 376,037,000 bd.ft. valued at the mill at about $17,000,000. The largest and oldest tuliptree in the eastern states is at Annapolis, Md.

The tuliptree is widely planted for ornament and, with protection when young, thrives in England, sometimes attaining a height of 80 ft (E. S. Hr.)

TULL, JETHRO (1674–1741), English agricultural writer and farmer, was born at Basildon, Berkshire, in 1674, probably in March. He entered St. John's college, Oxford, in 1691, and was called to the bar at Gray's Inn in 1699 but never practised. In that year he married and began farming on his father's land at Howberry, near Wallingford, and here about 1701 he invented and perfected his machine drill, and began experiments in his new system of sowing in drills or rows sufficiently wide apart to allow for tillage by plough and hoe during almost the whole period of growth. In 1709 he moved to a farm near Hungerford and from 1711 to 1714 travelled in France and Italy, making careful observations of the methods of agriculture in those countries which aided and confirmed his theories as to the true use of manure and the importance of "pulverizing" the soil. He did not publish any account of his agricultural experiments or theories until 1731, when his *Horse-hoeing Husbandry* appeared. This was followed by *Horse-hoeing Husbandry, or an Essay on the Principles of Tillage and Vegetation*, by J. T., in 1733. He was attacked in the agricultural periodical *The Practical Husbandman and Farmer* and accused of plagiarizing from earlier writers. He died on Feb. 21, 1741.

TULLAMORE, a market town and the county town of Co. Offaly, Ireland, on the Grand canal and a branch of the Great Southern railway, by which it is 58 mi. west by south of Dublin. Pop. (1946) 5,897 There is considerable trade in agricultural produce, and brewing and distilling are carried on. There are several small ruined castles in the neighbourhood, notably Shragh castle, dating from 1588.

TULLE, a town of central France, capital of the department of Corrèze, 58 mi. S.S.E. of Limoges by rail. Pop. (1946) 18,202. Tulle (*Tutela*) owed its importance in the middle ages to the abbey of St. Martin, founded in the 7th or 8th century. The abbacy was raised to the rank of bishopric in 1317. The town was taken by the English in 1346. It was again conquered by the English in 1369; but, when the inhabitants succeeded in freeing themselves, they were exempted from all imposts by Charles V. The Protestants seized Tulle in 1585. The town extends along the narrow valley of the Corrèze, its streets here and there ascending the hill-slopes on either side by means of stairways. Of its 12th century cathedral, once attached to an abbey, only the porch, nave and a tower of the 13th century, with a fine stone steeple of the 14th century, remain. The neighbouring cloister (12th and 13th centuries) has been restored. The abbot's house (15th century) has a carved doorway and well-preserved windows. Tulle is the seat of a bishop, of a prefect, of tribunals of first instance and of a chamber of commerce and a board of trade-arbitrators. Its principal industry is the manufacture of small arms, established in 1690, and now carried on by the state. There are other minor industries. The well-known cascades of Gimel formed by the Montane are near Tulle.

TULLOCH, JOHN (1823–1886), Scottish theologian, was born at Bridge of Earn, Perthshire, in 1823, and received his university education at St. Andrews and Edinburgh. In 1845 he became minister of St. Paul's, Dundee, and in 1849 of Kettins, in Strathmore, where he remained for six years. In 1854 he was appointed principal of St. Mary's college, St. Andrews. The appointment was immediately followed by the appearance of his Burnet prize essay on *Theism* (1855). At St. Andrews, where he held also the post of professor of systematic theology and apologetics, he lectured on comparative religion and treated doctrine historically, as being not a fixed product but a growth. In 1862 he was appointed one of the clerks of the General Assembly, and from that time forward he took a leading part in the councils of the Church of Scotland. In 1878 he was chosen moderator of the Assembly. He did much to widen the national Church of Scotland. He was deeply interested in the reorganization of education in Scotland, both in school and university, and acted as one of the temporary board which settled the primary school system under the Education Act of 1872. He died at Torquay on Feb. 13, 1886.

Tulloch's most important works include: *Leaders of the Reformation* (1859); *English Protestants and their Leaders* (1861); *Rational Theology and Christian Theology in the Seventeenth Century* (1872); a monograph on *Pascal* (1876); *Modern Theories in Philosophy and Religion* (1884); *Movements of Religious Thought in Britain during the Nineteenth Century* (1885). See the *Life* by Mrs Oliphant (1888).

TULLUS HOSTILIUS, third legendary king of Rome (672–640 B.C.). His successful wars with Alba, Fidenae and Veii shadow forth the earlier conquests of Latian territory and the first extension of the Roman domain beyond the walls of Rome. It was during his reign that the combat between the Horatii and Curiatii, the representatives of Rome and Alba, took place. He is said to have been struck dead by lightning as the punishment of his pride. Tullus Hostilius is simply the duplicate of Romulus. Both are brought up among shepherds, carry on war against Fidenae and Veii, double the number of citizens, organize the army, and disappear from earth in a storm. As Romulus and Numa represent the Ramnes and Tities, so, in order to complete the list of the four traditional elements of the nation, Tullus was made the representative of the Luceres, and Ancus the founder of the Plebs. The distinctive event of this reign is the destruction of Alba, which may be regarded as an historical fact. But when and by whom it was destroyed is uncertain—probably by the Latins.

See Livy 1. 22–31; Dion. Halic. iii. 1–35, Cicero, *De Republica*, ii. 17 and Roscoe, *Ancient History*.

TULSA, a city of Oklahoma, U.S., 218 mi. (by air) S. by W. of Kansas City, on the Arkansas river, county seat of Tulsa county. It is on federal highways 64, 66, 75 and 169; and is served by the Frisco, the Midland Valley, the Missouri-Kansas-Texas, the Sand Springs, the Santa Fe and the Tulsa-Sapulpa Union (electric) railways; also by American, Braniff, Continental and Central air lines. Pop. (1950) 180,586; (1940) 142,157 (84% native white and 12% Negroes) by the census. The land area is 27.3 sq.mi. The city is 800 ft. above sea level, at the meeting point of the old boundaries of the Creek, the Cherokee and the Osage nations. The old council tree of the Creeks, a large elm, was still standing at mid-20th century. A commission form of government was adopted in 1908. The water supply is brought from a reservoir in the Spavinaw hills (60 mi. E.) by force of gravity alone, though the difference in elevation of source and terminus is only 90 ft. A second flow line to the city was completed, and a second dam and lake were started in 1950 to provide water for a population of 500,000. Mohawk reservoir, a 2,100,000,000-gal. reserve, is the central feature of a park of 2,936 ac. of timbered land, with lagoons, lakes and watercourses fed by the surplus from the reservoir. The University of Tulsa, founded at Muskogee in 1894 as Henry Kendall college, was moved to Tulsa in 1907. The city's gross assessed valuation for

1950 was $172,782,588.

Tulsa is the commercial and financial capital of a rich agricultural country, and of world-wide petroleum exploration, production, refining and marketing, with 500 oil-industry companies of all types. The city is impressively clean because all industries use only natural gas as fuel.

White settlement began in 1882, when an extension of the Frisco line was completed to the Indian trading post. "Tulsey Town," as it was called then, grew slowly, reaching a population of 1,390 in 1900. It was chartered as a city in 1902. Oil developments began in 1901. In 1910 the population had increased to 18,182.

TULSĪ DĀS (*1532–1623*), the greatest and most famous of Hindī poets, was a Sarwariyā Brahman, born, according to tradition, in A.D 1532, during the reign of Humāyūn, most probably at Rājāpur in the Bāndā District south of the Jumna. His father's name was Ātmā Rām Dubé; that of his mother is said to have been Hulasī. A legend relates that, having been born under an unlucky conjunction of the stars, he was abandoned in infancy by his parents, and was adopted by a wandering *sādhū* or ascetic, with whom he visited many holy places in the length and breadth of India; and the story is in part supported by passages in his poems. He studied, apparently after having rejoined his family, at Sūkarkhēt, a place generally identified with Sōrōn in the Etah district of the United Provinces, but more probably the same as Varāhakshētra on the Gogra River, 30 m. W. of Ajōdhyā (Ayōdhyā). He married in his father's lifetime, and begot a son. His wife's name was Ratnāwalī, daughter of Dīnabandhu Pāṭhak, and his son's Tārak. The latter died at an early age, and Tulsī's wife, who was devoted to the worship of Rāma, left her husband and returned to her father's house to occupy herself with religion. Tulsī Dās followed her, and endeavoured to induce her to return to him, but in vain; she reproached him (in verses which have been preserved) with want of faith in Rāma, and so moved him that he renounced the world, and entered upon an ascetic life, much of which was spent in wandering as a preacher of the necessity of a loving faith in Rāma. He first made Ajōdhyā (the capital of Rāma and near the modern Fyzābād) his headquarters, frequently visiting distant places of pilgrimage in different parts of India. During his residence at Ajōdhyā the Lord Rāma is said to have appeared to him in a dream, and to have commanded him to write a *Rāmāyana* in the language used by the common people. He began this work in the year 1574, and had finished the third book (*Araṇya-kāṇḍ*), when differences with the Vairāgī Vaishnavas at Ajōdhyā, to whom he had attached himself, led him to migrate to Benares, where he settled at Asi-ghāt. Here he died in 1623, during the reign of the emperor Jahāngīr, at the great age of 91.

The period of his greatest activity as an author synchronized with the latter half of the reign of Akbar (1556–1605), and the first portion of that of Jahāngīr, his dated works being as follows: commencement of the *Rāmāyan*, 1574; *Rām-satsaī*, 1584; *Pārbatī-mangal*, 1586; *Rāmāyā*, 1598; *Kabitta Rāmāyan*, between 1612 and 1614. A deed of arbitration in his hand, dated 1612, relating to the settlement of a dispute between the sons of a land-owner named Tōḍar, who possessed some villages adjacent to Benares, has been preserved, and is reproduced in facsimile in Dr. Grierson's *Modern Vernacular Literature of Hindustan*, p. 51 Tōḍar (who was not, as formerly supposed, Akbar's finance minister, the celebrated Rāja Tōdar Mall) was his attached friend, and a beautiful and pathetic poem[1] by Tulsī on his death is extant. He is said to have been resorted to, as a venerated teacher, by Mahārāja Mān Singh of Jaipur (d. 1618), his brother Jagat Singh, and other powerful princes; and it appears to be certain that his great fame and influence as a religious leader, which remain pre-eminent to this day, were fully established during his lifetime.

Tulsī's great poem, popularly called *Tulsī-krit Rāmāyan*, but named by its author *Rām-charit-mānas*, "the Lake of Rāma's deeds," is perhaps better known among Hindūs in upper India than the Bible among the rustic population in England. Its verses are everywhere, in this region, popular proverbs. Not only are Tulsī's sayings proverbial: his doctrine actually forms the most powerful religious influence in present-day Hinduism; and, though he founded no school and was never known as a *guru* or master, but professed himself the humble follower of his teacher, Narharī-Dās, from whom as a boy in Sūkar-khēt he heard the tale of Rāma's doings, he is everywhere accepted as an inspired and authoritative guide in religion and conduct of life.

The poem is a rehandling of the great theme of Vālmīkī, but is in no sense a translation of the Sanskrit epic. Besides the *Lake of Rāma's deeds*, Tulsī Dās was the author of five longer and six shorter works, most of them dealing with the theme of Rāma, his reign, and devotion to him. The former are (1) the *Dōhābalī*, consisting of 573 miscellaneous *dōhā* and *sōraṭhā* verses; of this there is a duplicate in the *Rām-satsaī*, an arrangement of seven centuries of verses, the great majority of which occur also in the *Dōhābalī* and in other works of Tulsī; (2) the *Kabutta Rāmāyan* or *Kabittābalī*, which is a history of Rāma in in the *kabitta*, *ghanākshari chhappāī* and *sawaiyā* metres; like the *Rām-charit-mānas*, it is divided into seven *kāṇḍs* or cantos, and is devoted to setting forth the majestic side of Rāma's character, (3) the *Gīt-Rāmāyan*, or *Gītābalī*, also in seven kāṇḍs, aiming at the illustration of the tender aspect of the Lord's life; the metres are adapted for singing; (4) the *Krishnāwali* or *Krishna gītābalī*, a collection of 61 songs in honour of Krishna, in the Kanauji dialect, the authenticity of this is doubtful; and (5) the *Binay Patrikā*, or "Book of petitions," a series of hymns and prayers of which the first 43 are addressed to the lower gods, forming Rāma's court and attendants, and the remainder, Nos. 44 to 279, to Rāma himself. Of the smaller compositions the most interesting is the Vairāgya Sandīpanī, or "Kindling of continence," a poem describing the nature and greatness of a holy man, and the true peace to which he attains. This work has been translated by Dr. Grierson in the *Indian Antiquary*, xxii. 198–201.

A manuscript of the *Ayōdhyā-kāṇḍ*, said to be in the poet's own hand, exists at Rājāpur in Bāndā, his reputed birthplace. One of the *Bāl-kāṇḍ*, dated *Sambat*, 1661 (A.D. 1604) 19 years before the poet's death, and carefully corrected, it is said, by Tulsī Dās himself, is at Ajōdhyā. Another autograph is reported to be preserved at Malihābād in the Lucknow district, but has not, so far as known, been seen by a European. Other ancient MSS. are to be found at Benares, and the materials for a correct text of the *Rāmāyan* are thus available. Good editions have been published by the *Khadga Bilās* press at Bānkipur (with a valuable life of the poet by Baijnāth Dās), and by the *Nāgarī Pracharinī Sabhā* at Allahabad (1903). The ordinary bāzār copies of the poem, repeatedly reproduced by lithography, teem with interpolations and variations from the poet's language. An excellent translation of the whole into English was made by the late Mr. F. S Growse, of the Indian Civil Service (5th edition, Cawnpore, 1891). The best account of Tulsī Dās and his works is contained in the papers contributed by Dr. Grierson to vol. xxii. of the *Indian Antiquary* (1893). In Mr. Growse's translation of the *Rām-charit-Mānas* will be found the text and translation of the passages in the *Bhaktamāla* of Nābhājī and its commentary, which are the main original authority for the traditions relating to the poet. In the introduction to the edition of the *Rāmāyan* by the *Nāgarī Prachārinī Sabhā* all the known facts of Tulsī's life are brought together and critically discussed. For an exposition of his religious position, and his place in the popular religion of Northern India, *see* Dr. Grierson's paper in the *Journal of the Royal Asiatic Society*, July 1903, pp. 447–466. (C. J. L.; X.)

See Sir G. A. Grierson, *Notes on Tulsi Das* (Allahabad, 1921).

TULU LANGUAGE, otherwise TULUVA, a language of the Dravidian family, found chiefly in the south Kanara district of Madras. It has no literature, nor has it been adopted for official use even where it is spoken by the majority of the population. It is regarded as one of the most highly developed languages of the Dravidian family and must be classed as lying between Tamil and Kanarese, nearer to the latter than to the former. *See* Bishop Caldwell, *Comparative Grammar of the Dravidian Languages* (1875); *Linguistic Survey of India*, vol. iv. (1906).

TUMACO, a seaport city of southwestern Colombia in the department of Nariño, the southernmost of Colombia's port cities and, next to Buenaventura, the most important Colombian port on the Pacific side Tumaco is located on an island on the south side of the bay of Tumaco. It is served by a short railroad

[1] See *Indian Antiquary*, xxii. 272 (1892).

line which goes only as far as Diviso, by the Barranquilla-Guayaquil air line and by a road which joins the Simón Bolívar highway between Pasto and Ipiales. Pop. (1938) 9,671. Tumaco and the region around it were visited by Francisco Pizarro, and the city later gained some importance because of its port facilities during the period when Colombia was attempting to win its freedom from Spain.

Tumaco is a shipping centre for goods sent down the Rio Patía, which drains into the bay of Tumaco.

TUMBES, a department of Peru, is situated on the Pacific coast in the extreme northwest between Ecuador on the east and the department of Piura on the south. Formerly a littoral province, it was given departmental status in 1942. It is the country's smallest department, with an area of 1,591 sq mi. The population was 31,201 in 1950. Its capital is the city of Tumbes (pop. 7,712), on the Tumbes river 7 mi. from its port of Puerto Pizarro, with which it is linked by rail. The district was an ancient Inca stronghold, and Tumbes was a prosperous city when Francisco Pizarro made his initial landing nearby (1527) and used it as his base for the conquest of the Inca empire. The region's ready accessibility brought modern development early. In 1863 an oil well was sunk near Zorritos, marking the beginning of the important oil industry. The Zorritos-Chira oil fields (partly in Tumbes and partly in Piura) account for most of Peru's oil production and have reserves estimated at more than 5,000,000,000 bbl. Fishing, especially for lobster, is important. Other products include sugar, tobacco, coffee and cacao, along with salt and some gold. (L. W. Be.)

TUMBLEWEED, a botanical term for a plant which breaks loose at the ground line when dry, and is blown about, scattering its seeds by the way. Tumbleweeds are most abundant in semi-arid regions. Examples are: tumbling pigweed (*Amaranthus graecizans*), Russian thistle (*Salsola kali*), winged pigweed (*Cycloloma atriplicifolium*), bugseed (*Coriphernum hyssopifolium*), tumbling mustard (*Sisymbrium altissimum*) and witch grass (*Panicum capillare*).

TUMBLING MUSTARD (*Sisymbrium altissimum*), an annual weed of the mustard family (Cruciferae, *q.v.*), native to Europe and extensively naturalized in North America, especially in the northern states and adjacent Canada. It is tall, freely branching and has deeply cut leaves. The small pale-yellow flowers produce long, narrow, spreading seed pods. One plant may ripen more than 500,000 seeds.

TUMKUR, a town and district of southern India, in the west of Mysore state. The town (pop., 1941, 21,893), which is a health resort on the Devarayadurga hills, has a station on the Madras and Southern Mahratta railway, 43 mi. N.W. from Bangalore. The area of the district is 4,082 sq.mi.

It consists chiefly of elevated land intersected by river valleys. A range of hills rising to nearly 4,000 feet crosses it from north to south, forming the water parting between the systems of the Krishna and the Cauvery. The principal streams are the Jayamangala and the Shimsha. The population in 1931 was 861,405. The cultivated products consist chiefly of millets, rice, pulses and oilseeds.

TUMMEL, a river of Perthshire, Scot. Discharging from Loch Rannoch, it flows eastward to a point near the Falls of Tummel, where it flows southeast until it falls into the Tay, just below Logierait, after a course of 58 mi. from its source in Stob Ghabbar (3,565 ft.).

Its only considerable affluent is the Garry, 24 mi. long, which issues from Loch Garry (2½ mi. long, ¼ mi. wide). About midway in its course the Tummel expands into Loch Tummel (2¾ mi. long, ½ mi. wide), between which and the confluence with the Garry occur the pass and falls of the Tummel.

TUMOUR. In its broad sense the word "tumour" may be applied to any localized swelling irrespective of origin, location or composition. In its restricted sense, however, it denotes an abnormal growth of new tissue, arising by unknown cause from pre-existing body cells, having no purposeful function and being characterized by a tendency to autonomous and unrestrained growth. Thus we may recognize two main groups of swellings: **false** tumours or nonneoplastic **swellings,** and true tumours or neoplasms, conforming to the restricted definition just mentioned.

The essential basis for this distinction lies in the cellular composition of all living tissues, normal and abnormal. Only by a recognition of the distinctive appearance and characters of the individual cells forming a tissue or swelling can we attempt to define accurately the nature, origin and entity of a tissue mass. Swellings may be composed of (1) normal body cells, (2) abnormal body cells, or (3) foreign cells, introduced from without the body. Cells of the second variety differ from the first in having undergone alterations in appearance, character or arrangement as follows.

Hypertrophy denotes an increase in the size of individual cells. This feature is occasionally encountered in true tumours but occurs commonly in other conditions.

Hyperplasia denotes an increase in the number of cells within a given zone. In some instances it may constitute the only criterion of tumour formation.

Anaplasia denotes a regression of the physical characteristics of a cell toward a more primitive type. This is an almost constant feature of malignant tumours, though it occurs in other instances both in health and in disease.

True tumours in general are characterized by a growth of cells exhibiting one or more of these three variations from normalcy.

FALSE TUMOURS

These form a heterogeneous group. In most instances the cause and origin of the swelling is known and well understood

Inflammatory Swellings.—These are formed in the normal course of the reaction of the body to irritants. The mass of the swelling is composed mainly of cells of normal body type which, in response to a noxious stimulus, are incited to multiply and concentrate in the zone that is the seat of the attack. The two common causes of inflammation are trauma and bacterial infection. Traumatic swellings of an acute nature include such conditions as a bruise, a haematoma (viz., a black eye), or a sprain. Examples of chronic traumatic swellings are calluses, bursitis (viz., housemaid's knee), or an overgrowth of bone after an inaccurately healed fracture. Infectious swellings of an acute nature include boils, abscesses, felons, and inflamed lymphatic glands. Those of chronic type result from tuberculosis, syphilis, actinomycosis, leprosy, etc.

Hypertrophic Swellings.—The essential feature of these is an increase in the size (hypertrophy) and number (hyperplasia) of the cells constituting the organ or part concerned. The excessive muscular development of the calves of the legs of some ballet dancers is an example, likewise the enlargement of the breasts and uterus in pregnancy. All such swellings result from normal physiological processes and as such do not constitute true disease.

Parasitic Swellings.—These result from the multiplication within the body of living cells introduced from without. The only common example is hydatid disease which gives rise to the formation of cysts in the internal organs. Both the wall and the contained fluid are derived from the foreign cells. They evoke a variable amount of inflammatory response on the part of the adjacent body cells.

Cysts.—These constitute a heterogeneous group since some cysts are true tumours, which happen to develop in spherical form with a central space occupied by degenerative fluid products of their own cells. Other cysts result from cystic degenerative changes occurring within the solid substance of true tumours. Many, however, are not related to tumours at all, the following being specific examples: retention cysts, dilated glands whose effluent ducts are blocked, *e.g.*, sebaceous cysts (wens); distention cysts, formed by the dilatation of closed sacs which normally contain but little fluid, *e.g.*, hydrocele; congenital cysts, which do not necessarily appear at birth but are all derived from embryological structures which have persisted fortuitously, *e.g.*, thyroglossal, branchial cysts; parasitic cysts (described above); degenerative cysts, *e.g.*, a ganglion of the wrist, blood cysts.

All cysts contain fluid free within a closed cavity. The nature of the fluid may be bloody, mucoid, milky, etc. Clear fluids such

as lymph, in cysts near the surface of the body, will transmit light and hence are translucent Aspiration of the contents is frequently practised as a means of diagnosis Treatment consists in surgical removal where and when indicated.

Degenerative Swellings.—These result from distention of hollow organs or tissues following an abnormal weakness of their walls or their investing membranes. Examples include aneurysms, varicose veins, hernias, diverticula.

False Swellings.—Deeply seated organs or structures may become abnormally prominent because of the wasting of their superimposed coverings. A false impression of enlargement may therefore appear.

Swellings of Unknown Origin.—This group embraces a few swellings whose nature and origin is the subject of doubt and debate They may or may not be true tumours, inflammations or degenerations. The outstanding example is Hodgkin's disease of the lymphatic glands.

Phantom Tumour is a term applied to the apparent enlargement of the lower abdomen that occurs in women who suffer from an hysterical conviction that they are pregnant. It is not infrequently accompanied by alleged concomitant accessory signs of pregnancy.

The "tumour" promptly disappears under the influence of hypnosis or anaesthesia.

TRUE TUMOURS

These are composed of masses of tissue cells developed from pre-existing body cells. In some instances the tumour cells are normal in appearance, faithful reproductions of their parent types; such tumours are generally benign Other tumours are composed of cells slightly different from normal adult types, different in appearance, size, shape and structure; these tumours are usually malignant, and the specific changes in cell type are those of anaplasia.

Cause.—We have seen that the false tumours are initiated by a definite and in many instances a specific cause, but in the case of true tumours, the cause is unknown. The method by which a tumour grows; *i.e.*, the proliferation of body cells, is a process that normally occurs in health. Body cells, like men, have their allotted span of life, varying from a period of days to years, whereupon they are replaced. New cells do not arise *de novo* but by fission, one (mother) cell dividing into two (daughter) cells; the daughters (twins) are identical with each other and with their late mother. When tissue is lost, as by a burn of the skin, the defect is reconstituted by the multiplication of adjacent body cells This process proceeds until the defect is properly repaired, and then it ceases. We can see the necessity and logic for the initiation of such a process but we can only marvel at the mechanism which finally throttles the cellular proliferation at the exact moment of normalcy. It is presumed that the reparative process of cell proliferation is initiated by a normal stimulus and is stopped by a similarly normal stimulus.

Tumours arise by a proliferation of body cells in the absence of a normal stimulus, or, alternatively, in the presence of an abnormal stimulus; the precise nature of both processes still defied elucidation at mid-20th century. Without any discernible cause, the cells of a tissue start to multiply as though to fill a defect that does not exist One important difference from the normal reparative process is a tendency for the daughter cells to assume characters of a nature more primitive than that of their predecessors, hence becoming anaplastic.

Certain factors are generally believed to favour the initiation of tumour formation in isolated instances, and outstanding among these is chronic irritation. Employment in certain trades and occupations predisposes to the development of certain tumours; these occupations are associated with long continued exposure to mild irritation of various parts of the body. Experimental production of tumours by irritational methods has been accomplished in animals, but it is unlikely that these methods are identical with those that cause the spontaneous origin of tumours in otherwise normal human beings.

Among other factors is heredity. There is some evidence that inherited characteristics may predispose the development of tumours, particularly of the malignant type. Many experimental studies with mice demonstrate the possibility of breeding, by planned selection, a strain of animals that will show almost 100% cancer production. The extremely high incidence of human cancer in certain family groups is well known, but appears to constitute only a minor subfactor in the propagation of the disease.

Infection by micro-organisms has not been proved as a cause. Certain experimental tumours of fowl have been shown to be transmitted by a filterable virus. The only possible instance of this mode of tumour formation in man would appear to be the "crops" of "soft" warts commonly occurring in childhood, but there is some doubt that these warts are true tumours.

Trauma is a factor occasionally imputed, notably in instances coming to the attention of workmen's compensation boards It would seem that in some instances certain tumours, usually of a sarcomatous nature, may be causally related to trauma, but definite proof was far from established at mid-century, since the experimental production of a tumour in this manner had yet to be demonstrated conclusively.

The Vicious Autonomy of Tumours.—Natural inflammatory swellings are primarily beneficial to the body since they constitute one phase of the protective response of the body to noxious stimulus. True tumours, on the other hand, serve no such useful function. In many instances their only role is to kill the patient. They grow for their own sakes alone, and at the expense of the body economy.

The capacity of inflammatory tumours to form and function depends upon the general healthiness of the body. In people who are poorly nourished or ill, the inflammatory response may be poor or absent. True tumours on the other hand observe no such compliance with the general body resources. Even though a person be so physically exhausted that a recently sustained wound may fail to show any attempt at healing, a true tumour currently present will continue to grow by cell proliferation, ignoring the ebbing vitality of the patient. In this respect tumours behave as parasites.

Whenever normal cellular proliferation is required to carry out body repairs, the multiplying cells tend to reconstruct as faithfully as possible the normal architecture of the part lost or destroyed. Proliferating tumour cells on the other hand follow no plan or deviate grossly from the original tissue pattern This of course is at least consistent with their utter lack of function since no structural specification is therefore required. Indeed their perversity is sometimes manifested by the development of abnormal symptoms through their overproduction of malicious ferments, as in certain tumours of the thyroid gland and pancreas

Clinical Manifestations.—The mass of newly formed tumour cells usually constitutes a definite localised swelling. Should such a mass occur on or near the surface of the body, it can be felt or seen as a lump. But since tumours may develop in any organ or tissue, however deeply placed, the swelling may not always be palpable.

Some tumours, notably those of the malignant variety, may assume physical characteristics other than that of lumps. Thus they may appear as ulcers, indurated cracks or fissures, wartlike projections, or as a diffuse ill-defined infiltration of what appears to be an otherwise normal organ or tissue. The tumour cells may replace completely the normal cells of the part and should the processes of proliferation of new cells and the destruction of normal cells both proceed at the same pace, there may be only little gross change in the size of the part, though there will usually be an alteration in the consistency of the tissues. In other cases the normal cells may disappear more quickly than the tumour cells appear, so that the affected part may actually shrink in size. This is seen in certain cancers of the breast and in the annular type of cancer of the bowel.

Tumours which arise in the tubular structures of the body; *e.g.*, the intestinal, biliary or urinary tracts, are prone to cause obstruction since the normal contents of these tubes are no longer free to pass along their lumina. Thus intestinal, biliary, etc., obstruction may be produced. Furthermore, such tumours,

being located in the walls of these various tubes, actually may bleed into the tract concerned, and the blood subsequently appears at the natural body orifices; viz., the vomiting of blood resulting from cancer of the stomach, or the passage of bloody urine in cases of tumours of the kidney or bladder. Again, the tumour by virtue of its mass as a foreign body may initiate the production of pus or mucus and these substances likewise are passed to the surface of the body.

Tumours arising within the bony cages of the body; *e g*, chest, skull and spinal column, may cause symptoms by exerting direct pressure on adjacent vital structures such as the heart, brain and spinal cord. Those developing within the interior of a bone may so weaken the bone as to cause a collapse, bending or actual fracture. The destruction of specific tissue in which the tumour develops may so interfere with local function as to cause specific symptoms; *e.g.*, loss of vision in the case of an intraocular tumour.

Pain is a variable symptom. It may result from direct pressure on, or irritation of, adjacent nerve tracts, *e.g.*, the spinal cord, or by producing increases of pressure within a rigid cavity, *e.g.*, headache in the case of brain tumour; or by producing obstruction of a muscular tube with concomitant colic, *e g.*, tumours of the intestine. Thus, in their early stages all tumours tend to be painless, and even though they grow to a large size, should there be no interference with local function, they may remain painless. Later, however, the malignant variety commonly causes pain by the direct invasion of nerve trunks or by destruction of bone. Tumours themselves are largely devoid of nerve fibres, excepting, of course, those that are composed of nervous tissue.

Classification of Tumours.—When we recall that tumours may arise in any part of the body and from every type of cell and tissue in the body, that they may possess the phenomenon of malignancy in any degree, we must realize that an accurate, all-embracing classification has yet to be achieved.

The fact that we are still uncertain of the identification of some of the precursor cells from which tumours arise serves only to augment the difficulty.

Since all tumours are composed of cells, we try to classify them according to the specific type of cell predominating in any particular instance This constitutes the histologic basis of classification, the microscopic study of cellular structure. In general two main types of body tissue are recognized. (1) epithelial tissue, which forms the surfaces of the body and its tubular cavities and glands and (2) connective tissue, whose function is essentially supportive. It is therefore possible for tumours to be composed of three types of tissue, namely, epithelial tissue, connective tissue and tissues of mixed or uncertain type. The introduction of the last group adds a note of variability characteristic of all biologic processes.

Classification of Tumours

Classification according to behaviour	Classification according to tissue of origin		
	Connective tissue	Epithelial tissue	Tissue mixed or indefinite
Benign	lipoma fibroma angioma chondroma osteoma myxoma neuroma myoma fibromyoma osteochondroma glioma tumour	papilloma adenoma implantation dermoid	odontoma fibroadenoma adenomyoma fibropapilloma
Malignant	sarcoma	carcinoma	specific adrenal tumours
Variable in malignancy or locally malignant	giant cell tumour glioma endothelioma chordoma	rodent ulcer	melanoma mixed salivary tumour carcinoid tumour embryological tumours

Long before the advent of the microscope as an aid to histologic study, medical men classified tumours on the basis of their ultimate effect on the patient; *i.e.*, the clinical classification. While the histologic picture of a tumour is of interest to the pathologist, the effect of the tumour on the life and happiness of the patient is of far more importance to the patient himself. Hence the ancient clinical classification of tumours into the benign and the malignant types. The malignant tumours are those that, in general, always kill the patient eventually if left untreated of if not drastically eradicated at an early stage of development This distinction of the clinical behaviour of tumours holds good only up to a point, for it is known that some benign tumours; *e g*, a lipoma, may readily cause death purely by virtue of location by exerting pressure on the spinal cord. Other tumours appear to fall between the two main clinical divisions in that they may be only locally malignant, destroying all normal tissue in their vicinity, but not spreading widely from their point of origin. Thus we may classify tumours on a clinical basis as benign, malignant, or of local or variable malignancy. Again the acknowledgment of a third group, while typifying the vagaries of biologic processes, serves also to enhance the difficulties in formulating a satisfactory classification of tumours.

Malignancy of Tumours.—Malignancy refers to the tendency of a tumour to produce death. But we have seen that any tumour, of any type, may produce death by local effects if appropriately situated.

Thus the specific definition of malignancy implies an inherent tendency, on the part of the cells composing it, to invade the body widely and relentlessly, to become disseminated by subtle means, and eventually to kill the patient unless all the malignant cells can be drastically and completely eradicated.

The outstanding gross characteristic of malignancy is the property of tumour cells to wander from their site of origin. Though the tumour may arise from one site in one tissue or organ, it may eventually establish metastases in almost every tissue and organ of the body.

In contrast, the cells of a benign tumour invariably remain in contact with each other in one solid mass centring at the site of origin. This gross physical continuity of the benign tumour cells enables them to be removed completely by surgical means, providing the location is suitable. But the dissemination of malignant cells, each one individually possessing the facilities and tendency to give rise to new masses in new and distant sites, precludes complete eradication by a single manoeuvre in all but the earliest period of growth.

The question frequently arises, does a benign tumour ever become malignant? In other words, is malignancy a property that may be acquired by benign tumour cells? We know that normal body cells, if subjected to the appropriate (and unknown) stimulus, may form tumours and these tumours may be either benign or malignant *ab initio*. Both types of tumour rarely are found in the same individual at the same time. Still more rarely does a primarily benign tumour appear to become transformed into a malignant one. It is not easy to be certain concerning the acquisition of malignant transformation; it is possible for a primarily malignant tumour to remain quiescent, mimicking a benign one clinically, for a long time.

Of the group of tumours in which malignancy is variable, some are benign from the start and remain so; others are apparently malignant from their moment of origin; and finally, a few appear to change from innocent to malignant type. In the latter case the histologic picture of the tumour before and after malignant transformation may show no differences. Thus, acquired malignancy is not necessarily dependent upon discernible changes in the appearance of the tumour cells.

To sum up, a benign tumour may undergo malignant transformation but the cause of such change is unknown. The regression of a malignant tumour to benign type is, lamentably, unknown.

For a discussion of malignant tumours *see* under CANCER; CANCER RESEARCH.

BENIGN TUMOURS

Characteristics.—Benign tumours tend to occur in younger people, most of them appearing before the age of 40. Histologically their cells show no great variation in detail from those of normal tissue, in contrast to the appearance of cancer cells. The

arrangement of the new cells may suggest an abortive attempt to reproduce the normal structure of the part but this effort is usually crude and ineffectual. All tend to remain localized at the site of origin.

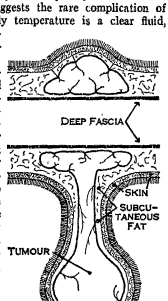
They enlarge by accretion, pushing aside the adjacent tissues without involving them intimately. Malignant tumours, on the other hand, invade the surrounding structures, thereby becoming fixed to them.

Many benign tumours are encapsulated. The capsule consists of a connective tissue derived from the structures immediately surrounding the tumour. While it serves to demarcate the tumour it does not act as a limiting membrane Malignant tumours, as a rule, do not possess a capsule though some of the sarcomas arising from soft tissues may have a pseudocapsule in their early stages. The chief effect of the capsule is to lend the physical property of mobility to the tumour mass. Well-encapsulated tumours are not anchored to their surrounding tissues. It may be possible to bounce the tumour about in the part; *e g.*, a fibro-adenoma of the breast or, should the tumour arise from a bone (an osteoma), the enveloping muscles and tendons will move freely over and around the mass.

Benign tumours of any one type are frequently multiple, several arising in different parts of the body either simultaneously or in succession. In such cases all the tumours are identical. It is most unusual for more than one malignant tumour to arise primarily, but, should this primary tumour give rise to metastases, these secondary masses tend to differ from the primary growth in their gross physical characteristics, though remaining identical histologically.

Benign Tumours Arising from Connective Tissue.—*Lipoma.*—This is the commonest of all neoplasms and consists of fat cells which are microscopically indistinguishable from normal fat cells They are invariably ensheathed in a delicate transparent capsule which sends fine septa through the body of the tumour making it lobulated. Thus are explained the two outstanding characteristics of the tumour; namely, lobulation and a firm demarcated edge. Small lipomas tend to be plaque-shaped, larger ones hemispheroidal, while others may become pedunculated. Since normal fat is a soft structure, so too are most lipomas, though in their infancy they are frequently firm. Pain is a most unusual feature and suggests the rare complication of calcification. Since fat at body temperature is a clear fluid, prominent tumours near the surface of the body may be translucent in a strong beam of light.

They tend to occur in all situations where normal fat is found and thus may be classified according to site; namely, subcutaneous, subfascial, subserous, submucous, subsynovial, with rarer occurrence in the subperiosteal and subcapsular regions. By far the commonest site is the subcutaneous plane, immediately deep to the skin (*see* fig. 1). While commonly single, they may be present in scores. They vary from the size of a pea to that of a football and while they may arise at any age they are rare in the first decade of life. It is generally conceded that they are not subject to malignant change, those so-called malignant lipomas being liposarcomas from the start.



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FIG. 1.—SUBCUTANEOUS LIPOMAS

Treatment consists of removal of the tumour by surgical excision, the indications being cosmetic defect or interference with the function of local structures; *e g.*, when the tumour is located within the bowel or is exerting pressure on the spinal cord. Complete removal is usually effected quite easily and is never followed by recurrence

Diffuse lipomas are characterized by absence of a limiting capsule. They are probably not true neoplasms but rather result from disturbances of metabolism.

Fibroma.—This is a rare tumour composed of white fibrous tissue enclosed in a thick tough capsule. It is usually spherical in shape, hard, painless, freely movable and varied in size but it seldom exceeds the dimensions of an orange. A "soft" variety is described but is uncommon. They are found in the bones—chiefly about the gums of the jaws and the nasopharynx; in the tendon sheaths—chiefly on the back of the wrist; in certain glands of the body (breast, ovary, testicle); and in the nerves.

The latter site is the commonest. Here the tumours spring from the fibrous sheath of the nerve rather than from the conducting tissue—hence they contain no nerve elements. The eighth cranial nerve is especially prone to be affected, giving rise to the so-called acoustic neuroma.

Von Recklinghausen's disease consists of multiple small fibromas affecting the subcutaneous nerves of the body and is accompanied by a patchy discoloration of the skin. The condition tends to be inherited and of familial proportions. Molluscum fibrosum, plexiform neuroma and elephantiasis neuromatosa are other clinical manifestations of multiple fibromas Two complications are observed, myxomatous degeneration and malignant transformation to sarcoma, the latter supervening particularly on the "soft" variety of fibroma

Treatment consists of early excision of the single types. There is no uniformly satisfactory method of dealing with the disease in its multiple form.

Angioma.—This tumour is composed of vessels of which there are two types (1) haemangiomas, or tumours of blood vessels and (2) lymphangiomas, tumours of lymphatic vessels.

The *haemangiomas* are of three varieties, depending on the type of blood vessel forming the tumour.

The capillary haemangioma is the commonest form of birth mark It consists of a mass of fine capillary vessels stuffed with circulating blood It is seen most commonly in the skin but may affect deeper structures as well. In its typical form it consists of a reddish, roughened, raised patch, painless, often with an ill-defined border. The colour is due to the concentration of blood and frequently this can be expelled partially by pressure with a finger tip, causing the zone so pressed to blanch. It does not possess a capsule.

The tumours, either single or multiple, appear shortly after birth and tend to increase in size for a few months. Many of them disappear spontaneously.

The only serious complication is haemorrhage, which in some instances may be fatal. Treatment consists of excision if feasible, if not, in radiation by means of X-ray or radium. They do not tend to recur.

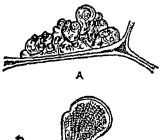
The cavernous haemangioma consists of a growth of blood vessels of the character of veins. Hence they appear, when near the surface, as soft, painless, bluish, wormy masses which can be emptied by compression and will refill by dependency. If located close to the trunk of the body, they may show an impulse on coughing. They occur in the subcutaneous plane, in the muscles, in the solid viscera and in the bones—one tumour only being the rule. In the bones they are prone to erode their parent site and cause collapse or fracture. Frequently they possess a partial capsule of thin connective tissue.

Treatment is best effected by excision if possible, otherwise—as in vertebral sites—by radiation.

The plexiform haemangioma consists of a mass of large vessels of arterial type and calibre. Not infrequently large venous channels are present as well. The temporal region of the head is the only common site, where the swelling appears as a pulsating mass which may erode the skin and the underlying bone. Treatment consists of complete and careful excision.

The *lymphangiomas* are rare tumours and, like their haemal cousins, are of three types. Capillary lymphangiomas consist of tiny pearly vesicles the size of pinheads, affecting chiefly the

lips and tongue. The cavernous type, also known as cystic hygroma, consists of large, thin-walled, translucent lymphatic cysts, usually found in the neck. The plexiform type consists of a wormy mass of grossly dilated lymphatic vessels and, like the capillary type with which they are frequently associated, they tend to affect the lips and the tongue. All lymphangiomas may be treated by excision or radiation. None possesses a well-defined capsule.



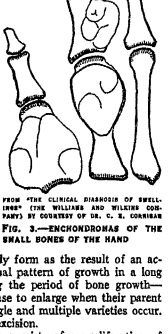
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FIG. 2.—(A) ECCONDROMA OF THE SCAPULA, (B) ECCONDROMA OF THE HUMERUS

Chondroma.—This is a tumour composed of hyaline cartilage which is the embryologic precursor of bone. While normally confined to bony sites, these tumours occasionally are encountered free in soft tissue sites. They form firm lobular masses enclosed in a thick capsule. Two types are described. The *ecchondromas* (fig. 2) grow outward from the surface of their parent bone—commonly the flat bones of the skeleton. They may attain the size of a coconut and they push aside the overlying structures. They are usually single. The *enchondromas* (fig. 3) develop within the interior of bones—usually the smaller long bones of the hands, feet and digits. They are commonly multiple and bilaterally placed. As they grow they expand and thin the cortex of their parent bone, producing considerable deformity. They may erupt through their bony covering and project outward into the surrounding soft tissues.

All chondromas tend to be painless, but are subject to myxomatous degeneration and sarcomatous change. All should be treated by complete surgical excision.

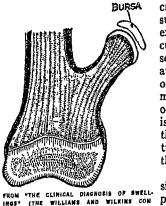
Osteoma.—This is a tumour composed of bone. Two varieties are distinguished. The *cancellous* osteoma (fig. 4) is made up of all the elements of the shaft of a long bone, including both the spongy medulla and the firm compact cortex. Its gross appearance suggests a ballooning outward of a portion of the parent bone at one point. They form hard painless masses deeply attached to the skeleton, displacing the soft tissues about them. Not infrequently they are capped by a bursa which may be the seat of periodic inflammation, thus causing pain overlying the swelling. These tumours probably form as the result of an accidental deviation from the normal pattern of growth in a long bone, for they arise only during the period of bone growth—under the age of 25, and they cease to enlarge when their parent bone reaches maturity. Both single and multiple varieties occur. Treatment is effected by surgical excision.



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FIG. 3.—ENCHONDROMAS OF THE SMALL BONES OF THE HAND

The *compact* osteoma (fig. 5) consists of a proliferation of the dense cortical layer only of a bone. They are usually single tumours and constitute the hardest substance the human body is capable of producing. They occur on the surface of the flat bones of the body, notably the vault of the skull and the lower jaw. In the case of the skull they may grow from either the external or internal surface, or both, thus occasionally projecting into the cranial cavity and exerting pressure on the brain. When growing externally they form a hard circumscribed boss over which the scalp rides freely. They occur at any age. Treatment consists of removal by sectioning the normal bone close to the periphery of the mass, since no instrument is sufficiently staunch to attack the tumour itself without fracturing the adjacent portion of the skull.



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FIG. 4.—CANCELLOUS OSTEOMA OF THE LOWER END OF THE FEMUR

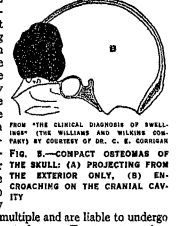
Myxoma is a rare tumour consisting of a mass of jellylike primitive connective tissue.

Neuroma is an equally rare tumour formed of nerve cells and fibres, usually derived from the autonomic nervous system.

Myoma, in pure form, is again a rare tumour consisting of muscle tissue only.

The *leiomyoma* is derived from smooth muscle fibres, the *rhabdomyoma* from striated muscle fibres.

Fibromyoma.—This is a tumour composed of two elements of connective tissue—fibrous tissue and smooth muscle tissue. It is a common tumour, occurring much more frequently than either of its composites in pure form. Its site of election is the uterus, where it is colloquially termed a "fibroid." It is also the commonest of all tumours of the uterus and develops there in three situations—either projecting outward from the womb, enlarging the body of the womb, or projecting into the cavity of the womb in which case it is prone to bleed. These tumours may grow to a colossal size, are frequently multiple and are liable to undergo simple degenerations and malignant change. Treatment consists in surgical removal which, owing to their multiplicity and their deep-seated location, may demand the complete removal of the uterus.



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FIG. 5.—COMPACT OSTEOMAS OF THE SKULL: (A) PROJECTING FROM THE EXTERIOR ONLY, (B) ENCROACHING ON THE CRANIAL CAVITY

Osteochondroma is the hybrid of the two "pure" tumours, osteoma and chondroma. They occur in sites common to the chondromas and clinically resemble the latter tumours closely. They should be treated by surgical removal.

Glomus Tumour.—This peculiar swelling consists of a mass of blood vessels, nerve cells and fibres and epithelioid cells. It occurs chiefly on the extremities; the hands, feet and digits are the common sites. It usually presents as a single, exquisitely tender, tiny reddish patch immediately deep to the skin or a finger nail. It is seldom as large as a grain of wheat when first discovered, the attention of the patient being focused by the inordinate pain which results from any manipulation of the part. It is believed to arise by proliferation of the local nervous mechanism of the lateral capillary "shunts." Treatment consists of surgical excision.

Benign Tumours Arising from Epithelial Tissue.—*Papilloma* consists of a sprouting projecting mass of new tissue derived from a surface epithelium. Three histologic types are described, based on the type of epithelium composing the tumour. None are encapsulated.

Squamous papilloma arises from a stratified squamous epithelium. The skin is the commonest site; there the process results in a wart. These are frequently multiple and in some instances

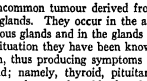
may not be neoplastic at all. Other sites include the tongue, mouth and vocal cords. All may be treated by surgical excision or radiation.

Transitional papillomas are confined to the urinary tract, the kidneys, ureters and bladder. They contain a rich arborization of blood vessels surrounded by a delicate layer of epithelium. Hence their usual complication is haemorrhage, which is manifest by the painless passage of blood in the urine. In addition they may give rise to urinary obstruction and infection. All transitional papillomas are prone to become malignant and should therefore be eradicated as soon as diagnosed. If they occur in the bladder they may be cauterized with an electric current.

Columnar cell papillomas spring from and project into the interior of the gastrointestinal tract, the larger ducts of the breast and the walls of certain cysts. They have a tendency to bleed easily, thereby producing bloody effluxes, and all are prone to undergo cancerous change. They should be removed surgically when diagnosed.

Adenoma in pure form is an uncommon tumour derived from the secreting cells and tubules of glands. They occur in the alimentary tract, mucous and cutaneous glands and in the glands of internal secretion. In the latter situation they have been known to elaborate an excess of secretion, thus producing symptoms of overactivity of their parent gland; namely, thyroid, pituitary, parathyroid or pancreas. Elsewhere they tend to bleed and in the intestine they may produce obstruction. They are usually small spherical painless masses surrounded by a definite capsule. Treatment consists in surgical removal.

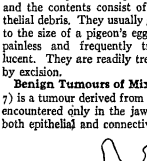
Implantation dermoid (fig. 6) is a tumour which assumes the form of a cyst. The common sites are the palms of the hands and the fingers. The popular theory of origin implies the growth of a bit of skin transplanted to a depth in the subcutaneous tissues. The wall of the cyst is formed of stratified squamous epithelium and the contents consist of epithelial debris. They usually grow to the size of a pigeon's egg, are painless and frequently translucent. They are readily treated by excision.



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FIG. 6.—IMPLANTATION DERMOID OF THE FINGER

Benign Tumours of Mixed Tissue Origin.—*Odontoma* (fig. 7) is a tumour derived from the elements of teeth and is therefore encountered only in the jaws. Since the teeth are derived from both epithelial and connective tissue elements, many varieties of odontoma may occur but man, in contrast to animals, is subject to few types but those of epithelial origin. As the process of tumour formation may afflict the teeth at any stage of their development three main types of epithelial odontoma are recognized; namely, fibrocystic disease of the jaw, dentigerous cyst and dental cyst. All these cause swelling of the jaw with considerable pain. All may be satisfactorily treated by excision.



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FIG 7.—A DENTIGEROUS CYST OF THE LOWER JAW

Fibroadenoma is a hybrid which, like fibromyoma, is of more common occurrence than each of its two "pure" composites. It consists of a mixture of white fibrous tissue and epithelial cells of a secreting gland. It is often multiple, usually painless, spherical in shape, firm in consistency and carries a thick capsule. Only two locations are commonly noted, the breast and the prostate gland.

It is the commonest tumour of the breast, where it must be differentiated from carcinoma—and vice versa. One or more tumours may be present in one or both breasts. It tends to develop before the age of 35. An outstanding clinical feature is the great mobility of the tumour within the breast tissue. Three varieties are described, hard, soft and cystic. The latter two may reach the size of a football but the hard type seldom exceeds the size of an orange.

Fibroadenomas have a small but definite tendency to become malignant. They should always be removed surgically as soon as they are diagnosed.

Adenomyoma and *fibropapilloma* are examples of rare hybrids. They assume the clinical features of one or the other of their constituent tumour tissues.

Diagnosis of Tumours.—Two main methods are commonly employed.

The first and oldest is that of clinical examination, an appreciation of the physical characteristics of the swelling, the symptoms it initiates, its site, its mode of growth and spread if any, and its effect on local and adjacent structures and functions. The success of this method depends essentially on the experience, skill and judgment of the physician. It may frequently be supplemented by X-ray studies of the part, notably in the case of tumours of the bones, intestinal tract and the more deeply seated lesions that cannot be directly seen or palpated.

The second method employed is the more scientific and accurate means of biopsy. Since all tumours consist of a new growth of cells, the microscopic study of these cells will give a true picture of the nature of the tumour. A bit of tumour tissue is therefore removed from the patient and submitted to histologic examination. This manoeuvre is employed where the diagnosis is in doubt, where the necessity of an extensive operation is being debated or where the method of treatment is in doubt. Some subvarieties of any one specific tumour may best be treated by operation, others by radiation or by a combination of both methods. Biopsy will usually provide the answer. While it constitutes the mainstay of accurate diagnosis it must be admitted that in some instances, notably in the case of near-malignant tumours, it may fail to clarify the diagnosis.

Occasionally adjuvant methods of diagnosis are employed. While there is no constant biochemical criterion by which tumours can be diagnosed, some of them, particularly of the adenoma group, will at times produce substances that alter the chemical and physical processes of the body in such a manner that the presence of a tumour may be inferred indirectly. By the study of these secondary effects alone the diagnosis may be established with certainty and an operation initiated for the purpose of searching for and removing the offending tumour, for example, an adenoma of the pancreas or the parathyroid gland.

The early diagnosis of tumours depends primarily on the patient who harbours one. Once having cause to suspect an abnormality he should pursue the matter of investigation as soon as possible. As mentioned above, some normally benign tumours tend to become malignant but this feature obtains only in cases where the tumour has been present for a long time. It is therefore obvious that early diagnosis is an essential factor in successful treatment.

Tumour Research.—The appalling loss of life caused by malignant tumours alone spurred world-wide efforts to unravel the mysteries of tumours. All aspects of the problem received meticulous investigation: the causation of tumours, their method of spread, factors which influence their growth and methods designed to eradicate them. The various fields of research include histology, biochemistry, physical chemistry, tissue culture, bacteriology, radiology, animal experimentation, surgery, clinical research, vital statistics and public health surveys. While notable advances were being made by mid-20th century, a satisfactory understanding of the problem was still lacking. It was not clear as to where the answer might be. The discovery of the cause, *e.g.*, might not yield the answer to the treatment, and vice versa.

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TUMULUS, an artificial mound of earth or stone, usually conical in shape, erected either as a memorial, or over the grave of a royal personage, noble or hero, or the relic of a saint. Funerary tumuli are sometimes known as barrows (q.v.).

TUNA, any of several fishes of the mackerel family, belonging to the subfamily Thunninae. They are typically large fishes,

of very robust body form, with a keel on each side of the caudal peduncle and with the pterotic bone excluded from the brain chamber by a deep pit or infolding behind the pro-otic bone. They are remarkable for maintaining their body temperature above that of the surrounding water and for having a peculiar vascular system, which is characterized by a large plexus along each side of the body. Most tunas inhabit warm seas, and many of them are circumtropical. They are believed to migrate extensively. Little is known about their biology. In the Atlantic ocean tunas spawn in the region of the Mediterranean.

They are among the most valuable food fishes in the world. Japanese fishermen, operating extensively through the western Pacific ocean, have caught about 460,000,000 lb. a year. California fishermen, voyaging as far as Ecuador, land an annual catch averaging around 158,000,000 lb, most of which is canned. Mediterranean fishermen contribute less than 10% of the world's total production of tunas. All the tunas are excellent game fishes. The best-known types are bluefin, or tunny (*Thunnus*), the albacore (*Germo*), the yellowfin (*Neothunnus*) and the skipjack, or striped tuna (*Katsuwonus*). (*See* also TUNNY.) (L. A. WD.)

TUNBRIDGE WELLS (ROYAL), a municipal borough and inland watering place of England, in the Tonbridge parliamentary division of Kent, 32 mi. S.S.E. of London by the S. railway. Pop. (1938) 32,620. Area, 9.4 sq.mi. It owes its popularity to its chalybeate spring and its beautiful situation in a hilly wooded district. The wells are situated by the Parade (or Pantiles), a walk associated with fashion since the wells were discovered. It was paved with pantiles in the reign of Queen Anne. A new assembly hall was opened in 1939. The town is built in a picturesquely irregular manner, and a large part of it consists of districts called "parks" occupied by villas and mansions. On Rusthall common about a mile from the town is the curiously shaped mass of sandstone known as the Toad Rock, and a mile and a half southwest is the striking group called the High Rocks. Five miles southeast is Bayham abbey, founded in 1200, where ruins of a church, a gateway and dependent buildings adjoin the modern Tudor mansion. The vicinity of Tunbridge Wells is largely residential. To the north lies the urban district of Southborough (pop 1938, 7,705). The industry known as Tunbridge Wells ware continued during 300 years, but the factory has closed and the small existing supply comes from the spare-time work of old hands. The ware includes tables, boxes, toys, etc., made of hard woods, such as beech, sycamore, holly and cherry, and inlaid with mosaic. Tunbridge Wells was incorporated in 1889. It owes its rise to the discovery of the medicinal springs by Dudley, Lord North, in 1606. Henrietta Maria, wife of Charles I, retired to drink the waters at Tunbridge Wells after the birth of her eldest son Charles. After the Restoration it was visited by Charles II and Catherine of Braganza. It was a favourite residence of the princess Anne before her accession to the throne, and from that time became one of the chief resorts of London society. In this respect it reached its height in the second half of the 18th century, and is associated with Colley Cibber, Samuel Johnson, Richard Cumberland the dramatist, David Garrick, Samuel Richardson, Sir Joshua Reynolds, Beau Nash and Mrs. Thrale (Hester Piozzi). The Tunbridge Wells of that period is sketched in Thackeray's *Virginians*.

TUNDRA, the cold, desert, treeless plains which form the Arctic lowlands of Europe and Asia. The name is also generally applied to a similar area in North America. The word is of Russian origin and means a marshy plain. The prevailing low temperatures are consequent on high latitude and proximity to the frozen northern ocean and result in very scanty vegetation.

TUNGABHADRA, a river of southern India, the chief tributary of the Kistna. It is formed by the junction of two streams, the Tunga and the Bhadra, which both rise in Mysore in the western Ghats. The united river for nearly all its course forms the boundary between Madras and the dominions of the nizam of Hyderabad. On its right bank stood the capital of the ancient Hindu dynasty of Vijayanagar, now a wilderness of ruins.

TUNG-CHOW, a city in the province of Hopei, China, on the banks of the Peiho, 12 mi. E. of Peiping. Its population is estimated at about 50,000. It is at the highest point of navigation of the Peiho, and is the port of Peiping. It is an old settlement known to the founder of the Han dynasty (206 B.C.) as Lu-Hien; under the T'ang dynasty (A.D. 618) its name was changed to Hüan-Chow, and at the beginning of the 12th century, with the advent of the Kin dynasty, Hüan-Chow became Tung-chow. Tung-chow, which was connected by light railway with Peiping, was headquarters of the puppet East Hopei Autonomous regime created in 1935, and a scene of early fighting in 1937.

TUNGKWAN, a Chinese fortress near the junction of Wei-ho and Hwang-ho. The way down the valley is hemmed in by great loess walls, sometimes on one side of the valley, sometimes, as at Tungkwan, on both. The Lunghai railway passes through Tungkwan, which was, from 1938 on, a key Chinese defense position against Japanese attacks from Shansi and Honan.

TUNG OIL. Two varieties are known, differng slightly in their physical properties, termed Chinese tung oil (China wood oil) and Japanese tung oil according to the country of origin. In China the oil is prepared from the seeds of *Aleurites cordata;* these are roasted in flat dishes over a fire, then coarsely powdered and expressed in primitive wooden presses. The kernels which contain up to 53% of oil yield in practice about 40%. The pale-yellow oil for exportation, known as "white tung oil" is obtained by expressing the seeds in the cold; the hot-pressed oil—"black tung oil"—is dark brown in colour and possesses a strong, unpleasant odour. Chinese tung oil has the highest specific gravity (0.940 to 0.944) of all known fatty oils, with the exception of castor oil, and the highest refractive index. The characteristic property of Chinese tung oil is the readiness with which it becomes polymerized, setting to a hard jelly on being heated for a short time to a temperature of 250° C. Polymerization is also induced by dropping saturated solution of iodine on to the surface of the oil, which immediately solidifies. The pronounced drying properties of tung oil render it suitable for use in the manufacture of paints and varnishes. In China it is further used for waterproofing paper. Tung-oil trees have been successfully introduced in the United States in the north-central part of Florida where more than 1,500 acres are planted. Up to 1939 all available seed was being used for planting. More than 100,000,000 pounds of the oil are imported annually and it is hoped that eventually the domestic supply will meet American needs. (*See* also OILS, FATS AND WAXES; and M. Toch, *Chemistry and Technology of Paints*, 1926.) (P. R. E. L.; G. H. W.)

TUNGSTEN. The name tungsten means "heavy stone" (Sw. *tung*, heavy, *sten*, stone), and directs attention to the high specific gravity of the element and its ores. (Symbol W, atomic number 74, atomic weight 184.0.) Up to the middle of the 18th century the mineral then known as tungsten, but now called scheelite, together with wolfram, were both considered to be ores of tin. In 1781, K. W. Scheele showed that this mineral contained a peculiar acid, which he named tungstic acid, combined with lime as a base, and in the same year T. O. Bergman advanced the opinion that the new acid was a metallic calx. Two years later the Spanish chemists, the brothers d'Elhuyar, proved that this acid was present in wolfram, and by heating the acid with carbon produced metallic tungsten for the first time.

Tungsten occurs in nature in the form of tungstates of iron, manganese and calcium, which may be divided according to their crystalline form into two groups. The iron and manganese tungstates, crystallizing in the monoclinic system, form the wolfram group, while calcium tungstate or scheelite belongs to the tetragonal system. Pure iron tungstate ($FeWO_4$) is known as ferberite and pure manganese tungstate ($MnWO_4$) as hübnerite. The mineral wolfram or wolframite is normally a mixture of these two compounds in varying proportions. Wolfram generally occurs in columnar, bladelike or massive forms, though sometimes it is found in well-formed prismatic or tabular crystals. It breaks up readily into thin flakes and its specific gravity ranges from 7.2–7.5. The colour may vary from nearly black to a brownish tinge characteristic of specimens rich in manganese. Scheelite or calcium tungstate ($CaWO_4$) may occur in the form of well-developed crystals which are usually double tetragonal pyramids, but frequently it is found in a massive form with four good cleavages.

The specific gravity is about six and the colour variable. It is generally gray, pale-yellow, or pale-brown, rarely green or reddish, with a waxy lustre. The world's principal supplies of tungsten ores have come from China, Burma, Japan, Australia, Bolivia and the United States.

Extraction and Manufacture.—The tungsten content of the ore as mined is usually 0·5 to 2.0%, so that a concentration process is necessary for extraction. The wolfram in the ore is associated with quartz and other gangue material, but it can be readily separated from these impurities owing to its high density. To remove cassiterite (SnO_2) which is present in a large proportion of wolframite ores, magnetic methods are employed. Wolfram, containing iron, is fairly magnetic, while cassiterite is not attracted as a rule even by powerful magnets. With scheelite, fortunately, the association of cassiterite is not common, otherwise (since scheelite is non-magnetic) chemical processes would have to be employed to effect the separation.

Many methods are available for the extraction of tungsten from its ores but the general principles involved in the extraction from wolfram may be illustrated by a brief summary of the sodium carbonate fusion process. The concentrate, after removal of cassiterite and other deleterious impurities, is mixed with excess of sodium carbonate and heated in a reverberatory furnace to about 1,000° C. in an oxidizing atmosphere. Thereby sodium tungstate is produced, and the iron and manganese present are converted to oxides:

$$4FeWO_4 + O_2 + 4Na_2CO_3 = 4Na_2WO_4 + 2Fe_2O_3 + 4CO_2$$
$$6MnWO_4 + O_2 + 6Na_2CO_3 = 6Na_2WO_4 + 2Mn_3O_4 + 6CO_2.$$

The soluble sodium tungstate is extracted with boiling water and on treatment with boiling hydrochloric acid an amorphous yellow precipitate of tungstic acid (H_2WO_4) is obtained which yields WO_3 on calcination. In the preparation from scheelite the finely ground ore is decomposed with hydrochloric acid, whereby calcium chloride passes into solution, and tungstic acid, together with insoluble impurities like silica, remains as a sludge.

$$CaWO_4 + 2HCl = CaCl_2 + H_2WO_4.$$

To purify the tungstic acid produced in these processes, it may be dissolved in ammonia and crystallized out as ammonium paratungstate, $5(NH_4)_2O.12WO_3.nH_2O$. This is decomposed by hydrochloric acid to yield purified tungstic acid, or ignited in air to tungstic oxide (WO_3).

Freedom from impurities and a suitable physical condition are absolutely necessary if tungsten is to be used for incandescent lamps or for wireless work. In this case, the method universally adopted for the preparation of the metal is reduction of the oxide by hydrogen, whereby the tungsten is obtained as a powder. For alloying purposes, however, where greater latitude is allowed in the amount of impurity and where the physical condition of the metal is of minor importance, the oxide is reduced by carbon and the resulting powder used for tungsten steels and other alloys.

The high melting point of tungsten precludes its industrial manufacture in the cast state from the powdered metal, and even if this were possible the product would be of little value as it would be both brittle and difficult to work mechanically. From the researches of W. D. Coolidge, who took out his first patent in 1906, a process has been developed which is capable of producing a fine tungsten wire that can be manipulated with little more difficulty than any other fine wire. In this process the powder is compressed in a hydraulic press into bars which are then heated to a high temperature in a furnace in an atmosphere of hydrogen, whereby a strong but brittle product results. This is now converted into rods by a mechanical hammering process in which the metal previously heated to 1,500° C. in an electric furnace in a hydrogen atmosphere, is subjected to 10,000 blows per minute in a special swaging machine. Further reduction of the diameter of the wire—usually from 1 mm.—is effected by drawing through dies. Tungsten wire can be drawn to 0.011 mm. diameter, while by immersion for 45 seconds in a fused mixture of sodium nitrate and nitrite at 340° C. a wire of diameter 0.014 mm. is uniformly reduced to 0.007 mm.

Physical and Chemical Properties.—Tungsten in the form of wire or sheet is dull white. The physical properties alter with changes in the structure of the metal, so that values for density, tensile strength, specific electrical resistance, etc., vary with the stage of swaging or drawing. The theoretical value for the density of pure tungsten, calculated from the atomic spacings, is 19·32. The probable melting point is 3,382° C., although the value 3,267°±30° C. is also quoted. Tungsten has the highest melting point of the metals. X-ray analysis shows that tungsten has a body-centred cubic lattice, the length of the cube edge being 3.155±0.001 Å. For further physical data, *see* C. J. Smithells, *Tungsten* (1926). Tungsten undergoes no appreciable oxidation on heating in air below red heat nor does it react with nitrogen, except when in the state of vapour. It is very resistant to the action of acids, neither *aqua regia* nor hydrofluoric acid attacking it to any appreciable extent. The best solvent for the fused metal is a mixture of concentrated nitric and hydrofluoric acids. Aqueous alkalis are without action but fused alkalis dissolve the metal.

Tungsten in its compounds exhibits valencies of 3, 4, 5 and 6, while, in addition, compounds of the empirical formula WR_2 (where R = Cl, Br or I) are known. In the case of chloride, however, the molecular formula is W_2Cl_6. The trioxide WO_3 is a bright canary-yellow powder which becomes dark orange when heated and fuses between 1,300°–1,400° C. It is insoluble in most acids including *aqua regia* but hydrofluoric acid dissolves it. With aqueous alkali hydroxides or carbonates it forms tungstates containing varying proportions of WO_3 to metallic oxide. A hexachloride and hexafluoride are known. The compounds $[WO_2Cl_2]$, $K_2[WOCl_5]$, $K_4[W(CN)_8]$ exhibit tungsten with co-ordination numbers of 4, 6 and 8.

Applications.—Tungsten finds wide application as a filament in electric lamps, and as it has a hardening effect on other metals with which it is alloyed it is a constituent of some of the most important industrial alloys. Tungsten steels are employed in the manufacture of cutting tools and permanent magnets. The stellite alloys containing cobalt, chromium and tungsten are extremely hard and are used for cutting tools and surgical instruments, as they are not affected by organic acids and ordinary antiseptics. Other uses of the metal include X-ray targets, thermionic devices, galvanometer suspensions, electrical contacts, refractory crucibles, etc. (W. Wa.)

TUNGSTEN STEEL. The earliest alloy of this type is Mushet steel (*q.v.*). It contains from 5.5 to 9.0% of tungsten and also carries enough manganese to give it air-hardening properties and to class it as a quaternary alloy. This article considers principally commercial ternary alloys of tungsten. High carbon steels containing tungsten up to 6% are essentially water-hardening steels. (*See* IRON AND STEEL: *Metallography and Heat Treatment;* METALLOGRAPHY.) The atoms of tungsten, being so much larger and heavier than those of iron, diffuse comparatively slowly in solid metal, so that a high temperature is required for solution before the quench. Accumulation of carbide particles upon tempering is also slow, hence the ability of tungsten steels to hold their hardness at high temperatures. Tungsten carbide also has a very high intrinsic hardness, approaching that of the diamond. For keen-edged tools tungsten in the alloy seems to prevent small particles from being torn away during use, and thus retards dulling.

Steel containing 0.9% carbon or more together with 1% to 2% tungsten is used for hack saw blades and for reamers, broaches and other tools which must show a minimum change in dimension after heat treatment. Steels with 1% carbon or more, and 3% to 7% tungsten, are much used for "fast-finishing" tools to cut hard metals or to make a fine smooth cut on softer tough metal. Dies for cold drawing wire and other shapes are made of higher carbon steels (2%) with tungsten ranging from 1% to 12%. Dies with the higher tungsten percentages are used for the harder metals or the finer wires. Chromium is often added to facilitate the diffusion of tungsten. When 0.5% or more is present the alloy may crack during water hardening. An oil quench, however, will harden it through to the centre. Chromium also causes the useful hardness to be retained at higher working temperatures. For working hot metal, tools would be made of 0.3% carbon steel with 10% tungsten and 3½% chromium (known as "semi-high-speed"). Permanent magnets for electric meters, magnetos, radio and telephone equipment absorb annually several thousand tons of steel containing 0.7% carbon and 5% to 6% tungsten.

In tungsten-iron alloys, substantially free from carbon, tungsten has the property of lowering the temperature at which delta iron changes to gamma iron and also of raising the temperature at which gamma changes to alpha iron. Consequently, the American metallurgist W. P. Sykes was able to show that no gamma iron is formed in carbon-free alloys containing more than 7% tungsten. Such an alloy is permanently austenitic, and cannot be hardened or tempered by heat treatment. In the alloys containing more tungsten the compound Fe_3W_2 appears; its solubility decreases with the temperature, and it is precipitated throughout the metal at a slow rate. To harden such an alloy it is necessary to anneal or "age" it at a moderate temperature for several hours or days. Brinell hardness numbers indicate the extent of this action:

	Brinell
Carbon free iron	70
Carbon free solid solution alloy, 80% iron, 20% tungsten	160
Above after aging	330
Carbon free aged alloy, 78% iron, 22% molybdenum	530

Such aged alloys of iron and tungsten and of iron and molybdenum (tungsten and molybdenum being very similar chemically) form excellent wire drawing dies, and have given 10 to 40 times the service that can be had from best high speed steel before the edge needs re-dressing. (*See* IRON AND STEEL; HIGH SPEED STEEL.) (E. E. T.)

TUNGUSES, a widespread north Asiatic people. They are the *Tung-hu* of the Chinese, probably a corrupt form of *tonki* or *donki*, that is, "men" or "people." The Russian form *Tungus*, wrongly supposed to mean "lake people," appears to occur first in the Dutch writer Massa (1612); but the race has been known to the Russians ever since they reached the Yenisei. The Tungus domain stretches from long. 60° E. to the Pacific ocean and from the Arctic to the Chinese frontier. The Tunguses are known to the Samoyedes by the name of *Aiya* or "younger brothers" The Oroches, Chapogir, Golds, Lamut, Manjour, Manegre and Oroke are partly in Manchuria and are Tungusic. The Tungus type is essentially Mongolic, with broad flat features, small nose, wide mouth, thin lips, small black and somewhat oblique eyes, black lank hair, dark olive or bronze complexion, low stature, averaging not more than 5 ft. 4 in. The square shape of the skull and the slim, wiry, well-proportioned figure are features especially of the typical Tunguses They are classed according to their various pursuits, as Reindeer, Horse, Dog, or Sedentary, Nomadic and Wandering Tunguses. A few have become settled agriculturists; but the great bulk of the race are still essentially forest hunters, using the reindeer both as mounts and as pack animals. Nearly all lead nomad lives in pursuit of fur-bearing animals, whose skins they barter in exchange for provisions, clothing and other necessaries of life. The national costume shows in its ornamentation and general style Japanese influence, due to intercourse at some period previous to the spread of the race to Siberia. Many of the Tungus tribes are reckoned as "Greek Christians"; but most of them are still Shamanists and nature worshippers, secretly keeping the teeth and claws of wild animals as idols or amulets, and observing Christian rites only under compulsion. Family and exogamic clan organization is relatively strong. Intercourse begins before marriage as soon as a portion of the bride price has been paid. Some practise polygamy. Exchange marriages occur. The levirate is common. A man may take his son's widow. Cousin marriage occurs and tree burial (*q.v.*) is found among them.

See M. Czaplicka, *Aboriginal Siberia* (1914).

TUNICATA. Tunicates are exclusively marine animals, related to vertebrates and therefore sharing with man a common but primevally ancient lineage. They are common, cosmopolitan, frequently seen but rarely noticed since for the most part they are fixed growing organisms resembling more a potato than a fish. Yet, at some time in the career of each individual it is provided with the forerunner of a backbone, a uniquely dorsal tubular spinal cord found nowhere among invertebrate animals, and similarly distinctive gills. Of these features, equally typical of the early human embryo, only the last usually survives into the adult animal, and mature tunicate animals in general are permanently attached forms with no capacity for locomotion, using an enlarged and elaborate gill system as a means of filtering large volumes of sea water for the sake of its contained microscopic life. As the name implies, a tunic is secreted by the skin which not only helps to anchor the animal to some solid structure but gives rigidity to its outer form, and allows the delicate inner organism to suck in and filter sea water to its heart's content. Many tunicates are solitary individuals growing to the size of an orange, but like most kinds of animals that have given up freedom of movement for a sedentary life, many have become colonial forms in which the individual becomes subordinated to an organic community.

Tunicates virtually are universally distributed throughout the seas of the world, from the intertidal zones down to the deep abyss, and inasmuch as certain types have given up a fixed existence for a drifting, floating life, the vast expanses of the open ocean are also inhabited by these forms. The more primitive group, associated with the sea bottom, is known as the ascidians, or sea squirts, and may be found along or near the shore of all the seven seas, growing on seaweeds, on or under rocks, in submerged sand flats, on coral reefs, submarine cables, ship bottoms, wharfpiles, and even on the shells of elderly lobsters and sea snails. They abound from polar regions to the tropics. Some species are cosmopolitan, found from Spitsbergen to Cape Cod, Naples to Singapore, others so limited as to be known only from grottos on a Brittany beach, or the Kerguelen Islands of the southern Indian ocean.

The group has many peculiar and fascinating features. Alone among animals it secretes its coat of *tunicin*, a substance almost identical with the ever-present cellulose of the plant kingdom. It has a heart similar to that of a chick embryo a few days after the onset of incubation, but unlike the chick heart the tunicate's reverses the direction of its beat periodically. Its blood is unique. While the blood has no respiratory pigment and can carry no more oxygen than a similar amount of sea water, it is frequently rich in both sulphuric acid and the rare element *vanadium*, substances more associated with the production of steel than body fluids. Not only are individuals hermaphrodite, that is, possess both ovaries and testes, but in many cases the same final organism can be produced either by a fertilized egg or by the growth and reconstruction of a fragment of adult tissue. Lastly, as the name of one genus, *Pyrosoma* or firebody, implies, some are brightly luminous at night, *Pyrosoma* appearing as a glowing candle-shaped body drifting through the surface waters of warm oceans.

The great French anatomist, Georges Leopold Cuvier, at the beginning of the 19th century placed ascidians with his "headless molluscs" the bivalves, and the class was named and defined by the evolutionist Jean Baptiste Lamarck in 1816, although the chordate nature and therefore the relationship with vertebrate animals was not recognized until many years later. Only after Charles Darwin's great theses on evolution had been published and become widely known, was it discovered that the sedentary sea squirts produced eggs that developed not directly into miniature sea squirts, but into tiny tadpoles of the same basic organization as the tadpole of the frog.

Life Cycle.—Ascidians are hermaphrodite animals, each individual producing both eggs and sperm, in many cases being able to fertilize their own eggs, in others unable to do so and cross-fertilization is obligatory. Most solitary ascidians produce small eggs in large numbers, each being surrounded by buoyant follicle cells which enable it to float away in the currents while development proceeds. The early developmental patterns, while on a small scale and also condensed in time, resemble closely those of primitive vertebrates and are unlike those of any invertebrate animals. This development leads directly to the formation of a minute swimming tadpole. In the case of these widely disseminated eggs the tadpoles are quickly formed—long before they are capable of feeding. They are equipped for swimming to the sea surface, at least for a few critical hours. Each possesses a tail for swimming consisting of a central supporting rod of cells, the notochord, which all vertebrates, including man, possess at some stage in their individual development as the immediate precursor of a vertebral column. In the case of ascidians, however, the development stops there. On either side of the notochord is a band of muscle fibres equivalent to the locomotory muscles of a fish, while a narrow tubular spinal cord overlies the notochord throughout its length. These features and their combined organization are distinctive of all vertebrate and chordate animals and definitely link ascidians and other tunicates with the main evolutionary line leading eventually to man himself, in spite of the obscure and bizarre appearance of the adult forms.

In the tadpole, the nerve tube expands in front as a small brain vesicle typically containing two sense organs. These enable the tadpole to orientate and swim towards the source of light, the sea surface, and away from the centre of gravity, away from the sea bottom. They represent an eye and an organ of balance in their simplest form.

The existence of such a tadpole ensures a wide dispersion of the species, compensating for the immobility of the adult. This purpose is served, however, after a few hours, and then degenera-

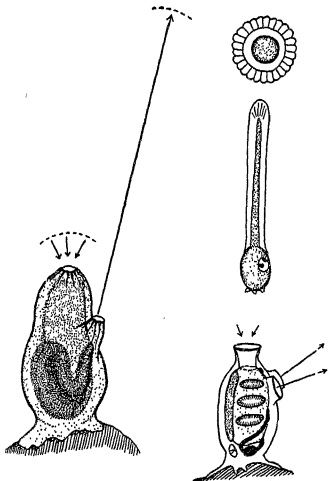


FIG. 1.—THE LIFE HISTORY OF AN ASCIDIAN

At the left an adult solitary ascidian of the genus *Ascidia* attached to a rock. The gill chamber and looped intestine show through the transluscent protective tunic. The solid arrows indicate the direction and extent of the ingoing and outgoing water currents. At the right is the egg with its outer layer of buoyant flotation cells, the tadpole that develops from it with swimming tail, orienting sensory apparatus, and three adhesive papillae; and, beneath, the organism following the metamorphosis of the tadpole, namely, a young ascidian with three pairs of gill slits, intestinal loop and heart below, and brain lying between the siphons

tive changes commence in the tadpole organization. It sinks toward the sea bottom, the tail becomes immobile, and the tadpole becomes attached by three adhesive structures on its nose to any solid structure sufficiently clear of soft mud. With the tadpole anchored, the tail absorbing somewhat as in the case of the frog, development continues through this period of metamorphosis to form the first stage capable of feeding. This consists of a small barrel-shaped animal attached by what was originally its chin region, with a large funnel-like mouth facing upwards and allowing water to flow into a capacious pharynx or throat. This bears gill slits on each side through which the water passes into a surrounding chamber opening externally by another funnel. These funnels are called siphons, inhalent siphon and exhalent siphon respectively, and are characteristic of tunicates in general.

In essentials the adult ascidian differs from the newly attached feeding individual in little more than increased size and the acquisition of sex glands. The existence of two such different types of organism as the ascidian tadpole and the ascidian adult has afforded the basis of much argument. Either the tadpole is a relic of a more aristocratic chordate ancestry and the adult represents a degenerate sacrifice of motility, or the attached adult is the more primitive type and the tadpole the newcomer. The first of these interpretations was the first to be adopted and is the orthodox view, the other is more recent and in many ways more plausible, but its implications concerning the origin of vertebrates are startling.

The typical ascidian is essentially a large sac corresponding to the throat region of a fish, into which leads the large inhalent siphon or mouth opening. The water taken in is strained through innumerable gill slits on each side of the sac, escaping into an external chamber leading to the exterior by way of the exhalent or atrial siphon. The remainder of the digestive canal is narrow and leads from the lower end of the gill chamber. It consists of an oesophagus, a simple stomach, and an intestine looped up to open close to the outlet of the exhalent siphon. In its loop the hermaphrodite sex gland is usually to be found. Close to the loop is a simple heart. A solid nerve mass, or "brain" lies between the two siphons, with nerves extending to each.

The reactions of the animal are practically limited to a swift closing of the siphons. At the base of the inhalent siphon a ring of tentacles prevents the passage of any particles too big to be managed, contact with the grid of tentacles producing the contraction reflex, and such a particle is rejected. Otherwise reactions are limited to mild responses to light stimulation.

Feeding Mechanism and Other Systems.—The mechanism for obtaining food is remarkable, both for its elaborate efficiency and for its ultimate evolutionary fate. The feeding mechanism consists essentially of two components, the production of mucus for the entanglement of food particles, and the production of a water current bringing in those particles. The water current streaming in through the inhalent siphon is produced by the outward-beating cilia (protoplasmic hairs) lining the numerous gill slits in the wall of the pharynx. On passing through these minute slits the water converges in the surrounding atrial cavity toward the exhalent siphon. It shoots out through this opening to a considerable distance, so that the water exhaled is not drawn in again

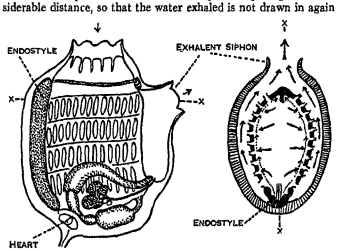


FIG. 2.—STRUCTURE AND FEEDING MECHANISM OF AN ASCIDIAN (GENUS PEROPHORA)

Solid arrows show direction of water currents, dotted arrows the direction of mucus transfer. Diagram at right represents a horizontal section at the level x——x of the individual shown at the left. Water flows in through the mouth past tentacles into the gill chamber and flows out through four rows of gill slits in each wall into the surrounding protective outer chamber, finally to the exterior by the exhalent siphon. Food particles are trapped by mucus, secreted by a deeply-grooved band (the endostyle, the forerunner of the thyroid gland of man), which passes up the inner walls of the gill chamber. The particles are passed into and digested by the looped intestine lying at the base of the gill sac. The combined reproductive gland, ovary and testes, lies within the loop formed by the intestine

through the mouth. The water entering the gill chamber contains small living plant and animal organisms suitable for food. These are trapped by the endostylar mechanism. The mechanism consists of a mid-ventral groove, the endostyle, extending the whole length of the gill chamber, and a band of similar tissue extending around the anterior end immediately behind the anterior ring of tentacles. The groove and band consist of glandular tissue secreting mucus or slime in strands into the main cavity. Food particles encountering the strands are entangled and the cords of slime and organisms are wafted toward the upper side of the chamber. Along the mid-dorsal line the cords are rolled into a single cord with the aid of the dorsal membrane, and the cord passes back to the

oesophagus. Passing through the oesophagus the cord reaches the stomach, is mixed with digestive enzymes and travels slowly through the looped intestine until the indigestible remnant emerges near the base of the exhalent siphon. Here the strong outgoing current carries away the faecal matter to a safe distance.

The food collecting apparatus as just described may become more elaborate in some, simplified in other forms of tunicates, but basically the system is the same in all. The same system is well developed in another chordate, *Amphioxus*, and even more significantly in the young of the lamprey, a true vertebrate. The adult lamprey, however, feeds in an entirely different manner and the greater part of the endostylar apparatus degenerates when the lamprey is about 6 in. long, except for the middle region of the endostylar groove itself, which emerges as the thyroid gland, the metabolic governor of all later vertebrates.

The blood and its circulation is of interest for several reasons. The pattern of blood vessels foreshadows that of the fishes. A large vessel passes from the heart forward beneath the endostyle, lateral vessels leave this and pass up the sides of the gill chamber to meet above in another longitudinal vessel. The heart itself is a tube folded lengthways within itself and has the unique property of periodically reversing the direction of its beat. After waves of contraction pass along it in one direction about 50 or 60 times, it slows to a stop and a new set of contractions begins, starting from the opposite end. The reversal is independent of any external nervous control. The blood is free to circulate in either direction owing to the absence of any valves limiting direction as they do in all vertebrates.

The blood itself is also peculiar. It transports no more oxygen than an equivalent amount of pure sea water and contains even less carbon dioxide. No respiratory pigment is present or necessary owing to the relatively enormous surfaces exposed to flowing water. At the same time pigmented cells are usually present in the circulating fluid and contain oxides of vanadium and free sulphuric acid. In certain solitary ascidians vanadium oxides may amount to as much as 15% dry weight of the blood, in spite of the fact that vanadium can barely be detected in sea water even by the most modern methods. How it is extracted by the animal and what part it plays in the activities of the organism are unknown. The sulphuric acid is also puzzling. Its presence is apparently associated—and probably its function as well—with that of vanadium. Apart from this it is difficult to understand how cells can tolerate within themselves a strong acid in a concentration sufficient to kill animal tissues in general.

Excretion of waste materials, especially the breakdown products of protoplasm itself, is managed in strange ways. Urates are deposited as solid concretions in sacs isolated within the body either single and large, or small and numerous, as permanent depositories. Other waste substances are eliminated at the external surface of the tunic. The tunic itself consists of tunicin, a substance closely allied with cellulose and secreted by cells characteristic of the middle body layer that have actually migrated through the outer skin to form a connective tissue in a most unusual place.

A tunicate could not be itself if it were not ambiguous. To complete the picture, there is a duct which passes from a glandular mass situated beneath the brain and opens by a ciliated funnel at the front and dorsal corner of the gill chamber. The structure of this apparatus and the nature of the cellular material passed down the duct to mix with the incoming water current indicate clearly that it is the homologue of the pituitary gland of vertebrates, the master gland of the body governing the endocrine glandular system as a whole. What the function is in the tunicates nobody knows.

Reproduction.—Tunicates have evolved in various directions not only as mature adult organisms but also in two other ways. The tadpole larvae vary remarkably in detail, while the faculty of reproducing nonsexually by the production of buds of various kinds has been evolved in some forms to a remarkable extent. The more elaborate types of tadpoles are relatively large with a relatively complex nervous system, beating heart and complex gill chamber almost ready for active life. In spite of such complexity, however, these tadpoles may have a free-swimming life of only a few minutes, being designed primarily for the selection of limited and specialized habitats upon which to settle, in the immediate neighbourhood of their parents. They are also associated with viviparous forms, that is, the eggs are retained in the atrial chamber or in some special brood pouch and develop there safely at least until the tadpole stage is reached. Wide dispersion of the species by the usual means of oceanic currents is sacrificed to a maintenance of the population in local territory together with the selection of a specialized niche. The brevity of free-swimming existence not only limits the extent of distribution but greatly reduces the chances of any particular tadpole being eaten. In other words a relatively small number of large eggs are given a high degree of protection in several ways that ensure their survival to a comparatively advanced stage. This is in contrast to disseminating large numbers of small eggs to develop unprotected over a protracted period in the currents of the sea.

Viviparity, generally speaking, is usually associated with types able to reproduce also by budding. The plantlike method of reproduction, asexual reproduction or gemmation, is characteristic of many ascidians and has apparently arisen within the sea squirts on at least three separate occasions. It is a reproductive method very usual among nonmotile animals. If the tunicates as a whole are included, a fourth case of independently evolved budding should be added.

Budding is essentially a separating off, either physically or physiologically of a fragment of a mature or of a developing individual itself. The processes involved are essentially those involved in the regeneration of missing parts, a capacity tunicates have to a very marked degree. The nature of budding varies considerably among the different orders of tunicates, but in virtually every case it is due to some form of constriction by the epidermis which divides the contained tissues into separate masses, the nature of the whole isolated mass depending on the nature and part of the particular tunicate involved. The process is usually associated with the presence of reserve food storing cells known as trophocytes. These are produced in large numbers especially in those forms that undergo a winter regression. The main growing

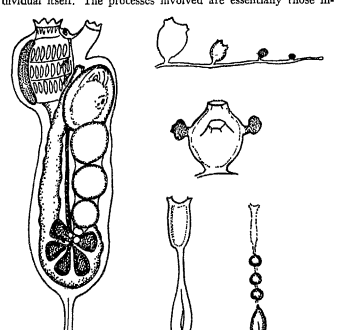


FIG. 3.—VIVIPARITY AND BUD FORMATION

Left: an individual (genus *Eudistoma*) with its intestinal loop extended posteriorly from the gill chamber shown with its ovary and testes still in the bend of the intestine, although the eggs are shown developing to the tadpole stage within the expanded oviduct. Upper right: buds are shown developing from a creeping stolon (*Perophora*), at the middle right buds develop from the lateral body wall of the parent (*Botryllus*), and at the lower right are two individuals (*Diazona*), one in functional form and one transformed into a string of living beads, each one of which is destined to form a new individual

season naturally coincides with the spring and summer when the microscopic food organisms are abundant in the sea. In the early winter the food supply dwindles and many ascidians degenerate In such as these the disintegrating tissues are absorbed by wandering reserve cells which subsequently migrate toward the base of the individual. There the epidermal constructions divide the congested contained mass of reserve tissue into small masses or buds capable of surviving the winter and developing into new individuals in the spring. This type of budding leads to the formation of the group known rather loosely as the social ascidians, where many individuals of a common egg parentage are closely clustered together and may even become imbedded in the same glutinous external tunic. In others the buds may remain partly attached to the parent and either in connection with their parents or with other individuals of their own bud generation develop community systems of blood vessels and exhalent siphons. These are true animal colonies in which the individuals are actually subordinated to the activity of the whole.

Tunicates can be large and solitary, or small and aggregate or colonial, that is, growth can be expressed in either of these two ways but not both ways at the same time. It is the small individuals of the social and colonial forms that have departed from the production of large numbers of widely disseminated small eggs, and have evolved to a high degree the practice of viviparity or bearing their young alive.

Viviparity in ascidians is apparently easily attained and there is no doubt that among them it has been acquired independently on many occasions. All openings of the body proper, namely gill slits, anus, oviduct and sperm duct, open not directly to the exterior but into the atrial cavity, reaching the outside finally by way of the exhalent siphon. In egg-laying forms the reproductive ducts together with the intestine reach almost to the base of the exhalent siphon, and the outgoing stream of water carries all the products immediately away from the body Accordingly all that is necessary for the retention of the eggs is a shortening of the oviduct so that they remain in the lower part of the atrial cavity, bathed by the water flowing through the gill slits. Increase in individual egg size ensures that under these circumstances the eggs will not be carried away by the water current, while the fact that the animals are hermaphrodite ensures fertilization and subsequent development of the retained eggs. When the tadpole stage is reached they swim away. This description applies to the majority of viviparous ascidians, but some are more specialized, such as *Distaplia*, and fertilized eggs are actually retained within the oviduct, which may bulge out from the side of the body as a distinct brood pouch While in *Botryllo*ides the egg is fertilized actually within the ovary, the tadpole escaping finally by bursting through the body wall

While in many cases the presence of budding is little more than a process of reproduction, that is, increasing the number of individuals in a local population, in others there is a considerable degree of organic continuity and co-operation so that a superorganism is formed and the individuals are subordinated to it The secretion of the external collagenous tunic plays an important part in this phenomena. The outer epidermis of different individuals remains distinct as in other forms of animal life, but the tunic secreted by adjacent individuals, if close enough together fuses into a compact whole Budding therefore is always likely to result in numerous individuals becoming imbedded in a common mass of tunic material. This is the basis for a true colonial system. Individuals arrange themselves into systems or groups with, for example, all exhalent siphons converging toward a common centre to unite in forming a cloacal chamber and outlet. This condition frequently occurs In a few types, as in *Botryllus* or *Symplegma*, buds remain in functional continuity with the circulatory system of the parents so that a colonial circulatory blood system is formed. Such a circulatory system within a mass of tunic survives though individuals associated with it may come and go as they each live through their individual cycles.

Selection of Habitat.—The form of solitary and colonial ascidians is closely adapted to the various types of possible habitats, or, to put it conversely the various special marine habitats are populated by ascidians that are able to survive in and exploit such niches

Solitary ascidians are generally relatively large as individuals, with all three spatial dimensions well represented. They need plenty of room They are to be found chiefly either attached to the surfaces of rocks, piles or ship bottoms, or imbedded in submerged sand or mud flats Attachment is made by the growing external coat of tunicin, with its contained vascular processes. In quiet, more or less protected waters, such as harbours, estuaries, or relatively deep water, attachment is usually by the posterior end with the siphons reaching out into the water, as for example, *Ciona intestinalis*, the most cosmopolitan example of them all. Where there is considerable wave action, attachment is usually by the whole of one side. Some species are of but one habit or the other and are consequently limited in their range, while others, of which *Ciona* is as good an example as any, vary their attachment according to circumstances and occur in a diversity of habitats. In two families of ascidians, however, species have forsaken an attached abode for the sifting sand, mud, or shell gravel of the sea floor of the continental shelf. These are molgulids and polycarps, and in order to maintain their anchorage in such an unstable environment, they are large, more or less spherical, and have innumerable hairlike extensions of the tunic to which sand grains or shell particles adhere, the whole being submerged in the sand except for the emergent siphons. Sand or shell particles adhere also to the siphons and the animals are in consequence perfectly camouflaged. At certain depths of the continental shelf and coastal inlets extensive beds of mud, sand, or shell gravel of suitable consistency occur and these large and more or less globular species of the genera *Polycarpa* and *Molgula* are found in enormous numbers. The sea bottom habitat and its great extent has apparently made it less desirable to send tadpoles wriggling to the surface of the sea, and in these genera the tadpoles have independently allowed their eye to degenerate, being responsive only to the force of gravity, while in many species of sand-living molgulae, not only the eye of the tadpole, but its gravitational organ, the otolith, and the tail itself are lost. The effect is that large numbers of developing eggs are scattered over the sea floor where there is abundant room.

Budding or compound ascidians on the other hand are conspicuously unable to survive in such places, and for the most part are attached to relatively flat surfaces over which a good but not violent supply of clean water is assured

Reproduction by budding, while leading to the formation of a colony unit rather than many separate individuals, has naturally an effect on the size of the individuals. An individual ascidian can either remain solitary and grow to a large size, or its growth is expressed in the formation of numerous individuals which repeat the budding process, thus increasing in number but hardly at all in individual size. If the process of budding is not too highly developed the individuals of a colony may be of a moderate size and number, and usually separate from though in contact with one another. These are often grouped together as the "social" ascidians to distinguish them from the "compound" forms that are more truly colonial. This grouping is not a natural one and brings together such distantly related types as *Clavelina* and *Stolonica*, genera which belong to different orders of ascidians The individuals being, however, of fair size need a corresponding amount of space, and in general this group is found attached to protected submerged rock ledges, to the anchoring processes of large laminarian seaweeds, or to the surface of corals and sea fans.

Where budding is more active, the individual size is reduced and the numbers increased, tending to create a virtually two-dimensional colony. Colonies such as these are often large in area though of little thickness, with relatively minute constituent individuals. Together with bryozoans and certain sponges they tend to form an encrusting film over the underside of rocks, coral crevasses, stalks and fronds of seaweeds, and solitary ascidians, for the most part in the highly diversified environment of coastal waters, lagoons, mangrove swamps, rocky shores, estuaries and the intertidal zone itself. As long as the water flows freely bringing life-sustaining oxygen and microscopic food organisms this

type of ascidian colony in general occupies a two-dimensional world of highly specialized niches In relation to this and to the small size of the composing individuals, such organisms produce a comparatively elaborate form of tadpole larvae. The small bulk of a colony and particularly of an individual results in a correspondingly reduced capacity to produce eggs When egg numbers are reduced below a critical value it becomes increasingly important to ensure the survival of an adequate number of those that can be produced If large numbers cannot be produced it is better to produce a very few with a great chance of surviving to maturity than a moderate number with little chance In any case the compound ascidians characteristically form a very small number of relatively large eggs that develop to the tadpole stage within the protection of the parental atrium or oviduct Once liberated the best chances of the tadpoles of survival is attachment to surfaces similar to that of the parent and therefore in the near neighbourhood. Again in any case the tadpoles are not only good swimmers because of their relatively large size, but are also better equipped with sensory and hold-fast mechanisms so that some selection of a particular type of abode is possible; limiting their range to local territory, the length of the free-swimming period is reduced from the more primitive duration of one or several days to a mere few minutes This form of adaptation has taken place in a number of unrelated families of ascidians independently, for example, *Botryllus, Perophora, Amaroucium. Clavelina* and *Didemnum*

Colonial ascidians in particular are frequently brightly coloured with yellow, brown, red, green, and even blue pigments, while in some the constituent individuals become grouped in small star-shaped systems. (*Botryllus*), ladderlike rows (*Botryllooides*) or rosettes (*Polyclinum*).

CLASSIFICATION

The ascidians are but one of three orders of tunicates, the remaining two being oceanic orders.

Ascidians have been classified in various ways, but primarily with regard to the position and nature of the reproductive glands, and according to the nature of the branchial or gill structure If the primitive type is considered to be relatively small with a moderately elaborate gill apparatus and an intestine looped beneath it and up one side toward the exhalent siphon, diversification within the order has been mainly in two directions The intestinal loop may remain in this position while the branchial region is elaborated, or the branchial region may remain simple, but the intestinal loop together with the heart and reproductive glands descend down the attachment stalk

Edmond Perrier divided the ascidians into Enterogona and Pleurogona, the Enterogona having the gonads or reproductive glands situated either within the intestinal loop or extending posteriorly from it, but in any case only a single unit of ovary and testis being present; the Pleurogona having gonads on each side of the body and extending into the outer wall of the atrial cavity. The division according to branchial structure was made by Fernando Lahille and later by Oswald Seeliger into three suborders, the Phlebobranchia with accessory longitudinal blood vessels internal to the branchial wall, the Haplobranchia without such vessels, the two suborders corresponding to the Enterogona; and the Stolidobranchia, corresponding to the Pleurogona, with internal longitudinal bars, in place of tubular vessels, the branchial wall usually being thrown into a series of folds.

The following is a synopsis of the group.

Class TUNICATA

Order I. ASCIDIACEA. Attached forms with dorsal exhalent siphon, branchial region (pharynx) with transverse rows of ciliated gill slits.

Section Enterogona Gonads on one side only, either within loop of intestine or projecting beyond it posteriorly.

Suborder 1. PHLEBOBRANCHIA (DICTYOBRANCHIA). With internal longitudinal tubular vessels Families: Cionidae, Perophoridae, Ascididae, Corellidae, Diazonidae.

Suborder 2. HAPLOBRANCHIA (KELKOBRANCHIA). No internal longitudinal vessels or bars. Intestinal loop always extends posteriorly into stalk Families: Clavelinidae, Polyclinidae, Didemnidae.

Section Pleurogona. Gonads usually paired, and in atrial wall.

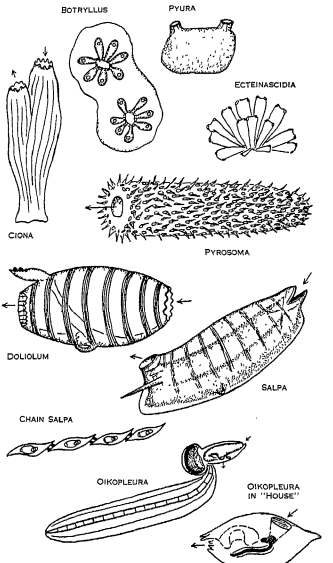


FIG 4.—TUNICATES

Examples representing the classes Ascidiacea (all attached forms—the solitary *Cionа* and *Pyura*, and compound *Botryllus* and *Ecteinascidia*), Thaliacea (floating oceanic forms—the colonial *Pyrosoma*, both solitary and chain forms of *Salpa*, and *Doliolum* with buds forming on its dorsal spur), and Copelata (permanent tadpolelike forms—*Oikopleura*, with and without its temporary feeding "house"). Arrows show direction of ingoing and outgoing water currents

Suborder 3. STOLIDOBRANCHIA (PTYCHOBRANCHIA). With internal longitudinal bars and wall of pharynx folded longitudinally to create greater filtration surface. Families: Pyuridae, Molgulidae, Styelidae, Botryllidae.

In addition to the order Ascidiacea, the tunicates comprise two others, the order Thaliacea and the order Copelata These are unattached forms inhabiting the oceanic currents, delicate transparent organisms not often seen but occurring in great numbers. The first of these is divided into three suborders, all members of which reproduce by budding to form colonies at some period of their life. The Copelata never bud and are permanently tadpole-like.

Order II. THALIACEA. Oceanic (pelagic), with inhalent and exhalent siphons at opposite ends of body; with long simple gill slits instead of rows of small gill slits.

Suborder 1. PYROSOMATA. Colonies form hollow floating tubes open at one end only, individuals being imbedded in the wall of the tube with their inhalent siphons extending from the outer surface and their exhalent siphons opening into the hollow interior of the colony. Eggs large, no tadpole larva being found Family: Pyrosomatidae

Suborder 2. DOLIOLIDA Primary individual nonsexual, reproducing by budding. Budded individuals become sexually mature. Recognizable

tadpole stage formed, but is temporary. Families. Doliolidae, Dolioplidae.

Suborder 3 SALPIDA. Primary individuals nonsexual, reproducing by budding Buds form a long chain, sometimes in form of wheel, and function before being liberated Eggs attached to parent and tadpole stage absent Families. Salpidae, Cyclosalpidae

Order III COPELATA Small oceanic forms with permanent tail, internal structures simplified, peculiar tunic house formed in relation to feeding mechanism. Families Appendiculariadae, Fritillariadae, Kowalevskiidae.

Both the Thaliacea and Copelata show adaptation to a pelagic existence in the upper layers of the ocean. *Pyrosoma* is the least modified and is essentially an unattached, floating colony, and is highly luminous It glides slowly through the water by means of the water currents passed by each constituent individual into the hollow interior of the colony. The accumulating water escapes through the open end of the tube and the colony moves slowly in the opposite direction by a weak form of jet propulsion.

The Salps and Doliolids have given up producing water currents through their interior by means of ciliary activity and have substituted muscle contraction Bands of muscle more or less encircle the body of an individual and their contractions force water through the barrel-shaped organism, thereby drawing the animal through the water

The Copelata on the other hand retain the tadpole tail as the organ of locomotion At times the action of the tail causes the animal to swim through the water, but most of the time there is present an external "house" of tunicin—secreted by the epidermis —which floats or drifts along, and the activity of the tail causes water to flow through it and from which microscopic food organisms can be filtered.

The relationship of the tunicates to chordate animals as a whole, and therefore to vertebrates and finally man, has been the subject of much speculation ever since the existence of a chordate tadpole was first discovered The first and Haeckelian interpretation was that the tadpole represented a relic of an ancient descent from an early vertebrate animal, the adult tunicate being in a sense highly degenerate, the tadpole being retained in the course of the development of the egg in conformation with the theory of recapitulation or biogenetic law. This view was universally held until the 1920s, and was relatively comfortable, for it accounted vaguely for the existence of the tunicates themselves as a by-product and at the same time threw no slanderous aspersions on the origin of the chordate-vertebrate group of animals as forms which from the beginning swam in the light of the sun near the ocean surface, never descending for an apprenticeship on the plebian sea floor. Such a habit was supposed to account for the uniquely dorsal position of the nerve cord in vertebrates in contrast to the ventrally placed cord of belly-crawling invertebrates

An alternative interpretation, however, appears to fit the facts better, a view first presented strongly and plausibly by Walter Garstang in 1928. This considers the attached ascidians to be of primitive habitat. Not present-day ascidians, but their ancestors of very ancient times, probably more than 1,000,000,000 years ago in the upper pre-Cambrian era, are thought to have been relatively small simple forms attached to the sea floor There they evolved a dorsal nerve mass for controlling the siphons: gill slits evolved for the escape of the food-bearing current, and a ventral heart to pump the blood Their eggs developed at first into simple larvae swimming by means of cilia like the larvae of most primitive marine groups From this originally simple larva the ascidian tadpole gradually evolved

No direct evidence can ever be obtained concerning the evolution of the tiny delicate organisms of pre-Cambrian times, but circumstantial evidence abounds and strongly supports this later theory concerning the origin of tunicates If valid, then not only are the thaliacean tunicates colonial forms that have abandoned a sessile for a pelagic life, but the Copelata, which at one time were thought to be the most primitive of tunicates, are considered to be descendants of the Thaliacea and in no way primitive forms.

If the tunicates were merely an isolated group of animals with no self-important relatives, the more plausible of two theories would be readily and more or less indifferently accepted. But somewhere near the level of tunicate organism are the remote beginnings of human evolution itself and the last theory directs the line of descent into and through the group instead of making a detour around into the great unknown In effect, the great group of vertebrate animals would have their origin in the enterprising young of a group of tiny water filterers cemented posteriorly to the sea floor

This is not implausible. Evolution does occur in relation to any stage in the life cycle of an animal, and larval types are known to have become the sexually mature adults. Tadpole-like larvae could have evolved from simpler larvae within the tunicate group, and such larvae could have suppressed their metamorphosis into an old-fashioned tunicate, and continued to grow into a sexually mature swimming chordate organism from which the vertebrates eventually evolved

It *could* have happened and such evidence as can be culled from living forms suggests that it did.

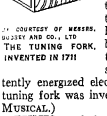
In other words, we can trace the dorsal position of our brain and spinal cord to the upward reaching siphons of a primitive attached tunicate, our heart and basic pattern of blood vessels to that of the same organism, our ear passage to a respiratory gill slit of an early shark and in turn to a water-escape passage of the sessile ascidian, our pituitary gland (the master gland of our endocrine system) to the subneural gland and hypophysial tube of the same form, while our tubular spinal cord and brain, our backbone and trunk muscles derive from the tail of the swimming larva the ascidian evolved and managed to make permanent.

Since the time primeval events such as these took place, the tunicates have had just as much time as all other surviving groups have had to become specialized in various ways, in their case to elaborate the gill-filtration system, budding and colony formation, etc , and there is no suggestion that in tunicates as they now exist we recognize our contemporary ancestors

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(N J. B.)

TUNING FORK, a two-pronged instrument of high-grade steel, which by the vibration of its prongs gives out a single pure musical tone of constant pitch. The pitch depends upon the natural period of vibration of the prongs, that is, upon their length and thickness.



COURTESY OF WESSEL, MILNEY AND CO., LTD
THE TUNING FORK, INVENTED IN 1711

Tuning forks may be made for all musical pitches in the audible range, and the fork which gives the A above middle C is usually taken as the musical standard. For laboratory purposes the forks may be mounted upon hollow boxes to increase the volume of sound by resonance. They may be set in momentary vibration by a light blow, or kept in constant vibration by the action of an intermittently energized electromagnet upon one of their prongs. The tuning fork was invented by John Shore in 1711. (*See* PITCH, MUSICAL.)

TUNIS, capital of Tunisia, in lat. 36° 48′ N. and long. 10° 12′ E., is on a mountainous isthmus separating the Sebkha Sedjumi from the Bahira, or Lake of Tunis, the west bank of which it occupies. The Bahira communicates with the sea 6 mi. E.N.E. of the town by a narrow, open channel. Tunis stands, as Carthage does, on the threshold of the western bay of the Mediterranean, at the natural outlet of the western bay of the Tunisian Tell and in easy communication with the south But its topographical situation differs profoundly from that of the ancient town: built at the end of a shallow lagoon, it has been obliged to make use of an intermediate town, Goletta (*q.v*) or La Goulette, for a part of its sea trade. While Carthage had an almost insular position,

Tunis was sheltered from the attacks of Christian fleets and has an almost continental site

Tunis consists of two towns side by side the old native town lies between the hills of Bir-Kassa and those of Ras-Tabia, on a slope down to the Bahira; the European town has developed on the flat, low-lying ground between old Tunis and the lake

European Tunis is built on a regular, somewhat monotonous plan, the blocks of houses are bordered by rectilinear avenues, some of which are planted with trees One avenue, nearly a mile long, laid out from east to west, bore successively the names of Avenue Jules-Ferry, Avenue de la Marine and Avenue de France. On this artery stand the residency, surrounded by gardens, the cathedral, the casino-theatre, the banks and the principal hotels and cafés It is cut at right angles by another avenue, called in its southern part Avenue de Carthage and in its northern part Avenue de Paris, which stretches for more than two miles From these two main avenues numerous streets branch off. The Avenue de France is the most animated street of Tunis and is the centre of the city's life.

The native town itself includes three distinct parts the Médina, or central city, which represents the primitive settlement, several gates of which are still standing; the suburb of Bab-Souika on the north, where the Jews live; and that of Bab-Djazira on the south The Djamâ Zitouna, or Mosque of the Olive Tree, is the seat of an important Moslem university, founded in 732 by the Omayyad governor Obeid-Allah and reconstructed by the Aghlabites (9th century), most of its buildings date from the 13th to the 15th centuries. Behind the Zitouna are the *souks*, which are the most interesting feature of the native town They are composed of little shops opening onto narrow, tortuous streets, covered by arches or roofs of planks, where only foot passengers can go. Each kind of trade, each group of craftsmen, has its special quarter. Tunis possesses many mosques, notably those of the Kasba (13th century) and Sidi-Mahrez (17th century). Christians may not enter them.

The port of Tunis, constituted in 1893 by the digging of a sea channel more than 6 mi. long and 7·5 m deep, comprises a central dock, a dock for ore and a dock for sailing ships. After World War II, during which much of the port was destroyed, a fairway and a 74-ac dock were opened at the outer harbour of La Goulette (10.5 m. deep), as well as two quays for hydrocarbons and phosphates. Tunis and La Goulette together form the major port of Tunisia, handling 2,000,000 metric tons a year (including 1,300,000 metric tons of exports, mainly wine, fruit, vegetables, oil, iron and phosphates) and providing also for passenger traffic and fisheries.

Tunis is the centre of a rich farming region. Its industrial products include beer, soft drinks and syrups, chocolate, canned vegetables and fruits, tobacco, leather, textiles and chemicals; the manufacture of carpets is an old-established craft. The industrial suburbs of Djebel Djelloud, Sidi Fatallah and Mégrine lie to the southeast

The urban population, 364,593 (1946 census), was estimated to be 380,000 in 1952, with the population of the suburbs added, the total amounted to 500,000, including 155,000 Europeans and 40,000 Jews. This represents a large proportion in a country of 3,500,000 inhabitants

Southeast of the city, along the valley of the Melain, are magnificent remains of the Roman aqueduct from Zaghouan to Carthage. Carthage itself is on the coast to the north, as also is another picturesque town, Sidi bou Said South of Tunis is the seaside resort of Hamman-lif.

Tunis existed in the Carthaginian epoch, but its importance dates only from the Moslem conquest. It became capital toward the end of the 9th century, under the Aghlabites, and reached its greatest prosperity in the Hafsid period, when it is said to have surpassed Cairo. Attacked in 1270 by Louis IX, who died under its walls, it was taken by Khair ed-Din Barbarossa in 1533. Charles V took possession of it in 1535; the Spanish were driven out in 1569, retook it in 1573, but ceded it to the Turks in 1574. Thereafter the history of Tunis merged with that of Tunisia (*q v*).

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TUNISIA, a French protectorate of North Africa, extending from lat 30° to 37° 20′ (Cap Blanc) N and from long 7° 35′ to 11° 40′ E It is bounded on the west by Algeria, on the north by the Mediterranean, on the east by the Syrtis (gulfs of Hammamet and of Gabès) and, from the sea to Ghadames, by Libya and on the south by the Southern Territories of Algeria. The total area is 48,329 sq mi, of which about 21,500 sq mi is Saharan territory beyond the Chott Djerid The country, halfway between the Straits of Gibraltar and the Suez canal, forms, with Sicily, the barrier between the eastern and western Mediterranean This situation and the possession of nearly 900 mi of coast line gives economic and political importance to Tunisia

Physical Features.—The mountains are formed of Secondary and early Tertiary rocks, while later Tertiary and Quaternary rocks cover the plains. The folds are Miocene in the main, as in the Atlas, but movement continued long after that period There are numerous short discontinuous chains of varying orientation and a number of small circular or elliptical domes

North of the concatenation of the Dorsal mountain ranges, which lies across the country from Tebessa to Cap Bon, the chains of the Tell tend from southwest to northeast Farther north rise the wooded sandstone mountains of Kroumirie (3,000 ft) and the Mogods, where the coast is broken and wild Next, standing round the alluvial plains of the middle and lower Medjerda and of Bizerta and Tunis itself, there are mountains and hills of chalk and marl used for pasturage or cultivation Relief is heightened in the High Tell, between Kef (Le Kef) and Téboursouk, and in the Dorsal mountains (Chambi, 5,065 ft), but between the massifs there are wide depressions, varying in elevation from 1,300 to 2,600 ft, which are under crops. South of the Dorsal, in the steppes, the barren mountain chains are not so high and tend southwest-northeast, west-east (Gafsa) and south-north; they are also further apart, with wide alfa-covered spaces between them To the east the plains of the lower steppe, with Qairwan (Kairouan) and Sfax, are watered in the north by the wadis Marguellil and Zeroud but are characterized elsewhere by closed depressions with sebkha. Behind Sousse stand the little hills of the Sahel Finally, to the south of Gafsa, the Sahara begins with the clayey depression of the chotts Gharsa, Djerid and Fedjedj, the dunes of the eastern Erg and the plateau of the Matmata tribes and of the Dahar The Dahar has on its eastern side the semiarid plain of the Djeffara, which borders the Gulf of Gabès In the gulf itself are the islands of Djerba and Kerkena.

With a Mediterranean climate, Tunisia shows fewer contrasts in its different regions than do the Tell, the steppe and the Sahara in Algeria The average January temperature at Tunis is 52·7° (maximum average 59.7°, minimum average 45.6°); the hottest month has an average of 79.2° (maximum average 92°, minimum average 66·4°).

The winds are chiefly northwest in winter and northeast in summer; the rainy season runs from October to May Rain is heaviest in the winter The distribution of rain is, however, highly irregular from region to region and from year to year, North Africa, in general, is in a zone of climatic discontinuity, and a small change of the winds may mean great changes in rainfall.

One zone gets more than 24 in. of rain per year, and this includes the massifs of Kroumirie and the Mogods, the next zone, with 16–24 in of rain, includes central Tunisia, the valley of the Medjerda, Cap Bon and the region of Tunis (Tunis 16 in., Téboursouk 20, Kef 19); a zone with 8–16 in. south of the Tunisian ridge includes the region of Qairwan and the Sahel (Qairwan 11 in., Sousse 14, Sfax 8); there is a zone with less than 8 in. in the south and extreme south (Gabès 4 in., Gafsa 6, Médenine 5). Despite the meagre precipitation there, the hills of the Sahel, the coastal plains of Sfax and even of the Djeffara and the islands of Kerkena and Djerba grow olives thanks to the humidity of the atmosphere, which condenses in the sandy soils

The principal river is the Medjerda, rising in Algeria near Souk-Ahras and flowing into the Mediterranean near Porto Farina It is

228 mi. long; its affluents are the wadis Méllègue. Tessa and Siliana, which come down from the High Tell. In floodtime the volume of the Medjerda may be 35,315 cu ft.; in drought it may go down to 35 cu ft. This river has formed large alluvial plains, filling up the ancient Gulf of Utica and joining a series of shore islets The rivers of the eastern slope (Zeroud, Marguellil) dry up in basins of the lowland which communicate with the sea only when rains are exceptionally heavy.

The northern coast is much dissected Standing out to sea is the island of La Galite; the Lake of Bizerta has kept its depth because the alluvium is deposited in the Garra Aghkel above it The Lake of Tunis is a shallow lagoon.

Beyond the Cap Bon peninsula, the eastern limit of the Gulf of Tunis, the east coast is low and sandy, bordered by lagoons in several places and shelving slowly into shallow water around the Kerkena archipelago and Djerba Island.

Flora for the most part is Mediterranean; 1,350 out of 2,000 plant species occur also in Italy Forest, scrub and steppe are the characteristic formations. The cork oak and the *zean* oak cover Kroumirie and the Mogods (400,000 ac.). The woods of the centre are less compact The Aleppo pine (2,000,000 ac.) and the thuja are the chief forms. In the south one finds, chiefly, the juniper, with some Aleppo pines and pistachio nuts Bled-Tala has a forest steppe with gum trees (*Acacia tortila*), the most northerly occurrence of a species found from Senegal to Arabia The scrub is usually degraded forest, and its most characteristic tree is *Zizyphus lotus*, the spiny jujube tree The steppe is covered by grasslike types such as the alfa or esparto grass and by species of *Artemisia*.

The fauna is much like that of Algeria, with European species Mammalian fauna is mainly Eurasiatic, but among reptiles and fish some Africano-Brazilian forms persist. Stag (*Cervus elaphus barbus*) is found in Kroumirie and the sleeved mouflon in the mountains. (J.-J. Ds.)

HISTORY

The history of Tunisia begins with the establishment of the Phoenician colonies (*see* CARTHAGE; PHOENICIA). The Punic settlers Semitized the coast but left the interior almost untouched Under the Romans, Punic speech and civilization gave way to Latin, a change which from the time of Caesar was helped by Italian colonization; to this region the Romans gave the name "Africa."

Rich in corn, herds and, in later times, oil, and possessing valuable fisheries, mines and quarries, the province of Africa, of which Tunisia was the most important part, attained under the empire a prosperity to which Roman remains in all parts of the country still bear witness Carthage was the second city of the Latin part of the empire, "after Rome the busiest and perhaps the most corrupt city of the West, and the chief centre of Latin culture and letters." The emperor Septimius Severus and the philosopher Apuleius were Africans. Moreover, in the early history of Latin Christianity. Africa holds a more important place than Italy, in Africa Christian Latin literature took its rise, and to this province belong the names of Tertullian and Cyprian, of Arnobius and Lactantius and, above all, of Augustine Lost by Rome to the Vandals, who took Carthage in 439, the province was recovered by Belisarius (533–534) and remained Roman till the Arab invasions of 648–669 The conqueror, Okba (Uqba) ibn Nafi, founded the city of Qairwan (671), which was the residence of the governors of "Ifriqiyah" under the Omayyads and thereafter the capital of the Aghlabite princes, the conquerors of Sicily, who ruled in merely nominal dependence on the Abbasids.

Arab and Berber Dynasties.—The Latin element in Africa and the Christian faith almost disappeared in a single generation; the Berbers of the mountains, who had never been Latinized and never really Christianized, accepted Islam without difficulty, but showed their stubborn nationality not only in the character of their Mohammedanism—which has always been mixed with the worship of living as well as dead saints (marabouts) and other peculiarities—but also in political movements. The empire of the Fatimites (*q.v.*) rested on Berber support, and from that time until the advent of the Turks the dynasties of North Africa were really native, even when they claimed descent from some illustrious Arab stock When the seat of the Fatimite empire was moved to Egypt (972), the Zeirids, a house of the Sanhaja Berbers, ruled as their lieutenants at Mahdia, and about 1050 Mu'izz the Zeirid, in connection with a religious movement against the Shi'ites, transferred his very nominal allegiance to the Abbasid caliphs Sent in vengeance by the Fatimite caliph, a vast horde of Bedouins from Upper Egypt (Beni Hilal and Sulaim) ravaged all North Africa. Unable to found an empire or overthrow the settled government in the towns, the invaders made order and prosperity almost impossible in the open parts of the country until its effective occupation by the French The Zeirid dynasty was finally extinguished by Roger II of Sicily, who took Mahdia in 1148 and established his authority over all the Tunisian coast. Even Moslem historians speak favourably of the Norman rule in Africa; but it was brought to an early end by the Almohade caliph of Morocco, Abd ul-Mumin, who took Mahdia in 1160

The Almohade empire soon began to decay, and in 1336 Abu Zakariya, prince of Tunis, proclaimed himself independent and founded a dynasty which subsisted till the advent of the Turks. The Hafsids (so called from Abu Hafs, the ancestor of Abu Zakariya) assumed the title of "prince of the faithful," a dignity which was acknowledged even at Mecca when, in the days of Mustansir, the second Hafsid, the fall of Baghdad left Islam without a titular head. In their best days the Hafsids ruled from Tlemçen to Tripoli, and they received homage from the Merinids of Fez; they held their own against repeated Frankish invasions, of which the most notable were that which cost Louis IX of France his life (1270) and that which Louis II of Bourbon led (1390), when English troops took part in the unsuccessful siege of Mahdia. The Hafsids adorned Tunis with mosques, schools and other institutions, favoured letters and in general appear to have risen above the usual level of Moslem sovereigns Their rule was troubled by continual wars and insurrections and later by family dissensions.

Turkish Rule.—The conquest of Algiers by the Turks gave a dangerous neighbour to Tunisia, and after the death of Mohammed the Hafsid in 1525 a disputed succession supplied Khair ed-Din Barbarossa with a pretext for occupying the city in the name of the sultan of Constantinople. Al-Hasan, the son of Mohammed, sought help from the emperor and was restored in 1535 as a Spanish vassal, by a force which Charles V commanded in person, while Andrea Doria was admiral of the fleet But the conquest was far from complete The interior was a prey to anarchy and civil war until, in 1570, Ali Pasha of Algiers utterly defeated Hamid, the son and successor of Al-Hasan, and occupied Tunis. In 1573 the Turks again retreated on the approach of Don Juan, who had dreams of making himself king of Tunis; but in the next year Sultan Selim II sent a strong expedition which drove the Spaniards from Tunis and Goletta (La Goulette) and reduced the country to the status of a Turkish province Nevertheless, the Spanish occupation left a deep impression on the coast of Tunis.

Within a few years after the Turkish conquest, a military revolution (1590) transferred the supreme power to a dey elected by the janissaries, who formed the army of occupation The government of the deys lasted till 1705. The beys, whose proper function was control of the tribes and who from 1637 onward had overshadowed the deys, took full control when Hussein ben Ali was proclaimed sovereign by the troops under the title of "bey" Being a prince of energy and ability, he was able to establish the hereditary sovereignty which lasted without change of dynasty.

Under deys and beys alike Tunisia was essentially a pirate state. Occasional acts of chastisement (of which the bombardment of Porto Farina by Robert Blake in 1655 was the most notable) and repeated treaties, extorted by European powers, checked from time to time but did not eliminate the habitual piracies, on which indeed the public revenue of Tunis was mainly dependent. The powers were generally less concerned for the captives than for the acquisition of trading privileges, and the beys took advantage of the commercial rivalry of England and France to play them off one against the other. The definite abandonment of piracy may

be dated from the presentation to the bey in 1819 of a collective note of the powers assembled at Aix-la-Chapelle. The government had not elasticity enough to adapt itself to so profound a change in its ancient traditions No attempt was made to improve conditions of the country, except perhaps under Mohammed as-Saduk, who succeeded to the throne in 1859 In the third quarter of the 19th century not more than a tenth part of the fertile land was under cultivation Taxation was ruinous, and borrowing in Paris increased the public debt enormously. The yearly charges on the debt exceeded the whole annual revenue Discontent flamed into insurrection under attempted constitutional and military innovations, and the inevitable revolution was postponed only by the rivalry of the European powers with interests in the country The French had come to regard Tunisia as the natural extension of Algeria, although after the Crimean War Turkish rights over Tunis were revived The embarrassed bey, after the Franco-German War, turned toward Great Britain for advice, and a British protectorate—suggested by the remarkable influence of the celebrated Sir Richard Wood, British diplomatic agent at the court of Tunis from 1855 to 1879 The railways, lighthouses, gas and waterworks and other concessions and industries were placed in British hands But in 1878, at the Congress of Berlin, Lord Salisbury agreed to allow France a "free hand" in Tunisia in return for French acquiescence in the British lease of Cyprus

The French Protectorate.—After 1862, however, the kingdom of Italy began to take an interest in Tunisia Italian residents outnumbered other European groups Italians were the commercial and industrial leaders. In 1879, of the 683 vessels entering the port of Goletta, more than 500 were Italian. When the country went bankrupt in 1869, a triple control was established over Tunisian finances, with British, French and Italian "controllers" In 1880 the Italians bought the British railway from Tunis to Goletta. This and other actions excited the French to act on the understanding effected with the British at the Berlin congress. In 1881 a French force crossed the Algerian frontier under pretext of chastising the independent Kroumir tribes on the northeast of the regency and, advancing on the capital, compelled the bey to accept the French protectorate. The conquest of the country was not effected without a serious struggle with the Tunisians, especially at Sfax; but all Tunisia was brought eventually under French control.

Mohammed VI, the reigning bey, signed the treaty acknowledging a French protectorate at the Bardo palace on May 12, 1881. He died in Oct. 1882, and a new treaty, that of La Marsa (June 8, 1883), was signed by his brother and successor, Ali IV. From 1884 onward the French, under a resident-general, carried out a thorough reform of the administration. Great Britain early recognized the protectorate, as did most of the other powers Turkey did not, and though the boundary between Tunisia and Tripolitania was established by the treaty of May 19, 1910, between France and the Ottoman empire, it was not until the treaty of Lausanne (1923) that Turkish claims to the regency were finally renounced Italy, however, was more deeply concerned by the establishment of the French protectorate, having looked forward to the acquisition of Tunis. The Italian government renounced its consular tribunals in Tunisia in 1884, as the other powers had done in 1883, but insisted on its other capitulatory rights (under a treaty of 1868) till 1896. By the terms of a convention then concluded the right of Italians in Tunisia to maintain their nationality was guaranteed British subjects had the same right, this affected chiefly the Maltese settled in the country The persistence shown by Italians and Maltese in maintaining their nationality, however, was a cause of annoyance and some practical inconvenience to the French. Decrees issued in 1921 declaring that British and Italian subjects, born of parents who were themselves born in Tunisia, would be deemed to be of French nationality provoked resentment, especially among the Italians. As to the British (*i.e.*, Maltese) an arrangement was reached in 1923 whereby the persons affected were entitled to decline French nationality. The Laval-Mussolini agreements of 1935, providing for the termination of Italy's special privileges, were never applied They were to be denounced in 1938 by Mussolini, who made the acquisition of Tunisia one of the aims for which Italy declared war on France in 1940

The nomad tribes in the south gave occasional trouble, but French rule was generally accepted. During World War I tribesmen from Fezzan, led by Turkish officers, had attacked the French outposts in southern Tunisia There was some sharp fighting in Sept and Oct. 1915, when the French re-established order Later, large numbers of Tunisian soldiers were employed in France. By the agreement of Sept. 12, 1919, the territory south of Tunisia forming salients between the oases of Ghadames and Ghat (Gat) and between Ghat and Tummo was transferred to Libya.

Nationalism arose in Tunisia before World War I under the leadership of "Young Tunisians" influenced by European education and thought The movement increased in importance under the stimulus of postwar movements in the near east; in 1920 various groups united to form a Constitutional party or Destour (Constitution), whose nine-point program had the objective of securing democratic forms of government. A series of economic councils was created in 1922, but nationalist activity continued until 1925, when the French took effective measures to disperse the leaders and break up the movement. The economic depression of the early 1930s and the appearance of younger leaders facilitated the revival of nationalism These leaders formed the Neo-Destour (1934), with a program of vigorous action involving organization of the masses and the assistance of French leftist leaders and nationalists in Morocco and Algeria. The Neo-Destourians expected much from the French popular front government of 1936, which, however, added only minor reforms in 1937 to those granted in 1933 and 1935 After clashes with the police in April 1938, 200 nationalists were arrested and both the Destour and the Neo-Destour were dissolved. (P. W. I.; X.)

Meanwhile, down to 1926, the Italians had been gaining on the French both by immigration and by natural increase, and after the rise of fascism in 1922 everything possible was done by the Italian government to encourage national ambition among them France therefore embarked on a policy of voluntary naturalization, made palatable by economic benefits After 16,824 Italians had been naturalized, the number of French nationals in Tunisia (108,068) was, in 1936, for the first time greater than the number of Italians (94,289)

After the Franco-German armistice and Italy's entry into World War II (June 1940), Tunisia, like the rest of French North Africa, came under Vichy rule. Trade was paralyzed, and there was an acute shortage of imports, particularly of fuel and textiles. The day after the Allied landings in North Africa (*see* WORLD WAR II) the Germans, unopposed by the resident-general, Adm. J. P Esteva, occupied the country (Nov 1942). For six months Tunisia was a battleground; then in May 1943 the German and Italian armies collapsed. Esteva fled, and the bey, Mohammed el-Moncef, was deposed by the French and replaced by their heir apparent, Mohammed el-Amin The French maintained that El-Moncef had collaborated with the Germans; but in fact he seems to have resisted German pressure to the best of his ability, and the French decision to depose him caused trouble down to his death in 1948 The Italian capitulations were abolished by an ordinance of June 22, 1944, duly recognized by the Italian government

At the end of 1943, meanwhile, the military rule established at first by Gen. Charles Mast, the new resident-general, was relaxed; many Arabs arrested for "collaboration" were set free. Some political reforms were promised but economic difficulties aggravated Moslem discontent, and nationalist agitation was resumed A repressive policy was adopted, and in April 1945 Habib Bourguiba, the influential leader of the Neo-Destour, fled to Cairo.

In Aug. 1946 the secretary-general of the Neo-Destour, Salah ben Youssef, summoned a meeting in Tunis of the nationalist parties and groups, which unanimously passed a resolution condemning the protectorate and demanding complete independence. The principal nationalist leaders were then arrested, to be released a few weeks later, when General Mast announced reforms.

In Feb. 1947 Jean Mons was appointed to succeed Mast as resident-general. Mons first tried [illegible]

failed because both the Destour and the Neo-Destour refused to accept either the continuance of the protectorate or the entry of Tunisia into the French union and insisted on the return of El-Moncef In Aug. 1947 Mons therefore formed a Tunisian ministry composed of moderate elements with no definite party leanings But whereas previously there had been only three Tunisian ministers, all departments of state being under French directors, all French directorships except those of education, finance and public works were now abolished and five more ministries given to Tunisians. These ministers were assisted by French councillors, whose agreement to ministerial propositions had to be obtained, differences between them being resolved by a "cabinet council" partly Tunisian and partly French. Mohammed Kaak, a lawyer, was prime minister and minister of justice.

In spite of great difficulties considerable progress was made in education But land-settlement plans came to nothing, health services lagged, and there was little diminution of the controlling power of the French in local as in central administration

The nationalists were therefore very restive. Habib Bourguiba (with official French sanction) returned to Tunisia in Sept 1949 and for the next six months campaigned throughout the country for the abolition of the protectorate and for the grant of autonomy. In April 1950 he went to Paris and published a program in which, while renouncing the claim to complete independence, he put forward in Aug 1946 and which the willingness to admit Frenchmen to elected Tunisian councils, he yet asked for a progressive transfer of sovereignty, for a new treaty and for internal autonomy.

In June 1950, Louis Périller, the new French resident-general, admitted that substantial reforms were necessary and that direct administration should be ended within the framework of the treaties establishing the protectorate In August a ministry was led by Mohammed Shenik in which the Tunisians participated in equal strength with the French and in which, for the first time, the Neo-Destour was represented by Salah ben Yussef. Because of pressure by the French settlers, no reform was achieved, but the Tunisian ministers' French advisers were removed Another step toward internal autonomy, however, was taken in Feb 1951, when it was decided that the council of ministers was henceforth to be under the chairmanship of the premier instead of that of the resident-general and that the certificate of the secretary-general of the residency was no longer required to validate ministerial decisions

While French settlers made known their fear that Tunisian emancipation would end in the eviction of the French, Habib Bourguiba and Ferhat Hashed, secretary general of the General Union of Tunisian Workers, tried to stir world opinion and sharply criticized the slowness of French policy A nationalist agitation began in December and at the beginning of Jan 1952 Jean de Hauteclocque succeeded Périller as resident-general The Shenik ministry made a complaint against France to the United Nations but this was ruled out of order by the Security council *Disorders* increased after Habib Bourguiba and 11 other Neo-Destour and Communist leaders were arrested.

In March the bey agreed to dismiss the Shenik ministry, which was succeeded by Salah ed-Din Bakkush's government. Tranquillity was restored in April. The French government proposed reforms as follows. Tunisian sovereignty to be recognized, with a gradual advance toward internal self-government, Tunisian assistant-directorships to be set up beside the French directorships, public offices to be reserved in principle for Tunisians; the legislative power to lie with the bey, assisted by two councils (one, legislative, entirely Tunisian, the other, financial, half Tunisian and half French); elections to be held for municipal councils and provincial assemblies

This plan met with sharp criticism in the French national assembly: the right wing thought it went too far, the left not far enough The bey rejected it in August Meanwhile in June the Arab states and certain Asian governments lodged a fresh complaint with the U N The French population of Tunisia objected to the idea of their being excluded from public affairs on the grounds that they paid more than half the taxes and that the country depended on France for financial investments and as a market for its primary products (oil, wine and wheat). The Neo-Destour on the other hand opposed joint sovereignty When the dispute was brought up in December before the general assembly of the U.N , France denied that body's right to interfere

On Sept. 9, 1952, the bey addressed a letter to Pres. Vincent Auriol summarizing the course of Franco-Tunisian relations since World War II in support of his contention that France had repeatedly broken its promise to restore self-government to Tunisia. President Auriol replied deploring the fact that his repeated appeals to the bey's wisdom had been met only by intransigence. On Nov. 29, the French resident-general called upon the bey to indicate by "a plain answer" his willingness to settle the outstanding problems. The situation deteriorated gravely as a result of the murder of Ferhat Hashed in mysterious circumstances during the night of Dec 4–5 On Dec. 20 the bey finally agreed to sign two reform decrees: one establishing elected municipal councils with a two-college system, the other organizing elected provincial councils (*conseils de caïdat*). During the year terrorist activities continued throughout the country.

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SOCIAL AND ECONOMIC CONDITIONS

Population.—The population by the 1946 census was 3,230,952, comprising 2,832,078 Moslems, 70,971 Jews and 239,549 Europeans It is concentrated in the cities and on the coast

The Moslems are mostly Berber mixed with Arab, but only about 1% speak Berber. The people of the island of Djerba are mostly of the Ibadhite sect of Islam. The Matmatas (100,000) are troglodytes, living in caves cut in rock or clay. The towns contain some primarily urban elements such as the Andalusian Moors and the Jews Europeans included 144,977 French, 84,935 Italians and 6,459 Maltese In 1931 the French numbered 46,000, the Italians 88,000. Of the European population, 85% live in the towns, 59% in Tunis alone

Tunis (97.9) is the chief city, with a population of 364,593. Other towns are Sfax (pop 54,636), Bizerta (36,560), Sousse (36,560), Kairouan (32,299), Mʼsaken (21,804), Ferryville (29,353) and Gabès (23,512) Other towns exist as ports, as oases or as agricultural centres.

Government and Administration.—By the treaty of Bardo (May 12, 1881) Tunisia came under the occupation of France, with rights set forth in the treaty and in the convention of June 8, 1883 The bey was theoretically sovereign, but a French resident-general, under the ministry of foreign affairs at Paris, controlled all military, naval and civil affairs of the regency. Besides the resident-general, who was assisted by a *délégué* and was also minister of foreign affairs for Tunisia, French directors supervised the army, marine, education, finance, public works, agriculture, post, telegraph and telephone, justice (French) and various other services Tunisians, under French supervision, filled the post of first minister, minister of the Pen (deputy first minister), minister of state and minister of Tunisian justice. However, under the French constitution of 1946, which allowed for the gradual transformation of protectorates into associated states of the French union, reforms were promulgated in 1947 and, more extensively, in Feb. 1951 whereby the sovereignty of the Tunisian state was affirmed and important public offices thrown open to the natives, so that the majority of ministers were thereafter Tunisians.

Local administration is conducted in the traditional form, which has been systematized: the bey is represented by caïds (42 caïdates, 6 of them in the Military Territories of southern Tunisia), seconded by *kahias* and *kalifats* and supervised by *contrôleurs civils* (20 in number) The sheikhs, nominated from a list of three chosen candidates, number about 600 and are the responsible representatives of the people The grand council, which votes the budget, consists of two sections, one French and one Tunisian

Justice is administered by Tunisian and French courts Matters regarding personal status, inheritance, private *habous* and real estate (where Europeans are not involved) are settled by caïds in *shara* courts. Other cases, civil and criminal, involving Tunisians, are judged in *ousara* courts by cadis The French system is composed of 15 justices of the peace, 4 tribunals of first instance and the court of appeals at Tunis (1941).

Tunisia has *melk* lands which are completely freehold, *habou* lands subject to special rules of inheritance, and tribal or group lands A cadastral register was established by law in 1885, with the object of lessening doubts as to ownership of land Colonization depends mainly on private enterprise, and the government came late into the matter. By laws of 1914, 1920 and 1924, those who take up previously domanial land acquire a right to live on them for life or for 20 years. *Habou* lands can be leased for long terms on payment of a perpetual rent (*enzel*), which rent may be redeemed on a basis of 20 years' purchase. Europeans own about 1,901,900 ac. divided into about 6,000 properties

Agriculture.—About 7,315,000 ac., out of a productive area estimated at 22,500,000 ac., are held to be arable. The returns, generally poor, are variable from year to year. Annual average acreage and production of the principal crops in 1945–50 were: hard wheat [illegible]

[illegible]

1950; figs, 2,500,000; oranges, 800,000; other citrus fruits, 300,000 The oases, particularly Tozeur and Nefta, in 1950 provided 3,100,000 date palms, which produced about 35,400 tons

Cattle Rearing and Natural Products.—Cattle rearing and crop growing are extensive rather than intensive. On an average, Tunisia raises annually about 400,000 cattle, 72,000 horses, 47,500 mules, 110,000 asses, 177,000 camels, 42,000 pigs, 1,200,000 goats and 2,000,000 sheep.

Forests (2,500,000 ac) provide firewood and timber (railway sleepers, pit props and stakes for vineyards), as well as cork for export Alfa (141,000 tons in 1950) is exported chiefly to England, for the manufacture of paper pulp Sea fishing is carried on in Tunisia under more favourable conditions than in Algeria The fish are also more varied in kind There are 13,000 fishermen, of whom 12,000 are natives and 1,000 Italians The catch consists mainly of tunny, sardines and sardinella Sponge fishing is carried on along the whole of the east coast, from Monastir to the frontier of Tripoli, especially at Sfax and in the Kerkena Islands, production in 1950 was 82 tons.

Mines.—Tunisia possesses practically inexhaustible deposits of phosphates The chief exploitations is carried on in the Gafsa region (Metlaoui, Ain-Moulares, Redeyef), and exports go through Sfax The phosphates of Kalaa-es-Senan and Kalaa-Djerda, found as a prolongation of those of Tebessa, are exported through Tunis. 1,525,000 metric tons were produced in 1950 Iron ores, abundant and of good quality, are found, especially to the south of Kef and not far from the Algerian frontier, at Douaran, at Djerissa and at Nebzas in the Mogods; production in 1950 amounted to 758,000 metric tons, chiefly red and brown haematite Lead (30,700 tons) and zinc (5,744) come from the country round Béja and the High Tell Other minerals are mercury, manganese, copper, iron pyrites and salt, petroleum has been sought at various places The output of lignites at Cap Bon declined after World War II Power is derived from imported coal and petroleum products; consumption of electricity amounted to 141,000,000 kwhr in 1950. Important industries include flour milling, oil refining, lead melting and distilling; after World War II, moreover, there was considerable industrial development, comprising preserved food, building materials and light engineering workshops. Thermal and mineral springs are numerous

Communications.—Tunisia had 5,622 mi of roads and 1,283 mi of railways in 1950 In the north the Algerian railways and the lines from Tabarka and Bizerta have a gauge of 1 44 m., in the centre and the south the lines of the Haut Tell and the Sousse-Sfax-Gabès, Sousse-Gafsa, Sfax-Gafsa (these two serving the phosphate deposits) and Sfax-Tozeur lines have one of 1 m The major ports are. Tunis, with La Goulette (Goletta) as its forepport, handling imports and exporting the agricultural produce of the Tell and the phosphates of the Haut Tell, Sfax, exporting phosphates, oils and alfa grass, Bizerta, a great naval base that also handles the iron ore of the north, and Sousse, which does little business but deals in olive oil The Tunis aerodrome is an important link in communications between Africa and the east.

Commerce.—Tunisia, Algeria and France are under a single customs union for a number of products, notably cereals For other products, such as wine, Tunisia is under a contingent regime; that is, its products are allowed free into France in quantities established each year French goods receive privileged treatment in the regency. The trade of Tunisia in 1950 amounted to 89,739,000,000 fr. (imports 52,210,000,000 fr ; exports 37,529,000,000 fr) Of the imports, 82% came from the franc area, 4% from the sterling and 7% from the dollar, of the exports, 50%, 13% and 3% went to the same areas, respectively. Tunisia imports textiles and clothing (19% of the total value of imports), food products (16%; e g , sugar, tea and dairy produce), raw materials and unfinished goods (20%), supplies for building and development (19%); and fuel. Principal exports are olive oil (74,000 tons in 1950), wheat and barley (only in good years), wines and alfa grass, mineral produce comes second in value, comprising phosphates (1,688,000 tons), lead and iron ore.

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(J.-L. DE.; X.)

TUNNEL, a more or less horizontal underground passage made without removing the overlying rock or soil. In former times any long tube-like passage, however constructed, was called a tunnel. In 1928 the word was sometimes popularly applied to an underground passage constructed by trenching down from the surface, building the arching or other form of structure and then refilling over the top with soil; but a passage so constructed, although indistinguishable from a tunnel when completed, is more correctly termed an "aqueduct," a "covered way" or "subway" (depending on its use) and the operations "cutting" and "covering," instead of tunnelling. Making a small tunnel, afterwards to be converted into a larger one, is called driving a heading, and in mining operations small tunnels are termed galleries, drifts and adits. If the passage leading underground is vertical it is called a shaft; if inclined from the vertical it is called a slope, or inclined shaft; if the shaft or slope is begun at the surface the operations are known as sinking; and if worked upwards from a previously constructed heading or gallery the operations are called risings or stopes (*See* COAL AND COAL MINING, MINING, METALLIFEROUS).

Tunnels may be driven through earth, which usually requires timbering during excavation (and there are many systems of timbering) or the use of a shield, or in rock, which may or may not require timbering, depending on the firmness (*See* Plate, figs. 2 and 3) In earth, and often in rock some form of permanent lining is necessary and it is sometimes formed of closely spaced heavy timbers but more often of some type of masonry Tunnels may be excavated either above or below water level, and in the former case excavated in free air, but, in the latter, where in earth, modern practice usually requires the use of compressed air

Tunnelling has been effected by natural forces to a far greater extent than by man. In limestone districts innumerable swallow-holes, or shafts, have been created by sinking rain water following joints and dissolving the rock, and from the bottom of these shafts tunnels have been made by the water to the sides of hills in a manner strictly analogous to the ordinary method of executing a tunnel by sinking shafts at intervals and driving headings therefrom. Many rivers thus find a course underground In Asia Minor one of the rivers on the route of the Mersina railway extension pierces a hill by means of a natural tunnel The Mammoth Cave of Kentucky, the caverns at Carlsbad, New Mexico, and the Peak caves of Derbyshire are due to natural tunnelling.

Mineral springs bring up vast quantities of matter in solution. It has been estimated that the Old Well spring at Bath has discharged since the beginning of the 19th century solids equivalent to the excavation of a 6 ft. by 3 ft. heading, 9 m. long; and yet the water is perfectly clear and the daily flow is only the 150th part of that pumped out of the great railway tunnel under the Severn. Tunnelling is also carried on to an enormous extent by the action of the sea

Subaqueous Demolitions.—The most gigantic subaqueous demolition hitherto carried out by man was the blowing up in 1885 of Flood rock, a mass about 9 ac. in extent, near Long Island sound, N.Y. To effect this gigantic work by a single instantaneous blast a shaft was sunk 64 ft. below sea-level, from the bottom of which 4 m. of tunnels or galleries were driven so as comple.ely to honeycomb the rock The roof rock ranged from 10 to 24 ft. in thickness, and was supported by 467 pillars 15 ft. square; 13,286 holes, averaging 9 ft in length and 3 in. in diameter, were drilled in the pillars and roof. About 80,000 cu yd of rock were excavated in the galleries and 275,000 remained to be blasted away. The holes were charged with 110 tons of "rackarock," a more powerful explosive than gunpowder, which was fired by electricity. The sea was lifted 100 ft. over the whole area of the rock.

Early Examples of Tunnelling.—With so many examples of natural caves and tunnels in existence it is not to be wondered at that tunnelling was one of the earliest works undertaken by man, first for dwellings and tombs, then for quarrying and mining and finally for water-supply, drainage and other requirements of civilization. A Theban king on ascending the throne began at once to drive the tunnel which was to form his final resting place, and persevered with the work until death. The tomb of Mineptah, at Thebes, was driven at a slope for a distance of 350 ft into the hill, when a shaft was sunk and the tunnel projected a farther length of about 300 ft, and enlarged into a chamber for the sarcophagus. Tunnelling on a large scale was also carried on at the rock temples of Nubia and of India and to some extent by the Aztecs in America, and the architectural features of the entrances to some of these temples might be studied with advantage by the designers of modern tunnel portals.

Flinders Petrie has traced the method of underground quarrying followed by the Egyptians opposite the Pyramids. Parallel galleries about 20 ft. square were driven into the rock and cross galleries cut, so that a hall 300 to 400 ft. wide was formed, with a roof supported by rows of pillars 20 ft. square and 20 ft apart. Blocks of stone were removed by the workmen cutting grooves all round them, and, where the stone was not required for use, but merely had to be removed to form a gallery, the grooves were

wide enough for a man to stand up in. Where granite, diorite and other hard stone had to be cut the work was done by tube drills and by saws supplied with corundum, or other hard gritty material, and water—the drills leaving a core of rock exactly like that of the modern diamond drill.

As instances of ancient tunnels through soft ground and requiring masonry arching, reference may be made to the vaulted drain under the south-east palace of Nimrod and to the brick arched tunnel, 12 ft. high and 15 ft. wide, under the Euphrates. In Algeria, Switzerland and wherever the Romans went, remains of tunnels for roads, drains and water-supply are found. Pliny refers to the tunnel constructed for the drainage of Lake Fucino as the greatest public work of the time It was then by far the longest tunnel in the world, being more than 3 5 m in length, and was driven under Monte Salviano, which necessitated shafts no less than 400 ft in depth. Forty shafts and a number of cuniculi, or inclined galleries, were sunk and the excavated material was drawn up in copper pails, of about 10 gal capacity, by windlasses The tunnel was designed to be 10 ft high by 6 ft. wide, but its



FIG. 1.—EARLY MINING METHODS IN "DE RE METALLICA" (1556) BY GEORG AGRICOLA

A. Shaft, *B*, *C*, *D*. Drifts, *E*. Tunnel, *F*. Tunnel mouth

actual cross-section varied It is stated that 30,000 labourers were occupied 11 years in its construction. With modern appliances and a small percentage of the men, such a tunnel could be driven from the two ends without intermediate shafts in far less time.

No practical advance was made on the tunnelling methods of the Romans until gunpowder came into use. Old engravings of mining operations early in the 17th century show that excavation was still accomplished by pickaxes or hammer and chisel, and that wood fires were lighted at the ends of the headings to split and soften the rock in advance. (*See* fig 1) Crude methods of ventilation by shaking cloths in the headings and by placing inclined boards at the top of the shafts are also on record. Before the advent of the railroad, tunnels were built for canals at many locations and some were of very early date. On the introduction of railways tunnelling became one of the ordinary incidents of a contractor's work. Probably upwards of 4,000 railway tunnels have been excavated, including in this list some of the longest tunnels in the world, such as the Mont Cenis, Saint Gotthard, Simplon and Loetschberg in the Alps; the Hoosac, Moffat and Cascade mountains of the United States, and the Connaught at Rogers pass in Canada. On mountain railways, tunnels often form a large percentage of the length; on the Mexican railway in a distance of 66 m. there are 21 tunnels; on the Southern Pacific 11 tunnels in 25 m., including a spiral tunnel. There are also several long spiral tunnels on the Canadian Pacific railway at the Kicking Horse pass The longest single tunnel, however, is the Shandaken tunnel, 18 1 m. in length, built by the City of New York (1917–24) as an extension of the Catskill aqueduct system for water-supply, in Greene county, N.Y.

TUNNELLING UNDER RIVERS AND HARBOURS

Through Tunnelling Methods.—In 1818 Marc Isambard Brunel took out a patent for a tunnelling process, which included a shield, and which mentioned cast iron as a surrounding wall His shield foreshadowed the modern shield, which is substituted for the ordinary timber work of the tunnel, holds up the surrounding earth during excavation, affords space within its shelter for building the permanent lining, overlaps this lining in telescope fashion and is moved forward by pushing against the front ends The advantages of cast iron lining are that it has great strength in small space as soon as the segments are bolted together, and its joints can be caulked water-tight

First Use of Shield.—In 1825, Brunel began, and completed in 1843, after several suspensions of operations, the Thames tunnel between Rotherhithe and Wapping. It was constructed for a highway, but was never used for that purpose It was sold in 1866 to and has since been used by the East London railway, which operates its trains through it. This early tunnel, built of brick, in the form of two arches with frequent openings between them, has a length of 1,200 ft., and required an excavation opening 27 ft. in width, which is still one of the widest ever built under such conditions Brunel employed a peculiar form of shield, made of timber, in several independent sections. Part of the ground penetrated was almost liquid mud, and the cost of the tunnel was about £433 per linear foot. In 1830 Lord Cochrane (afterwards the 10th earl of Dundonald) patented the use of compressed air for shaft sinking and tunnelling in water-bearing strata. Water under any pressure can be kept out of a subaqueous chamber or tunnel by introducing sufficient air of a greater pressure, and men can breathe and work therein—for a time—up to a pressure exceeding four atmospheres. To confine the compressed air it is necessary to provide a substantial bulkhead across the workings To pass men and materials through the bulkhead there is a mechanical device called a lock, which is a large steel tube, with doors at each end, both of which open inward toward the working chamber, and both of which can never be opened at one time because of the difference in air pressure between that in the working chamber and that back of the bulkhead. Valves are provided to admit compressed air to the lock from the working chamber, and also to exhaust it from the lock to back of the bulkhead, in order to manipulate the doors.

The Severn tunnel 4 33 m. in length, for a double line of railway, was begun in 1873 and finished in 1886. Hawkshaw, Son and Hayter were the engineers, and T. A Walker the contractor. At the lowest part the depth of water was 59 ft at low water and 104 ft. at high water, and the thickness of sandstone over the brickwork was 45 feet. Under a depression in the bed of the river on the English side there is a cover of only 30 ft of marl. Much water was met with throughout. In 1879 the works were flooded for months by a land spring on the Welsh side of the river, and on another occasion from a hole in the river bed at the Salmon pool. This hole was filled with clay and the work completed beneath The total amount of water raised

at all the pumping stations was about 27,000,000 gal. in 24 hours.

The length of the railway tunnel under the Mersey between Liverpool and Birkenhead, is 1 m. between the pumping shafts on each side of the river From each a drainage heading was driven through the sandstone with a rising gradient towards the centre of the river. This heading was partly bored out by a Beaumont machine to a diameter of 7 ft. 4 in and at a rate attaining occasionally 195 ft. per week. All of the tunnel excavation, amounting to 320,000 cu.yd , was done by hand labour, as heavy blasting would have shaken the rock. The minimum cover is 30 ft. between the top of the arch and the bed of the river Pumping machinery is provided for 27,000,000 gal. per day, which is more than double the usual quantity of water. Messrs Brunlees and Fox were the engineers and Messrs Waddell the contractors for the work which, taking six years, was completed in 1886

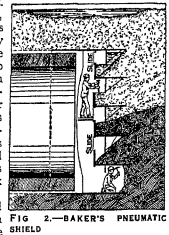


FIG 2.—BAKER'S PNEUMATIC SHIELD

Some 30 m. of brick-lined waterworks tunnels have been built under the Great Lakes since 1864, mostly in clay, without the use of shields, although in the later ones compressed air was utilized. A large portion of one of the tunnels at Cleveland, O , 9 ft. interior diameter, was built at the rate of 17 ft. per day at a cost of about $18 per foot. During this work three explosions of inflammable gases occurred in which 19 men were killed and others were injured. Later a fire at the shaft in the lake caused the death of ten men. Work was thereafter completed under the direction of George H. Benzenberg. Less serious accidents, principally explosions of marsh gas, occurred in many of the other tunnels.

In 1869 P. W. Barlow and J G Greathead built the Tower footway under the Thames, using for the first time a cast iron lining and a shield which embodied features of Brunel's design

First Tunnel in Compressed Air.—Compressed air was first used in tunnel work by Hersent, at Antwerp in 1879, in a small drift with cast iron lining In the same year compressed air was used for the first time in any important tunnel by D. C. Haskin, in the famous first Hudson River tunnel, from Hoboken, N.J., to Morton street, New York city. This tunnel was to be of two tubes, each 16 ft wide by 18 ft. high In June 1880 the northerly tube had reached 360 ft. from the Hoboken shaft. The compressed air blew a hole through the soft silt of the roof at this spot, and the water entering drowned the 20 men. With British capital and largely under the direction of British engineers (Sir Benjamin Baker and E. W Moir), the northerly tunnel was extended 2,000 ft. to about three-fourths of the way across but in 1891, the tunnel was allowed to fill with water and it so remained for ten years Both tubes were completed in 1908, under the direction of Charles M. Jacobs, engineer In the meantime, two others were started crossing under the Hudson from beneath the Pennsylvania railroad station in Jersey City to Cortlandt street, New York, and connecting tubes on the New Jersey side paralleling the Hudson river. These tunnels which form parts of the Hudson and Manhattan railroad system, were put in operation in 1910 under electric traction by third rail (*See* ELECTRIC TRACTION.)

The use of compressed air in the first Hudson tunnel, and of annular shields and cast iron lining in constructing the City and South London railway (1886–90) by Greathead, became widely known and greatly influenced subaqueous and soft-ground tunnelling thereafter. The pair of tunnels for this railway, from near the monument to Stockwell, from 10 ft. 2 in. to 10 ft. 6 in. interior diameter, were constructed mostly in clay and without the use of compressed air, except for a comparatively short distance through water-bearing gravel. In this gravel a timber heading was made, through which the shield was pushed. The reported total cost was £840,000. Other tunnels, lined with cast-iron segments and constructed by means of annular shields and the use of compressed air, were constructed after the City and South London work was well advanced.

The St Clair River tunnel (Joseph Hobson, engineer) from Sarnia to Port Huron, Mich , was built in 1889–90, through clay, and for a short distance through water-bearing gravel It is 1·14 m. in length and 21 ft external diameter. This tunnel was the first one completed in America in which were used all the essential elements for successful subaqueous work; *i.e.*, a shield, compressed air and cast-iron rings

In 1890–93 a shield-driven vehicular tunnel was constructed in sand and gravel across the Clyde in Glasgow, Scotland It consists of three parallel cast iron tubes with an internal diameter of 16 ft , the centre one being a footway and the outer tubes for vehicles in each direction. The footway is reached by inclined ramps and stairs, but the vehicles are lowered and raised by elevators in shafts of 76 ft. inside and 80 ft outside diameter. The distance between shafts is 700 feet The cost was £287,000 This tunnel was not a financial success because of competition by a municipal ferry and its use, though interrupted, was resumed

In 1891 the tunnel of the Ravenswood Gas Co. in New York city was started by Jacobs and Davies, engineers, crossing beneath the East River and Blackwell's island from between 70th and 71st streets in Manhattan, to Ravenswood in Long Island city. It was expected to be a rock tunnel throughout and the section was to be 8 ft. 6 in. high and 10 ft 6 in. wide, to provide room for two 3 ft. and one 4 ft gas mains. Soft ground was encountered and great difficulty was found because of the depth and water pressure. Compressed air was adopted, the pressure at times reaching as high as 46 lb per square inch. Eventually, it was necessary to line the soft ground sections with cast iron rings of 10 ft. 2 in. internal diameter. The work was completed in 1894.

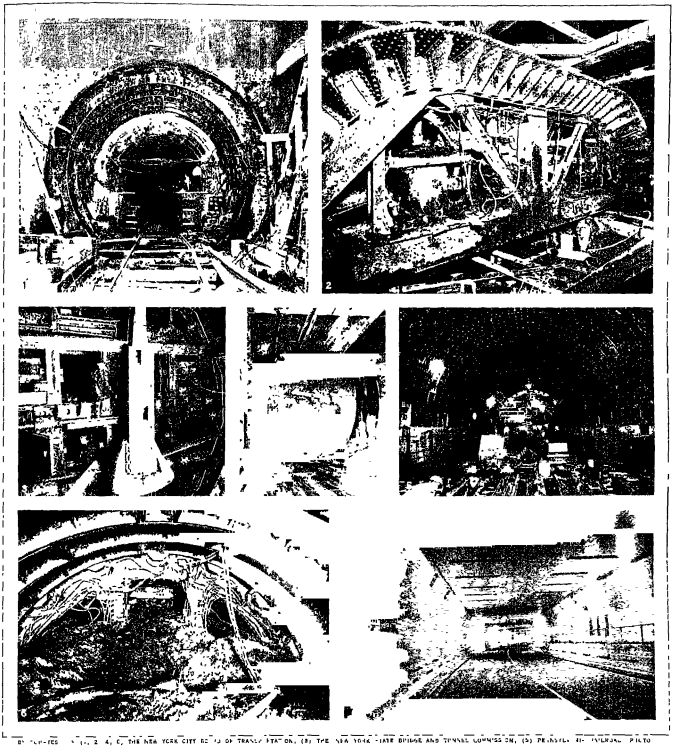
The notable Blackwall tunnel, under the Thames about 6 m. below London bridge (Sir Alexander Binnie, engineer, and S Pearson and Sons, contractors), was built in 1892–97, through clay and 400 ft of water-saturated gravel. The tunnel is about 3,116 ft *long*, the external diameter 27 ft and the internal diameter 24 ft. 3 inches. The shield, 19 ft. 6 in. long, contained a bulkhead with movable shutters, as foreshadowed in Baker's proposed shield (fig. 2) There are a roadway 16 ft. wide for vehicles and two footwalks 3 ft. wide. The maximum grade is 2·78%.

Numerous tunnels of small diameter have been constructed by the use of shields under the Thames and Clyde for electric and cable ways, several for sewers in Melbourne and under the Seine at Paris for sewer siphons.

The Rotherhite tunnel, under the Thames, about 2·25 m below London bridge, provides for a vehicular roadway 16 ft. wide and two footwalks 4 ft. 8 in. wide. It has a length of 4,863 ft. between portals, of which about 1,400 ft. are directly under the river The exterior diameter of the tunnel is 30 ft. and the interior 27 feet The maximum grade is 2·7%. It is constructed of cast iron rings and concrete lining, and a shield and compressed air were used It was begun in 1904 and finished in 1908. Maurice Fitzmaurice was the engineer of design and construction, and Price and Reeves the contractors The top of the main tunnel excavation in the middle of the river was only 7 ft. from the bed of the Thames, and a temporary blanket of filled earth, usual in similar cases, was prohibited owing to the close proximity of the docks.

The East Boston tunnel, built in 1901, was the first important example of a shield-built monolithic concrete arch, and extends from the Boston subway to East Boston It is 1·4 m. long, 3,400 ft being under the harbour. One mile was excavated by tunnelling with roof shields about 29 ft wide, through clay containing pockets of sand and gravel. The shields reacted against iron bars set in the concrete and moved forward on the masonry side walls The engineer was H. A Carson, and the contractors the Boston Tunnel Construction Company and Patrick McGovern.

A number of tunnels of marked importance, of the subaqueous shield-driven type, operated solely with electric cars (*see* ELECTRIC TRACTION) in addition to the Hudson and Manhattan tun-



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TUNNEL EXCAVATING AND CONSTRUCTION

1. View of tunnel from bottom of steel caisson shaft, showing cast-iron walls of tunnel lining with conduits for electric cables. Old slip—Clark street, East River tunnel, New York city
2. Roof shield used in excavating two-track tunnel for subway in dry sand. Flatbush avenue, Brooklyn, N.Y.
3. Shield of the Holland tunnel, New York city, showing tail end of shield and part of temporary rings in shaft
4. Looking down in a completed caisson shaft, sealed against soil and water pressure at the bottom, the shield being placed in position to start tunnel excavation, Montague street, Brooklyn
5. Union tunnel, Baltimore, Md., shield driven without compressed air
6. Interior of tunnel, back of shield, after a "blowout"
7. Interior view of the Queens-Midtown tunnel, New York city, under the East river

nels already mentioned, have been built under the East and Hudson rivers at New York They are divided into two groups, those built as parts of the Pennsylvania-Long Island railroad systems, and those forming parts of the rapid transit system built by the City of New York

Of the rapid transit tunnels, the first two tubes, of 15 ft. 6 in. interior diameter and 4,150 ft long, penetrate gneiss, sand and gravel directly under the East river, between the Battery, in Manhattan, and Joralemon street, Brooklyn They were begun in 1902,

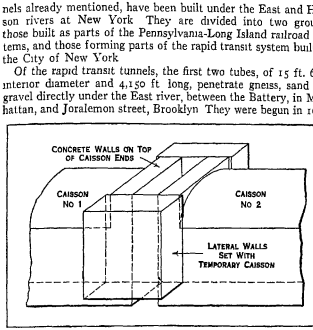


FIG. 3 —PERSPECTIVE SHOWING MANNER OF ENCLOSING SPACE BETWEEN TUNNEL CAISSONS FOR THE METROPOLITAIN UNDER THE SEINE AT PARIS

with Wm. Barclay Parsons (and later George S. Rice) as chief engineer, and were finished in Dec. 1907, under the direction of Walton I. Aims and D. L. Hough of the New York Tunnel Company, contractors Two other tubes, also of the same size, built (also through gneiss, sand and gravel) between 1905 and 1907 by the Degnon Contracting Company, with R A. Shaler as the contractors' engineer, extend from 42nd street, Manhattan, to Long Island City. These tubes were built as an independent line, but were bought and merged with the rapid transit system, under the operating contracts of 1913 Under these contracts four other tunnels each consisting of two tubes, were also driven beneath the East river, from Whitehall street, Manhattan, to Montague street, Brooklyn; Old Slip, Manhattan, to Clark street, Brooklyn, 14th street, Manhattan, to North 7th street, Brooklyn; and from 60th street, Manhattan, to Long Island City They are of larger size At the 60th and 14th street tunnels the tubes in part are above the original river bed and were built in an artificial but permanent bed of clay protected by rip-rap of stone. On both the Joralemon and Whitehall street tunnels blowouts of compressed air occurred during the progress of construction which carried workmen through to the river surface, and in each case one man survived without injury. The chief engineer for the city was Alfred Craven, and, later, Daniel L Turner The work was done between 1914–20. Under contracts let by the city for a proposed independent rapid transit system for municipal operation (Robert Ridgway, chief engineer for the board of transportation, City of New York), two other tube tunnels were constructed under the East river. from Fulton street, Manhattan, to Cranberry street, Brooklyn, and Fifty-third street, Manhattan, to, Long Island City. The 53rd street tunnel was built in part in an artificial river bottom of clay filling. A tunnel was also built under the Harlem river, from Manhattan to the Bronx, at 145th street. The greatest shield progress, that on the Whitehall-Montague street tunnel, was 95 ft in a week of six working days A pressure of 48 lb was used in the 60th street tunnel

Four somewhat larger tubes, measuring 23 ft. on the outside diameter were built under the East river in 1904–09 for the Pennsylvania and Long Island railroads. Alfred Noble was chief engineer, S. Pearson and Son, contractors, and E W. Moir was general manager for the contractors. Blowouts were prevented by placing clay blankets (sometimes 25 ft. thick) on the river bed, which could be carried up to 20 ft depth of water in the slips and back of the pierhead lines, and by filling the pores of the sand and gravel at the face of the shield with dry blue lias lime or applying plastic clay. Under the Hudson river, two tubes of the same size as those under the East river were built for the Pennsylvania trains to New Jersey

In 1914 a highway tunnel, started in 1907 and very similar to that at Glasgow, was completed in sand beneath the Elbe river at Hamburg, Germany Access is here also obtained by elevators, in shafts 1,471 ft. between centres. The shafts are 72 ft. inside and 84 ft. outside diameter and each contains four elevators for vehicles and two for foot passengers The lift is 78 feet Each of the two tubes between shafts provides for a single roadway 6 ft wide and two foot-walks 4 ft. wide. The tubes are of cast iron 19 7 ft. external diameter and the clear width inside is 14 8 feet. The lining is concrete faced with decorative tiles

The water-supply intake tunnel at Cleveland O., extends out 2 8 mi, below the surface of Lake Erie, at a depth of 95 ft below the surface and 40 to 50 ft. below the lake bottom. It was driven with a shield and compressed air in soft clay and sand The air pressure for most of the work varied from 15 to 25 lb. per square inch. The tunnel has an internal diameter of 10 ft and is lined with concrete blocks 12 in. thick.

The notable Holland tunnels connect Canal street, New York, with Twelfth street, Jersey City, passing beneath the Hudson river. For a description of these and of the Lincoln tunnel, *see* HOLLAND AND LINCOLN VEHICULAR TUNNELS The Holland tunnels are named in honour of Clifford M. Holland, the first chief engineer, who died on Oct. 27, 1924, two days before the meeting of the tubes beneath the river The tunnels consist of two tubes 1 61 mi. in length between the portals Except for the land approaches, they consist of circular cast iron rings, 29 ft in exterior diameter. They are solely for motor-propelled vehicular traffic and each tube provides for two lines of traffic in one direction only, with a roadway width of 20 feet. The tubes beneath the river were driven with shields under compressed air. The maximum grade, with traffic, is 4% and against traffic, 3 6%, both on the New York side of the river. The roadways are paved with granite blocks, and the clear headroom is

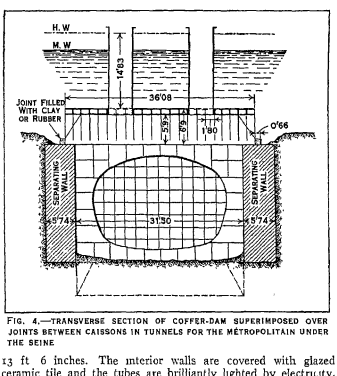


FIG. 4.—TRANSVERSE SECTION OF COFFER-DAM SUPERIMPOSED OVER JOINTS BETWEEN CAISSONS IN TUNNELS FOR THE MÉTROPOLITAIN UNDER THE SEINE

13 ft 6 inches. The interior walls are covered with glazed ceramic tile and the tubes are brilliantly lighted by electricity. The entrance and exit portals are separated at each end by two city blocks and large plazas are provided to prevent traffic congestion. Artificial ventilation is provided. The tunnels have fire fighting equipment, water lines, sand boxes, telephones, traffic signals, wrecking equipment, etc. A footwalk is provided for policing and inspection, but the tunnels are not open to pedestrians. Power for the equipment is obtained from two independent sources on each side of the river and three independent

cables from each source of supply Each cable has a capacity sufficient to carry the full load. It was estimated that the tunnels would have a traffic capacity of 1,900 vehicles per hour for each tube. About 52,000 vehicles have used the tunnels in a single day, without reaching their capacity. Construction began on July 1, 1919, and the tunnels were opened to traffic on Nov 11, 1927 The cost of construction and real estate was about $48,000,000 Tolls are collected (R Rv)

The River Mersey vehicular tunnel between Liverpool and Birkenhead, England, is the largest subaqueous tunnel in the world, having an outside diameter of 46 ft 3 in. and inside diameter of 44 ft. The main roadway is formed at about the diameter line of the tunnel, and provides for four lines of mechanically propelled traffic on a width of 36 ft. A narrow footwalk for patrol purposes is provided on each side. The whole of the upper part of the tunnel is exposed to view, there being no separate duct for the exhaust air, experiments having established this as unnecessary except near each exhaust shaft. Below the main roadway, in the portion of the tunnel under the river, there is space for a future roadway for two lines of traffic The fresh air supply ducts are also located under the roadway. The bottom of the under-river tunnel at its deepest point is 170 ft. below high water. The distance between shafts on each side of the river is 1,735 yards, and the total length of main tunnel and branch tunnels is 2 62 miles. The branch tunnels have an inside diameter of 26 ft 6 in., and only provide for two lines of traffic They have a length of 6 mile. The gradient is 1 in 30. The capacity of the tunnel is 4,150 cars per hour, 100 feet apart and moving at 20 miles per hour At this speed, the time required to pass through the tunnel is 6½ minutes 82,000 tons of cast iron were used in lining the tunnel. The tunnel was opened to traffic on July 18, 1934. The total cost of construction, including land, but excluding interest charges during construction, was £6,919,000 The Government contributed £1,500,000, and the balance was borne by the Corporations of Liverpool and Birkenhead The annual loan charges on sums borrowed are being provided by tolls to the extent of £153,000 per annum, and the remainder out of rates levied on Liverpool and Birkenhead The late Sir Basil Mott was the engineer responsible to the Tunnel Committee for the construction of the tunnel. 14,800,000 vehicles passed through the tunnel by end of November, 1938, and £1,200,000 was collected in tolls. (D. A)

Tunnels have been proposed for undersea connection between England and France, beneath the English channel, even between Alaska and Siberia and beneath the entrance to the Mediterranean at Gibraltar; but aside from the great cost, due to great length and depth, questions of national military defence arise

SINKING TUBES, CAISSONS, COFFER-DAMS, ETC.

In 1845, De la Haye, in England, doubtless having in mind the tedious and difficult work of the Thames tunnel, proposed to make tunnels under water by sinking large tubes on a previously prepared bed and connecting them together. Since then many inventors have proposed similar schemes. In 1866 Belgrand sank twin-plate iron pipes, 3.28 ft in diameter and 512 ft. long, under the Seine at Paris for a sewer siphon, and there have since been numerous examples of sunk cast iron subaqueous water-pipes.

First Subaqueous Trench Tunnel.—It is believed that the first tunnel of this class, large enough for men to move upright in, was by H A Carson, assisted by W. Blanchard and F. D Smith (in 1893–94), in the outer portion of Boston harbour, for the metropolitan sewer outlet. The later tubes were about 9 ft. exterior diameter, in sections each 52 ft long weighing about 210,000 lbs., made of brick and concrete, with a skin of wood and watertight bulkheads at each end. A trench was dredged in the harbour bed and saddles were accurately placed to support the tubes The latter, made in cradles above the water alongside a wharf, were lowered and towed ½ to ¾ m. to their final positions. After sufficient water had been admitted they were lowered to their saddles by travelling shears on temporary piles. The temporary joints between consecutive sections were made by rubber gaskets between flanges which were bolted together by divers. The later operations were backfilling the trench over the pipes and, in each section, pumping out the water, removing its bulkheads and making good the masonry between consecutive bulkheads, this masonry being inside the flanges This work, about 1,500 ft in length, was done without contractors, by labourers and foremen under the immediate control of the engineers and was found perfectly sound

The double-track railroad tunnel at Detroit, made in 1906–09, for the Michigan Central railroad, was built under the direction of an advisory board consisting of W J. Wilgus, chairman, H A

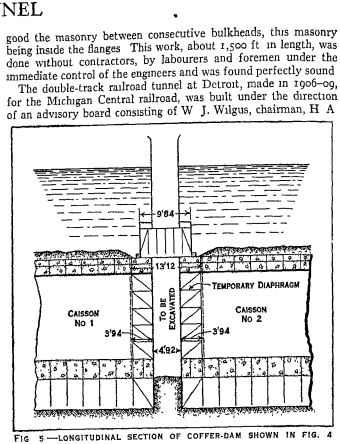


FIG 5.—LONGITUDINAL SECTION OF COFFER-DAM SHOWN IN FIG. 4

Carson and W. S. Kinnear, chief engineer The tunnel is 1 5 m. long, with a portion of 0 5 m. directly under the river A trench was dredged with a depth equal to the vertical dimension of the tunnel below the river bed and about 70 ft below the river surface and grillages were accurately placed in it to support the ends of thin steel tube forms, inside of which concrete was to be moulded and outside of which deposited. These tubes, each about 23 ft in diameter and 262 5 ft. long, were in pairs (one tube for each track) and were joined together at intervals of 12 ft by thin steel diaphragms surrounding the tubes. The planking, to limit the concrete, was secured to the outside edges of the diaphragms. The tubes were made tight, bulkheaded at their ends, floated into place, sunk by admitting water, set on the grillages and the ends of successive pairs connected together by bolts through rubber gaskets and flanges.

The second (1913–15) tunnel crossing of the rapid transit system at New York beneath the Harlem river from Lexington avenue, in Manhattan, to Mott avenue, in the Bronx, consists of four tubes 1,080 ft. long. The general design and method of construction were modifications of those used in the Michigan Central railroad tunnel at Detroit. The tunnel was built in five sections, 199 to 220 ft. in length. A trench was dredged with a width of 81 ft. and side slopes of 45°. The sections (770 tons) were erected on timber falsework and, to launch them, flat boats were run beneath the sections at low tide and the rising tide lifted them from the falsework The ends of the tubes were provided with timber bulkheads to make the tubes float, and when free from the falsework they were towed by a tug into the river, where the flat boats were scuttled and sunk by opening valves provided for the purpose. The tubes then floated on their own bottoms and were towed to the tunnel site and sunk on the timber caps provided for their support in the river The water was then pumped from the tubes and they were lined with concrete The tunnels were completed without the use of compressed air for any part of the work. Alfred Craven was chief engineer for the Public Service Commission and the contractor was the Arthur McMullen and Hoff Company.

The vehicular tunnel beneath the Detroit river, from Detroit, Mich., to Windsor, Canada, was started in 1928. It consists of one tube, 0.95 m. long between portals, with an inside diameter

of 28 ft 4 inches. The portion beneath the river, 2,500 ft long, was built by the subaqueous trench method as in the case of the Michigan Central tunnel at Detroit, and the second Harlem River tunnel, at New York. The land portions, 1,000 ft and 500 ft. in length, were shield-driven The estimated cost was $10,000,000. Because of the international character of this tunnel, it is necessary not only to provide for collection of tolls but for customs and immigration inspection, which requires unusual plaza facilities at both ends of the tunnel Parsons, Klapp, Brinckerhoff and Douglas were engineers and Porter Brothers, contractors

The largest diameter tunnel built by the subaqueous trench method is the Oakland-Alameda estuary tube, in California It is a single tube, 0.67 m in length between portals, of which 2,436 ft. is made up of 12 sections of tubes, each 203 ft long, sunk in a dredged trench, with a depth of water over the tubes of 42 feet The tube sections present the novelty of being made of reinforced concrete, 37 ft. external diameter, with a shell thickness of 30 in and they are enveloped with a membrane of three-ply waterproofing. They were cast in forms in a dry dock at San Francisco, then floated to position and sunk The tunnel has a roadway for vehicles that is 23 ft wide and also has foot-walks that are protected by railings The cost was estimated at $4 500.000 or about one-half the estimated cost if done by the shield method. C E Posey was chief engineer

Tunnelling by Sinking Caissons.—The first New York rapid transit tunnel under Harlem river, built in 1904–05, is an example of tunnel caissons built under water and in part of the work a portion of the permanent tunnel was itself made to serve as the roof of the caisson The tunnel has two tubes, each about 15 ft. in interior diameter, the portion beneath the river being 400 ft long, with a surrounding shell of cast iron itself surrounded by concrete. The outside width of concrete is about 33 feet. Its top is 28 ft. below high water and about 3 ft below the bed of the river The method of construction was devised by McMullen and MacBean, the contractors, who dredged a trench in the river to within 7 or 8 ft of the required depth They then enclosed a space of the width of the tunnel, from shore to mid-stream, with 12 in sheet piling, which was evenly cut off some 2 ft. above the determined outside top of the tunnel On top of this piling was sunk and tightly fitted a flat temporary roof of timber, 3 ft. thick in sections, which was covered with about 5 ft of dredged mud. An air lock was provided in the roof and the water was expelled from this subaqueous chamber by compressed air, after which the remaining earth was easily taken out, and the cast iron and concrete tunnel walls were then built in the chamber For the remaining part of the river the foregoing process was varied by cutting off the sheet piling at mid-height of the tunnel and making the upper half of the tunnel, which was built above and lowered in sections through the water, serve as the roof of the chamber in which the lower half of the tunnel was built in compressed air

Subaqueous tunnels are usually started from shafts near the margins of the streams and, when in soft ground, the shafts are sunk by the use of caissons under compressed air. The caissons remain as part of the permanent construction and from them the shields are started

It may therefore be said that nearly all tunnels of this class are built in part by caissons.

The tunnels of the Métropolitan railway of Paris (F Bienvenue, engineer-in-chief) under the two arms of the Seine, between Place Chatelet and Place Saint Michel, were made by means of compressed-air caissons sunk beneath the river bed, L Chagnaud being the contractor. They were built of plates of sheet steel and masonry, with temporary steel diaphragms in the ends, filled with concrete, making a cross wall with a level top about even with the outside top of the tunnel and about 2 ft below the bottom of the Seine. The caissons were sunk on the line of the tunnel so that adjacent ends and the walls just described, were nearly 5 ft. apart with (at that stage) a core of earth between them Side walls joining the end walls and thus enclosing the earth core on four sides (fig. 3) were next made by the aid of temporary small caissons sunk through about 26 ft. of earth under the river. The tops of the side walls were made even with the end walls. A steel rectangular coffer-dam (figs 4 and 5) was sunk to rest with rubber or clay joint on these surrounding walls. The coffer-dam had shafts reaching above the surface of the water, so that the earth core was easily taken out in free air, after removing the water The adjacent chambers under the caissons were then connected together Three caissons, of a total length of 396 ft were used under the large arm and two, of an aggregate length of 132 ft under the smaller arm of the Seine. Construction was started in 1905 and operation was begun in Jan. 1910, the cost of the tunnel was 2,134 francs per linear foot.

At San Diego, Calif , a tunnel 1,200 ft. long was constructed in 1928 by the caisson method. The tunnel has a cross section of 11 by 12 ft., and forms the intake for cooling water for a power plant

Tunnels Built in Coffer-Dams.—The first subaqueous highway tunnel in the United States was that at Washington street, beneath the Chicago river, in Chicago It is not properly a tunnel, having been built in a coffer-dam. It was constructed in 1866–69 and has two roadways each 11 ft. wide and 13 ft. high, and a footway 10 ft. wide and 10 ft high. It has twice been rebuilt to provide a deeper waterway, the original depth being only 14 feet After the great fire of 1871, it formed the only means of communication between the west side and the business district pending the reconstruction of the bridges In 1869–71 a similar roadway tunnel was constructed at La Salle street and in 1889–94 one at Van Buren street, both beneath the Chicago river These also required rebuilding at later dates to provide deeper waterways. All these tunnels are now used for surface cars only.

TUNNELLING BY THE FREEZING METHOD

Tunnelling by freezing the water contained in the soil, and then excavating through the frozen material in a manner similar to rock, has often been proposed. The method has been used for sinking shafts with a fair degree of success in a number of cases Siberian miners have for years taken advantage of low temperatures to penetrate saturated ground to reach mineral deposits. F. H Poetsch applied the method in 1883 in sinking a shaft in Saxony, for the Archibald mine

While fairly successful as applied to shafts, the method has rarely been used for driving tunnels and then not with entire success In 1884–86, in Stockholm, Sweden, a tunnel for pedestrians was driven in part by the freezing method by Captain Lindmark The length of the tunnel was 758 ft. and it passed beneath a ridge dividing two parts of the city. The cross section was 12 ft. 8 in. high and 13 ft 2 in. wide and the material was coarse gravel with large stones and some clay. It contained water and had very little cohesion. The material was frozen by using a dry air (Lightfoot) machine delivering 25,000 cu.ft of air per hour. The temperature of the air at the machine was —55° C Only about 80 ft. of the tunnel was constructed by this method, the balance of the soil being of firmer material

TUNNELLING THROUGH MOUNTAINS

Where a great thickness of rock overlies a tunnel through a mountain it may be necessary or advisable to do the work wholly from the two ends without intermediate shafts The problem largely resolves itself into devising the most expeditious way of excavating and removing the rock. Experience and modern mechanical devices, such as compressed air drills, and mucking and loading machines, have led to speed and economy

The Hoosac tunnel, in Massachusetts, on the line of the Fitchburg railroad, was the first prominent tunnel in America, and for many years the longest, being 4 73 m. long It was begun in 1855 and finished in 1876, after many interruptions It was memorable for the original use in America of compressed air drills and nitroglycerin, mechanical drilling being adopted in 1866.

In 1857 the first blast was fired in connection with the Mont Cenis work in the Alps, in 1861 machine drilling was introduced and in 1871 the tunnel was opened for traffic. It is located between Modane, France and Bardonecchia, Italy It is a single tunnel 7 98 m. long, with a "horseshoe" section 26 ft. 3 in. by 24 ft 7 inches. The material penetrated was granitic and the

average progress 7·7 lin ft. per 24 hours The approximate cost was £75 per linear foot. With the exception of about 900 lin.ft. the tunnel is lined throughout with brick or stone During the first four years, by hand labour, the average progress was not more than 9 in per day on each side of the Alps, but with compressed air drills the rate towards the end was five times greater.

In 1872 the St Gotthard tunnel was begun and in 1881 the first locomotive ran through it. It lies between Goschenen and Airolo, in Switzerland. It is 9·3 m in length and of the same

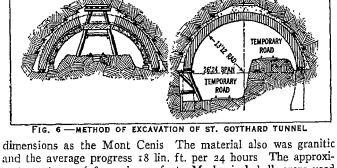


FIG. 6.—METHOD OF EXCAVATION OF ST. GOTTHARD TUNNEL

dimensions as the Mont Cenis The material also was granitic and the average progress 18 lin. ft. per 24 hours The approximate cost was £48 per linear foot Mechanical drills were used from the beginning Tunnelling was carried on by driving in advance a top heading about 8 ft. square, then enlarging this sideways and finally sinking the excavation to invert level (*See* details in fig. 6) Air for working the rock-drills was compressed to seven atmospheres by water turbines of about 2,000 horse-power The two inclines leading to the summit, which total about 36 m., are 28% tunnel, including seven spirals forming almost complete loops within the mountains, in order to gain altitude and distance

The driving of the Arlberg tunnel was begun in 1880, and the work was completed in little more than three years. It is a single tunnel, 6·36 m long, between Innsbruck and Bludenz, in the Tirol. It is 25 ft 3 in. wide and the average progress in 24 hours was 27·2 linear feet The approximate cost was £36 per linear foot The main heading was driven along the bottom of the tunnel and shafts were opened to the upper heading 75 to 210 ft. apart, from which smaller headings were driven right and left. The tunnel was enlarged to its full section at different points simultaneously in lengths of 24 ft., the excavation of each occupying about 20 days and the masonry 14 days. Ferroux percussion air drills and Brandt rotary hydraulic drills were used, the performance of the latter being especially satisfactory. After each blast a fine spray of water was injected, which assisted the ventilation materially. In the St Gotthard tunnel the discharge of the air drills was relied on for ventilation In the Arlberg tunnel over 8,000 cu.ft. of air per minute was thrown in by ventilators. To keep pace with the miners, 900 tons of excavated material had to be removed, and 350 tons of masonry introduced daily at each end of the tunnel, which necessitated the transit of 450 wagons The cost per linear foot varied according to the thickness of masonry lining and the distance from the mouth of the tunnel. For the first 3,000 ft from the entrance the prices per linear foot were £3 16s. for the lower heading; £2 11s. for the upper one; £10 3s. for the unlined tunnel; £15 for the tunnel with a thin lining of masonry; and £21 8s. with a lining 3 ft. thick at the arch, 4 ft. at the sides and 2 ft. 8 in. at the invert

The Simplon tunnel was begun in 1898 and completed in 1905 It lies between Brigue, Switzerland and Iselle, Italy It has a length of 12·3 m. and is over 30% longer than the St Gotthard The greatest depth below the surface is 7,005 feet. A novel method was introduced by driving two parallel headings (56 ft. apart, connected at intervals of 660 ft by oblique galleries), which greatly facilitated ventilation and resulted in increased economy and rapidity of construction, while also insuring the health of the men. One of the headings was enlarged at once to 16 ft. 5 in. wide by 19 ft 6 in. high, for a single track railroad, but the second was left to be enlarged and similarly used at a later date. (This was undertaken in 1918, during the World War, and completed a few years later) Had one wide tunnel been made instead of two narrow ones, it would have been difficult to maintain its integrity, even with the narrow cross section employed, the floor was forced up at points in the solid rock from the great weight above, and had to be secured by building heavy inverts of masonry About 25 m from the portal at Iselle, the "Great Spring" of cold water was struck. It yielded 10,564 gal. per minute at 600 lb pressure per square inch, and reduced the temperature to 55·4° F, the lowest point recorded A spring of hot water was met on the Italian side which discharged into the tunnel 1,600 gal per minute with a temperature of 113° F The maximum flow of cold water was 17,081 gal per minute, and of hot water 4,330 gal per minute These springs often necessitated a temporary abandonment of the work. Water-power from the Rhone at the Swiss and from the Diveria at the Italian end provided the power for operating all plants during construction of most of the work The material penetrated was gneiss, micaschist, limestone and disintegrated mica-schist The average progress per 24 hours was 35 lin ft and the approximate cost £49 7s per linear foot Among the able engineers connected with this work must be mentioned Alfred Brandt, a man of remarkable energy and ability, whose drills were used with much success He died early in the work of injuries received from falling rock.

A group of tunnels—the Tauern, Barengraben, Wocheiner and Bosruck—was undertaken by the Austrian Government in connection with new Alpine railroads to increase the commercial territory tributary to the seaport of Trieste, which at one time was greater than Hamburg

The Loetschberg tunnel, in the Alps of Switzerland, between Kandersteg and Goppersteln, is 9·04 m. long and the maximum grade 0·38% It is a double track railway tunnel, and its construction was begun in Oct 1906 and completed in Sept 1911 It was originally planned to be 8·5 m in length and straight It passed beneath the ancient glacial gorge now filled with detritus and occupied by the Kander river, but at a great depth and it was supposed it would be in solid granite After driving the heading for nearly 2 m it broke through into the gorge which was filled with sand, boulders and water under great pressure In the space of a few moments about 8,000 cu-yd of the material was carried into the heading Twenty-five men, the drills and all equipment were lost beyond hope of recovery. It was bulkheaded off and the line bent to throw it farther into the mountains and beneath the gorge and was then successfully completed, the length being increased one-half mile. The tunnel is operated electrically, using 15,000 volts, single phase, alternating current of 16 cycles

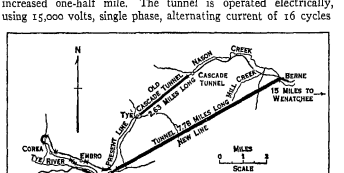


FIG. 7.—MAP SHOWING NEW AND OLD TUNNEL IN THE CASCADE MOUNTAINS, STATE OF WASHINGTON, U.S.A.

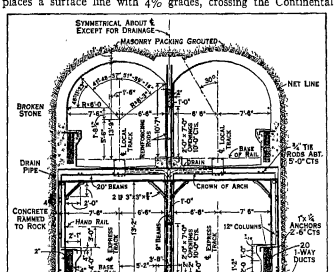
The Connaught tunnel at Rogers pass on the Canadian Pacific railway, pierces the Selkirk range of the Canadian Rockies. It is 5 m. long and replaces a surface line 540 ft higher up Its construction saves 5 m. of distance and replaced 5 m. of snow sheds in a distance of 13 miles. It is a double track tunnel, operated electrically and has a maximum grade of 2·2%. It was built between 1913 and 1916 and was the first American tunnel in which a parallel pioneer tunnel was used. Progress on the pioneer heading reached as high as 817 ft. in 30 days.

Much important tunnel construction has been done in Japan by the Japanese government railways. Probably the most notable

is the Tanna tunnel, between Atami and Mishima, which was started in 1918 and is not yet (1928) completed, as extraordinary difficulties have been encountered. The tunnel is 4,89 m in length and passes under two mountains and the valley between them. The maximum depth below the surface is 1,300 ft and below the valley 600 feet It is partly in soft ground and partly in rock. The rock is andesite. Several methods of excavation have been tried but difficulty with water prevails. At the Atami side, 17 cu ft. per second at a pressure of 240 lb per square inch enters the work, and at the Mishima side 48 cu ft. per second. The actual tost of construction up to the present (1928) has been $500 00 per linear foot.

The Liberty vehicular tunnels penetrate the south hills at Pittsburgh, Pa , and connect with the Liberty bridge, over the Monongahela river. They consist of two parallel tunnels, 59 ft. between centres, each 26 ft. 7 in wide, and 1·1 m long. Each tunnel provides a single line of street railway track not installed and two lines of vehicular traffic on a roadway 21 ft. wide There is also a foot-walk, 4 ft wide, in each tunnel. The tunnels are lined with concrete 24 in. thick. The alignment is straight and the grade continuous at the rate of 0·392%. The work was begun in 1919 and completed about three years later. The total cost was about $6,000,000 For tunnels of their size, unusually rapid progress was made in excavating which was due largely to a bonus system of paying the workmen. Eleven hours' pay was allowed for 9 ft. advance of excavation and 12 hours' for 10 ft , whether summed or not There was also sharp rivalry between the forces in the two tunnels, and the men completing their shift first were allowed to display an American flag at the entrance, the following day, while their competitors were compelled to display a black flag. The average rate of advance per day in the tunnels was over 10 ft. for a period of several months.

The Moffat tunnel, on the Denver and Salt Lake railroad, replaces a surface line with 4% grades, crossing the Continental



BY COURTESY OF N.Y. CITY BOARD OF TRANSPORTATION

FIG 8.—TYPICAL FOUR TRACK TUNNEL IN ROCK

Divide, about 50 m. west of Denver, Colo. At the time of construction it was the longest railroad tunnel in America. It lies at an elevation of 9,200 ft. above sea-level, as compared with 11,660 on the surface line at the summit of the Divide. The work was begun in 1923 and the first train was run through in Feb. 1928. The work consists of two parallel tunnels, 75 ft. apart, one for a single track railroad, 16 ft. by 24 ft. and one for a water tunnel, 8 ft. by 8 ft., which may be used for the future water-supply of the City of Denver. The work was done by the Moffat Tunnel Commission, and paid for by a bond issue by a district of the State in the vicinity and the City of Denver The railroad tunnel is leased to the Denver and Salt Lake railroad. The length of the tunnel is 6·1 m. and the cost including the water tunnel was about $15,470,000. The grades of the railroad tunnel rise from the ends toward the centre, on rates of 0·3% from the east and 0·9% from the west. The construction of both tunnels at one time was taken advantage of to use the water tunnel as a pioneer heading, with cross connections to the main railroad tunnel at intervals of about 1,500 ft., as was done in the Simplon tunnel and the Connaught tunnel at Rogers pass, which offered ad vantages in speed and ventilation. Chloride of lime dumped in one of the lakes, 1,400 ft. above, was found in the tunnel water two hours later

The new Cascade tunnel of the Great Northern railway, between Berne and Scenic, in the State of Washington, is 7·79 m. long. (*See* fig 7) It is the fifth longest railway tunnel in the world and the longest railway tunnel in America. The alignment is straight and the grade 1·565% downward to the west from Berne. Work was started in Dec. 1925. The tunnel was driven from the two portals and a shaft, 622 ft. deep, 2·41 m from the east end, by the centre heading method, to allow radial drilling. A pioneer tunnel, 66 ft. to one side and parallel with the main tunnel, was also driven, from which cross-drifts were driven at 1,500 ft. intervals. This provided a number of points of attack and insured proper ventilation and drainage. The pioneer heading has a width and height of 10 ft. and was advanced 984 ft in one month The pioneer heading was holed through in May 1928, and the main tunnel was completed during the same year and put in operation Jan. 12, 1929 The power used in construction was 2,300 volts, 60-cycle, 3-phase current. The total compressor capacity was 10,450 cu ft. of free air per minute. Haulage in the headings was by 6-ton, 250-volt trolley locomotives, and for the full section 20-ton trolley locomotives. The locomotives were equipped with gathering reels, which allowed their working 500 ft. beyond the suspended trolley. The line speed of the skip hoists at the shaft was 900 ft. per minute. A total force was employed of about 1,800 men and, because far distant from any settlement, complete camps with cottages, schools, recreation halls, stores and shops were provided, equipped with water-supply, electric lights, sewers and modern plumbing. The line through the tunnel is to be operated electrically The estimated cost is $16,000,000. (*See* ELECTRIC TRACTION) The electric railway from Eiger glacier to near the summit of the Jungfrau includes a tunnel 4.4 mi. long, 11 ft. 10 in. wide and 12 ft. 6 in high, with a midway station having arches through the side from which a large part of northern Switzerland can be seen From the Jungfrau terminus, at an elevation of 11,340 ft., an elevator operates to the Meteorological observatory on the peak of the "Sphinx," 376 ft above. The summit, at an elevation of 13,670 ft., can be reached only on foot

Among other important rock tunnels may be mentioned the Albula, through a granite ridge of the Rhaetian Alps, for a single-track narrow-gauge railroad, 3·6 m. long; the Giovi, 6 m. long, north of Genoa, Italy; tunnels on the Midland railway, near Totley in Derbyshire, over 3·5 m. long, largely in shale and at Cowburn, over 2 m. long, in shale and harder rock, each 27 ft. wide and 20·5 ft. high inside; the Arthur Pass tunnel in New Zealand, begun in 1908, 5·3 m. long, for a single track, narrow gauge railway; the Suram, on the Trans-Caucasus railway, for double track, 2·47 m. long, through soft rock; the Gravehois tunnel, on the Bergen railway, in Norway, 3·3 m. long (the longest in northern Europe); the tail-race tunnel for the Niagara Falls Power Company, being 1·3 m. long, 19 ft. wide and 21 ft. high, through argillaceous shale and limestone, costing about $1,250,000; the Tequixquiac outlet to the drainage system for the City of Mexico, 6 2 m. long, costing $6,760,000; the first Cascade tunnel, Washington, part of the Great Northern railway system, 2·63 m long and saving 9 m in distance (now replaced by a still longer tunnel, 7·79 m.); the Gunnison, 5·8 m. long, irrigating 147,000 ac. in Colorado; the double track railway tunnel of the Canadian Northern railway, under Mount Royal in Montreal, Canada, 3·5 m long; and the double track Musconetcong tunnel of the

Lehigh Valley railroad, a little less than 1 m long and costing $5,000,000, holed through in 21 months (June 1928) An example of a small tunnel of considerable length is the Strickler tunnel. It supplies water to Colorado Springs, from Pike's peak of the Rocky Mountains, in Colorado It is 1 22 m long and the cross-section is only 4 by 7 feet

For many reasons, including both safety of the work and interest charges on the capital investment, speed in tunnel construction is desirable, and such work is always pushed as fast as possible During the World War, the Northern railway of France built the Marseille-en-Beauvaisis tunnel, a single track railway tunnel, paralleling a similar one in operation and 60 ft. from it, at the rate of 16 ft per day. It is 1,200 ft long, in badly fissured chalk formation and is lined with concrete It was begun May 21, 1918, the headings met June 28 and it was in operation Aug. 4, a period of 75 days.

TUNNELLING IN TOWNS

Where tunnels have to be carried through soft soil in proximity to valuable buildings special precautions have to be taken to avoid settlement An early successful example of such work is the tunnel driven in 1886 for the Great Northern Railway Company, under the metropolitan cattle market, London. This was done by the crown-bar method, the bars being built in with solid brickwork The subsidence in the ground was from 1 to about 3½ inches Several buildings were tunnelled under without any damage

The District subway of Glasgow, Scotland, consists of a double tube line in the form of a loop, connecting Partick and the northern districts with the centre of the city. It has a length of 6·5 m., and consists in large part of circular tubes, 11 ft internal diameter, built as tunnels, lined with cast iron and driven with a shield and compressed air The line crosses twice beneath the Clyde Work was begun in 1891 and the line opened to traffic in 1897

London has now some 90 m of tunnels for railways, mostly operated by electric traction. (*See* ELECTRIC TRACTION) Most of those which have been constructed since 1890, comprising some 50 m of double tube railways, have been tunnelled through clay by the use of cylindrical shields and have linings of cast iron plates. The tubes are generally small, from 10 to 12 ft in inner diameter, but shields about 23 ft in diameter were used in constructing the stations on the Central London railway, and one 32 ft. 4 in. in diameter and only 9 ft. 3 in long was used for a short distance on the Clapham extension of the City and South London railway. The first of the London tube railways to be built was 3 5 m., of the City and South London, from the Bank under the Thames to Stockwell, begun in 1886 and completed in 1900.

Paris has an extensive system of underground railways some 60 m in length, portions of which were built as tunnels, and a considerable number of which were constructed under the engineering direction of F. Bienvenue. The first line was built in 1898, from Porte Maillot to Porte de Vincennes, and other lines followed at later dates. Instead of using completely cylindrical shields and cast iron walls, as in London, roof-shields (*bouchers de voute*) were employed for the construction of the upper half of the tunnel, and masonry walls were adopted throughout In general, the upper half of the tunnel was executed first and the lower part completed by underpinning

In the case of the tunnelling near important buildings in Boston, in 1896, with a roof-shield 29 ft 4 in in external diameter, the vertical side walls were first made in small drifts, the roof-shield running on top of these, and the core of earth was taken out later and the invert or floor of the tunnel put in last. Each hydraulic press of the shield reacted against small continuous cast iron rods imbedded in the brick arch.

In some large sewerage tunnels in Chicago the shields were pushed from a wall of oak planks, 8 in. thick, surrounding the brick walls of the sewer. The same method was employed in constructing the portion of the Dorchester tunnel, a part of the Boston subway system, beneath Fort Point channel The length of this section was 3,060 ft. the external diameter 24 ft. 2 in. and the thickness of the wood 9 inches

The Pennsylvania railroad tunnels crossing New York city under 32nd and 33rd streets are of unusual size and excavated through mica schist Owing to the close proximity of large buildings and other structures, special methods were adopted for mining the rock to lessen the vibrations from explosions.

Quite long sections of the rapid transit system beneath the streets in New York have been built in tunnels There are about 3 m. of double tube, shield-driven tunnels in Brooklyn. Shorter sections also were built in Manhattan A portion of the line under Flatbush avenue was built in sand with a roof shield of unusual size rolling on the completed side walls, as in the case of the Boston subway. A number of the rock tunnels disclose an exceptional size On the Lexington avenue line, four tracks, two on each of two levels, are in one tunnel excavation, about 32 ft. high and wide (*See* fig. 8) The upper level is carried on steel beams supported by columns at the side and centre. The concrete roof is formed of two arches carried by columns The central portion is known as an "umbrella" section, which it resembles Beneath St Nicholas avenue and Fort Washington avenue five of the subway stations are constructed in tunnel, four of which contain two tracks and two platforms within a single arch having a clear span of 48 feet. The width of excavation required was 57 ft and the height 30 feet. In one case the arch carries a mezzanine platform the entire length of the station, supported by hangers from the roof arch alone

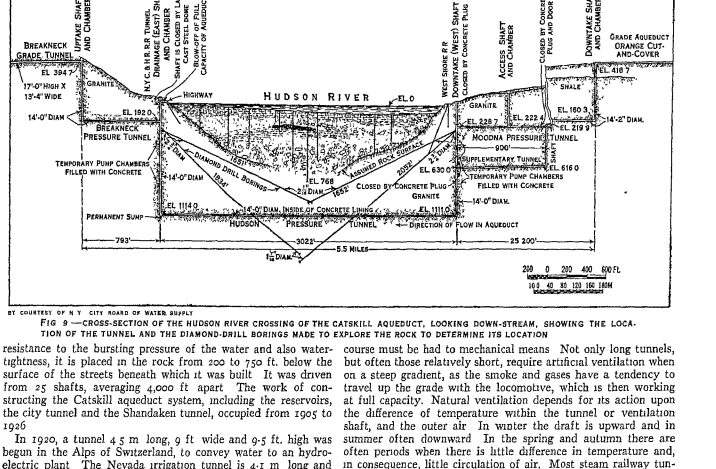
TUNNELS FOR CONVEYING WATER

From very early days, water has been conveyed in aqueducts formed by tunnelling, and some early examples have been mentioned. Generally such tunnels were of small cross-section, but many of them were of great length They also generally followed the grade of the flowing water and where valleys were encountered they were crossed by aqueducts of stone arches, of which examples still exist. Examples of modern tunnelling in connection with water-supply may be found in many sections of the world. Where necessary to obtain water for the supply of large cities it sometimes must be brought from great distances and the sources of supply are generally in mountainous districts.

Both the largest and longest aqueduct tunnels are those supplying water to the City of New York. They also present the novelty of sinking to great depths below the hydraulic grade line and rising again to that line to pass beneath river gorges, which are crossed at many points and also to pass beneath the entire length of Manhattan island. This introduces an internal or bursting pressure in the tunnel, which is called "a pressure tunnel."

The Croton aqueduct, from the Croton dam to the gate house at 135th street, constructed 1885–90, forms, in its completed state, a tunnel 31 m long and includes an inverted siphon or pressure tunnel, passing beneath the Harlem river. A number of short sections were built in open excavation and then covered over

The Catskill water-supply system, which extends from the Catskill mountains to New York city, a distance of about 160 m., consists in large part of true tunnels and includes both the largest tunnels for such purpose, and the longest tunnels for any purpose in the world All are concrete lined There are 25 tunnels on the hydraulic grade, with a total length of 32 m., including the tunnel beneath the Shandaken mountains, 18 1 m long, about 40 m. south-west of Albany, N.Y. It has a "horseshoe" section 11 ft. 6 in. high by 10 ft. 3 in. wide and is the longest continuous true tunnel in the world for any purpose. Seven shafts were used in constructing this tunnel There are also seven pressure tunnels crossing beneath river valleys, including that beneath the Hudson river from Storm King to Breakneck mountain, at a depth of 1,114 ft. below sea-level It is 14 ft internal diameter and 3,022 ft. between the shafts on either side of the river. (*See* fig 9) The total length of the Catskill aqueduct pressure tunnels exclusive of the city aqueduct tunnels is 17 m. and they are from 14 ft. to 17 ft. 6 in. in diameter. The city aqueduct tunnel extends from Hillview reservoir, beneath the Harlem river and nearly the entire length of Manhattan island and the East river, to shafts in Brooklyn, a distance of 18 miles It is the second longest tunnel in the world, and the longest carrying water under pressure. To provide



BY COURTESY OF N Y CITY BOARD OF WATER SUPPLY

FIG 9.—CROSS-SECTION OF THE HUDSON RIVER CROSSING OF THE CATSKILL AQUEDUCT, LOOKING DOWN-STREAM, SHOWING THE LOCATION OF THE TUNNEL AND THE DIAMOND-DRILL BORINGS MADE TO EXPLORE THE ROCK TO DETERMINE ITS LOCATION

resistance to the bursting pressure of the water and also water-tightness, it is placed in the rock from 200 to 750 ft. below the surface of the streets beneath which it was built It was driven from 25 shafts, averaging 4,000 ft apart The work of constructing the Catskill aqueduct system, including the reservoirs, the city tunnel and the Shandaken tunnel, occupied from 1905 to 1926

In 1920, a tunnel 4.5 m long, 9 ft wide and 9.5 ft. high was begun in the Alps of Switzerland, to convey water to an hydro-electric plant The Nevada irrigation tunnel is 4.1 m long and has a cross-section 9 by 9 feet. It was completed in May 1928 at a cost of $1,500,000.

TUNNELS FOR CANALS OR WATERCOURSES

Tunnels for the diversion of streams or canals are of very early date. South of Seleucia, in Turkey in Asia, a river flows through a tunnel 20 ft wide and 23 ft high, excavated 1,600 years ago through rock so hard that the chisel marks are still discernible. In 1766 a tunnel 9 ft wide, 12 ft. high and 1 63 m. long was begun on the Grand Trunk canal, England, and completed 11 years later; and this was followed by many others.

The largest of its kind is the recently completed (1927), Rove tunnel, connecting the Port of Marseilles, France, by canal with the river Rhone. It is 72 ft. wide (width of water 60 ft.) and 50 ft high inside and 4.53 m. long. The cross-sectional area is about six times that of the average double track railway tunnel. Its construction occupied 15 years, and its cost was about 135,000,000 francs, paid by the French Government, the chamber of commerce and the City of Marseilles. The entire cost is to be returned by tolls. The quantity of material excavated was greater than any other tunnel in Europe, about 2,250,000 cu.yd , or 25% more than the great Simplon tunnel. It is lined with masonry, has a tow path 6 ft wide on each side in the form of a series of small arches and has a large masonry portal at each end. This tunnel is 1.7 m. longer than a similar canal tunnel between the Marne and the Rhine.

VENTILATION OF TUNNELS

Ventilation of Steam Railway Tunnels.—The simplest method for ventilating a railway tunnel is to have numerous wide openings to daylight at frequent intervals. If these are the full width of the tunnel, at least 20 ft in length, and not farther apart than about 500 ft., a tunnel can sometimes be naturally and adequately ventilated. Such arrangements are, however, frequently impracticable, especially in long and deep tunnels, and then recourse must be had to mechanical means Not only long tunnels, but often those relatively short, require artificial ventilation when on a steep gradient, as the smoke and gases have a tendency to travel up the grade with the locomotive, which is then working at full capacity. Natural ventilation depends for its action upon the difference of temperature within the tunnel or ventilation shaft, and the outer air In winter the draft is upward and in summer often downward In the spring and autumn there are often periods when there is little difference in temperature and, in consequence, little circulation of air. Most steam railway tunnels are poorly ventilated, except where the difference in elevation of the ends or the prevailing winds, creates a natural draft through them. The need for ventilation is far greater with steam locomotion than with electric motors

The first application of mechanical or fan ventilation to railway tunnels was made in the Lime street tunnel of the London and North Western railway, at Liverpool, which has since been replaced by an open cutting. At a later date fans were applied to the Severn and Mersey railway tunnels

Where possible, the principle ordinarily acted upon, where mechanical ventilation has been adopted, is to exhaust the vitiated air at a point midway between the portals of a tunnel, by means of a shaft with which is connected a ventilating fan of suitable power and dimensions In the case of the tunnel under the Mersey river such kind of shaft could not be provided, owing to the river being overhead, but a ventilating heading was driven from the middle of the river (at which point entry into the tunnel was effected) to each shore, where a fan 40 ft. in diameter was placed In this way the vitiated air is drawn from the lower point of the railway, while fresh air flows in at the stations on each side to replenish the partial vacuum

The principle was that fresh air should enter at each station and "split" each way into the tunnel, and that thus the atmosphere on the platforms should be kept pure In the Mersey tunnel there are five fans; two are 40 ft. in diameter by 12 ft. wide and two 30 ft. in diameter by 10 ft. wide, one of each size being erected at Liverpool and at Birkenhead respectively. In addition there is a high speed fan, 16 ft in diameter, in Liverpool, which throws 300,000 cu.ft. per minute. The ventilation of this tunnel was satisfactory up to a train schedule of 300 trains per day, or one each way every five minutes. As the traffic increased the air shaft became coated with soot several inches thick and arrangements were made to instal electric power.

The central point of the Severn tunnel lies toward the

Monmouthshire bank of the river and ventilation is effected from that point by means of one fan placed on the surface at Sudbrooke Monmouth, at the top of a shaft which is connected with a horizontal heading leading to the centre of the tunnel. This fan, which is 40 ft in diameter by 12 ft. in width, removes from the tunnel some 400,000 cu.ft per minute, and draws in an equivalent volume of fresh air from the two ends.

About 1896 an excellent system was introduced by Signor Saccardo, an Italian engineer, which to a great extent minimized the difficulty of ventilating long tunnels under mountain-ranges where

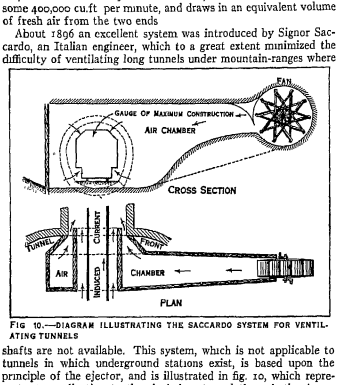


FIG 10.—DIAGRAM ILLUSTRATING THE SACCARDO SYSTEM FOR VENTILATING TUNNELS

shafts are not available. This system, which is not applicable to tunnels in which underground stations exist, is based upon the principle of the ejector, and is illustrated in fig. 10, which represents its application to the single-line tunnel through the Apennines at Pracchia. This tunnel is one of 52 single line tunnels, with a gradient of 1 in 40, on the main line between Florence and Bologna, built by Thomas Brassey. There was a great deal of traffic which had to be worked by heavy locomotives Before the installation of a ventilating system, under any condition of wind, the state of this tunnel, about 9,000 ft in length, was bad; but when the wind was blowing in at the lower end at the same time that a heavy goods or passenger train was ascending the gradient the condition of affairs became very much worse. The engines, working with the regulators full open, often emitted large quantities of both smoke and steam, which travelled concurrently with the train. The goods trains had two engines, one in front and the other at the rear, and when, from the humidity in the tunnel, due to the steam, the wheels slipped and possibly the train stopped, the state of the air was indescribable A heavy train with two engines, conveying a royal party and their suite, arrived on one occasion at the upper exit of the tunnel with both enginemen and both firemen insensible; when a heavy passenger train came to a stop in the tunnel, all the occupants were seriously affected

In applying the Saccardo system, the tunnel was extended for 15 or 20 ft by a structure either of timber or brickwork, the inside line of which represented the line of maximum obstruction of the tunnel, and this was allowed to project for about 3 ft. into the tunnel (fig 10) The space between this line and the exterior constituted the chamber into which air was blown by means of a fan. Considering the length of tunnel, it might at first be thought there would be some tendency for the air to return through the open mouth, but nothing of the kind happened. The whole of the air blown by the fan, 164,000 cu.ft. per minute, was augmented by the induced current yielding 46,000 cu.ft per minute, making a total of 210,000 cu.ft.; and this volume was blown down the gradient against the ascending train so as to free the driver and men in charge of the train from the products of combustion at the earliest possible moment. Prior to the installation of this system the drivers and firemen had to be clothed in thick woollen garments, pulled on over their ordinary clothes, and wrapped round and round the neck and over the head.

The Saccardo system was installed in 1899 at the St. Gotthard tunnel with most beneficial results. The ventilating plant is situated at Goschenen at the north end of the tunnel and consists of two large fans operated by water-power The quantity of air pressed into the narrow mouth of the tunnel is 413,000 cu ft per minute at a velocity of 686 ft., this velocity being much reduced as the full section of the tunnel is reached. After installation, a sample of the air taken from a carriage contained only 10 19 parts of carbonic acid gas per 10,000 volumes

In the Simplon tunnel (12·3 m long), where electricity is the motive power, mechanical ventilation was installed at the time of construction at each end of the tunnel, both for construction purposes and to serve as permanent equipment It is based on a different principle than the Saccardo system A steel sliding door is arranged at each entrance to be raised and lowered by electric power. After the entrance of a train the door is lowered and fresh air forced into the tunnel from the same end at considerable pressure by fans Since completion of the second tunnel following the World War an additional ventilation plant has been built at the north end of the tunnel

The Moffat tunnel in Colorado (6 1 m. long) is ventilated by a mechanical plant based on the principle of forced or induced draft created at one end of the tunnel A building was erected at the east portal which forms an extension of the tunnel and provides a fan chamber on each side A vertical lift gate is provided to close the portal. Two fans are provided, which differ for experimental reasons Each has a diameter of 9 ft and width of 6 feet The motors are of 750 and 500 h.p. with capacities of 450,000 and 350,000 cu. ft. per minute, at velocities of 14 and 10 m. per hour, respectively. Only one fan is operated, the other held in reserve The ventilation is by forced draft for east bound trains and induced draft for west bound trains, which forces the smoke back along the train The results are very satisfactory

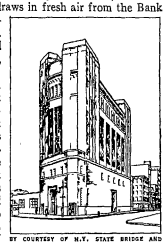
Other railway tunnels partially or completely ventilated by mechanical draft are the Giovi tunnel, in Italy; Hoosac tunnel, in Massachusetts; East Mahanoy tunnel, in Pennsylvania; Big Bend tunnel, in West Virginia, Elkhorn tunnel, in West Virginia; and the Gallitzen tunnel, in Pennsylvania.

Volume of Air Required for Ventilation of Railway Tunnels.—The consumption of coal by a locomotive during the passage through a tunnel having been ascertained, and 29 cu ft of poisonous gas being allowed for each pound of coal consumed, the volume of fresh air required to maintain the atmosphere of the tunnel at a standard of purity of 20 parts of carbon dioxide in 10,000 parts of air is ascertained as follows The number of pounds of fuel consumed per mile, multiplied by 29, multiplied by 500 and divided by the interval in minutes between the trains, will give the volume of air in cubic feet which must be introduced into the tunnel per minute.

Ventilation of Tunnels for Electric Traction.—The introduction of electric traction has simplified the problem of ventilating intra-urban railways laid in tunnels at a greater or less distance below the surface, since the absence of smoke and products of combustion from coal and coke renders necessary only such a quantity of fresh air as is required by the passengers and staff For ventilation the shallow tunnels which form the underground portions of the Metropolitan and District railways in London, open staircases, blow-holes and sections of uncovered track are relied on. When the lines were worked by steam locomotives they afforded notorious examples of bad ventilation, the proportion of carbonic acid gas amounting to from 15 or 20 to 60, 70 and even more parts in 10,000 Since the adoption of electricity as the motive power the atmosphere of the tunnels has very much improved. Samples taken from the cars in 1905 after the adoption of electricity gave as low as 11·27 parts in 10,000.

When deep level "tube" railways were first constructed in London, it was supposed that adequate ventilation would be obtained through the lift-shafts and staircases at the stations, with the aid of the piston action of the trains which, being of nearly the same cross-section as the tunnel, would, it was supposed, drive the air in front of them out of the openings at the stations they were

approaching, while drawing fresh air in behind them at the stations they had left. This expectation, however, was disappointed and it was found necessary to employ mechanical means. On the Central London railway, which runs from the Bank of England to Shepherd's Bush, a distance of 6 m., the ventilating plant installed in 1902 consists of a 300 h.p. electrically driven fan, which is placed at Shepherd's Bush and draws in fresh air from the Bank end of the line and at other intermediate points. The fan is 5 ft. wide and 20 ft. in diameter, and makes 145 revolutions a minute, its capacity being 100,000 cu.ft a minute. It is operated from 1 to 4 A.M and, the openings at all the intermediate stations being closed, it draws fresh air in at the Bank station. The tunnel is thus cleared out each night, during the period when trains are not operated, and the air is left in the same condition as it is outside. The fan is also worked during the day from 11 A.M to 5 P.M., the intermediate doors being open. In a number of the later tube railways in London—such as the Baker street and Waterloo, and the Charing Cross and Hampstead lines—electrically driven exhaust fans are provided at about half-mile intervals; these each extract 28,500 cu.ft of air per minute from the tunnels and discharge it from the tops of the station roofs.



BY COURTESY OF H.Y. STATE BRIDGE AND TUNNEL COMMISSION

BUILDING FOR THE HOUSING OF THE MACHINERY BY WHICH FRESH AIR IS FORCED INTO THE HOLLAND TUNNEL AND USED AIR WITHDRAWN

The Boston system of electrically operated subways and tunnels is ventilated by electric fans capable of completely changing the air in each section about every 15 minutes. Air admitted at portals and stations is withdrawn midway between stations.

In the southerly 5 m of the first rapid transit subway at New York, constructed between 1900 and 1904, which is a four track structure of rectangular section, having the area of 650 sq ft. and built as close as possible to the surface of the streets, ventilation by natural means through the open staircases at the stations was at first relied upon. The results were satisfactory as regards the proportions of carbonic acid gas found in the air, but when intensely hot weather prevailed the tunnel air was sometimes 5° hotter still, due to the conversion of electric energy into heat. Ventilation chambers were added on each side of the subway at points between stations, and the condition became much improved. These chambers are beneath the sidewalks and covered by gratings, and they have been incorporated in the construction of all subways built later. In addition, a partition wall separates trackways for trains running in opposite directions and the piston action of the trains induces a satisfactory circulation of the air.

Ventilation of Vehicular Tunnels.—The need of mechanical ventilation of vehicular tunnels is a development of the last generation due to the advent of vehicles propelled by internal combustion engines. The exhaust from such engines contains smoke and gases, which are irritating to the eyes and also contains a considerable percentage of carbon monoxide, a highly poisonous gas. The first studies of the need of ventilation for vehicular tunnels were undertaken in connection with the construction of the Holland tunnel, at New York, because of its length and the large volume of traffic which was expected to use it. At that time (1920) natural draft was relied upon for the ventilation of all such tunnels in operation, including the Blackwall and Rotherhithe tunnels, in London, which were by far the most important. The traffic in them, however, was only about 100 motor vehicles per hour for each tunnel, compared with an estimated traffic of 1,900 motor vehicles per hour in each tube of the Holland tunnel. Research studies and exhaustive tests were made for this tunnel with the co-operation of the U.S. Bureau of Mines to determine first, the amount and composition of exhaust gases from motor vehicles; second, the physiological effects of these gases and third, the friction losses and power required to handle large quantities of air through concrete ducts.

In the Holland tunnel, the transverse system of ventilation was adopted. The fresh air is introduced continuously along each tube, from conduits provided for the purpose, and taken off at frequent intervals at opposite points. The air therefore travels a course transverse to that of the vehicles and there is a practically equal degree of purity at all points in the tubes. Because carbon monoxide is lighter than air and the exhaust motor gases are warmer than the fresh air introduced in the tunnel and therefore tend to rise, the fresh air ducts are placed beneath the roadways and the exhaust ducts above the roadway ceiling but all in the same tunnel tube. The fresh air is introduced in each roadway by continuous slots along each side above the floor, and the vitiated air is exhausted through louvers in the roof at 15 ft. intervals. The entire tunnel atmosphere is completely changed every 1¾ minutes or 40 times per hour, but so uniformly and gently that the current is hardly perceptible. This eliminates the fire hazard incident to a longitudinal circulation of draught. There are four ventilation shafts, one at each pierhead line and one about midway between the pierhead and portal on each side of the river. The fans are located in the shaft buildings and there are 84 in all, one-half blowers and one-half exhausters

The Liberty tunnels were the first long vehicular tunnels in which artificial ventilation was used. The method adopted is the longitudinal draft system, based on Saccardo's, with modifications by C. S. Churchill. The flow of air in each tunnel is with the traffic, and is induced from a shaft near the centre of each tunnel. Each shaft is divided into two compartments, one of which is used to exhaust the air which enters at the portal from the first half of the tunnel, and the other to blow fresh air into the tunnel at the centre and force it forward to the exit portal Suitably designed nozzles at the centre of the tunnels, at the shafts, prevent the mixing of the air being introduced and ejected. The flow of air is continuous in each tube in opposite directions and wind pipes are provided at the exit of each tube to prevent interference with the ventilation by adverse winds. The ventilating plant and fans are on the hilltop near the centre of the tunnels, at the shafts. The plant was designed to provide for a double line of motor cars in each tube, spaced 200 ft., moving at 15 m. per hour and a proportion of carbon monoxide at 8 parts in 10,000 at the point of exit, the average, therefore, being 3 parts in 10,000. This required the supplying of 280,000 cu.ft. of air per minute in each tube at a velocity of 6 m per hour. (*See* also ELECTRIC TRACTION; TRANSPORT; AQUEDUCTS; etc.) (R. RY.)

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TUNNY or BLUEFIN TUNA (*Thunnus thynnus*), the largest of the tunas. It grows to a large size, in some parts of the world reaching a length of over 10 ft. and a weight of 1,500 lb. It is robust in form, has a short pectoral fin, is bluish above, grey spotted with silver below. It is world-wide in distribution and generally is found in more temperate waters than are the other tunas. It is excellent as food and the object of important fisheries in the Mediterranean, in California and in Japan. Anglers, ranking this fish among the greatest trophies obtainable, pursue it in many parts of the world with rod and reel. Large specimens are often called horse mackerel (*See* also TUNA)

TUNSTALL (or TONSTALL), **CUTHBERT** (1474–1559), English prelate, natural son of Thomas Tunstall of Thurland Castle, Lancashire, seems to have studied at Oxford, at Cambridge and at Padua. Having held several livings in quick succession, he became chancellor to William Warham, archbishop of Canterbury,

in 1511 He was employed on diplomatic business by Henry VIII and Wolsey, being sent to Brussels in 1515 and to Cologne in 1519, while he was at Worms during the famous Diet of 1521 In 1516 he had been made master of the rolls, in 1521 he became dean of Salisbury; in 1522 bishop of London, and in 1523 keeper of the privy seal. For Henry VIII he negotiated with Charles V after his victory at Pavia in 1525 and he helped to arrange the Peace of Cambrai in 1529. In 1530 he succeeded Wolsey as bishop of Durham Tunstall adhered firmly to the traditional teaching of the Church, but after some slight hesitation he accepted Henry as its head and publicly defended this position. In 1537 the bishop was appointed president of the new council of the north, but although he was often engaged in treating with the Scots he took part in other public business and attended parliament, where in 1539 he participated in the discussion on the bill of six articles. Although he disliked the religious policy pursued by the advisers of Edward VI. and voted against the first act of uniformity in 1549, he continued to discharge his public duties without molestation until after the fall of the protector Somerset; then in May 1551, he was placed in custody A bill charging him with treason was introduced, but the House of Commons refused to pass it; he was, however, deprived of his bishopric in October 1552. On the accession of Mary in 1553 he was released and was again bishop of Durham, but during this reign he showed no animus against the Protestants When Elizabeth came to the throne he refused to take the oath of supremacy, and he would not help to consecrate Matthew Parker as archbishop of Canterbury He was placed under arrest at Lambeth, where he died on Nov. 18, 1559.

Among Tunstall's writings are *De veritate corporis et sanguinis domini nostri Jesu Christi in eucharistia* (1554), and *De arte supputandi libri quattuor* (1522). The bishop's correspondence as president of the council of the north is in the British Museum.

TUNSTALL, former market town of Staffordshire, England, and one of those which amalgamated to form Stoke-on-Trent (*q v*), of which it is in the Burslem parliamentary division. The town is of modern growth. The Victoria Institute (1889) includes a library and schools of art and science The neighbourhood is full of collieries, ironworks and potteries Kidsgrove, Chatterley and Talk-o'-th'-hill are large neighbouring villages. There are brick and tile works in Tunstall, but the chief manufacture is earthenware Primitive Methodism originated here.

TUPELO, a city of northeastern Mississippi, U S A , on the west fork of the Tombigbee river, the county seat of Lee county It is at the intersection of federal highways 45 and 78, and is served by the Frisco and the Gulf, Mobile and Ohio railways. Pop. (1950) 11,507; (1940) 8,212 by the federal census It has the largest weekly cattle auctions in the United States

TUPIAN (Tupi), a group of tribes of South American Indians, occupying at the time of the first European contact a narrow and probably continuous strip of the Brazilian coast, from the vicinity of Rio de Janeiro northward nearly to the mouth of the San Francisco river. The original home of this stock probably lay in southern Matto Grosso and Paraguay.

The Tupi tribes were everywhere sedentary or semi-sedentary agriculturalists, hunters and fishermen, but on the Atlantic coast fish was almost the staple food As a rule they wore very little clothing, made much use of feather ornaments and decoration, and wore small labrets in the lower lip. They lived in large communal houses of light construction, although some had the walls of wattle and daub, and protected their often large villages by means of palisades. Their weapons were the bow and club, but they made no use of poison on their arrows They were skilled canoemen, and their vessels carried as many as 60 men. The Tupi tribes were warlike, and strongly organized for war, and commonly ate their prisoners. The dead had their burial in large pottery urns. The language of the coastal Tupis was adopted by the Jesuit missions as a lingua franca throughout a large part of Brazil, and this in time grew into the still considerably used *lingua geral.*

See C. F P von Martius, *Beitrage zur Ethnographie und Sprachenkunde Amerikas,* etc. (Leipzig, 1867); H von Ihering, *The Anthropology of the State of S. Paulo, Brazil* (São Paulo, 1906).

TUPPER, SIR CHARLES, BART. (1821–1915), British colonial statesman, son of the Rev Charles Tupper, D D , was born at Amherst, Nova Scotia, on July 2, 1821, and was educated at Horton Academy. He afterwards studied for the medical profession at Edinburgh University, where he received the diplomas of M.D. and L R C S. In 1855 he was returned to the Nova Scotia Assembly for Cumberland county In 1862 he was appointed governor of Dalhousie College, Halifax; and from 1867 till 1870 he was president of the Canadian Medical Association. Tupper was a member of the executive council and provincial secretary of Nova Scotia from 1857 to 1860, and from 1863 to 1867 He became prime minister of Nova Scotia in 1864, and held that office until the Union Act came into force on July 1, 1867, when his government retired He was a delegate to Great Britain on public business from the Nova Scotia government in 1858 and 1865, and from the Dominion government in March 1868. Tupper was leader of the delegation from Nova Scotia to the Union conference at Charlottetown in 1864, and to that of Quebec during the same year, and to the final colonial conference in London, which assembled to complete the terms of union, in 1866–1867. He was sworn a member of the privy council of Canada, June 1870, and was president of that body from that date until July 1, 1872, when he was appointed minister of inland revenue This office he held until February 1873, when he became minister of customs under Sir John Macdonald, resigning with the ministry at the close of 1873. On Sir John's return to power in 1878, Tupper became minister of public works, and in the following year minister of railways and canals Tupper was the author of the Public Schools Act of Nova Scotia, and had been largely instrumental in moulding the Dominion Confederation Bill and other important measures Sir Charles represented the county of Cumberland, Nova Scotia, for thirty-two years in succession—first in the Nova Scotia Assembly, and subsequently in the Dominion parliament until 1884, when he resigned his seat on being appointed high commissioner for Canada in London

Shortly before the Canadian Federal elections of February 1887, Tupper re-entered the Conservative cabinet as finance minister. By his efforts the Canadian Pacific railway was enabled to float a loan of $30,000,000, on the strength of which the line was finished several years before the expiration of the contract time. He resigned the office of finance minister in May 1888, when he was reappointed high commissioner for the Dominion of Canada in London Tupper was one of the British plenipotentiaries to the Fisheries Convention at Washington in 1887 When the Dominion cabinet, under Sir Mackenzie Bowell, was reconstituted in January 1896 Tupper accepted office, and in the following April he succeeded Bowell in the premiership On both patriotic and commercial grounds he urged the adoption of a preferential tariff with Great Britain and the sister colonies. At the general election in the ensuing June the Conservatives were severely defeated, and Tupper and his colleagues resigned, Sir Wilfrid Laurier becoming premier At the next general election, in 1900, Tupper, long the Conservative leader, sustained in his own constituency of Cape Breton his first defeat in forty years.

See his *Recollections of Sixty Years* (1914); and E M. Saunders, *Life and Letters of Sir Charles Tupper* (2 vols, 1916).

TUPPER, MARTIN FARQUHAR (1810–1889), English writer, the author of *Proverbial Philosophy,* was born in London on July 17, 1810, the son of a doctor of Huguenot descent He was educated at Charterhouse and at Christ Church, Oxford. He was called to the bar at Lincoln's Inn, but never practised. He began a long career of authorship in 1832 with *Sacra Poesis* and in 1838 he published *Geraldine, and other Poems,* and for fifty years was fertile in producing both verse and prose; but his name is indissolubly connected with his long series of didactic moralisings in blank verse, the *Proverbial Philosophy* (1838–67) which for about 25 years enjoyed an extraordinary popularity. The first part was, however, a comparative failure, and N. P. Willis, the American author, took it to be a forgotten work of the 17th century He died at Albury, Surrey, on Nov. 29, 1889

TURA, COSIMO (1430–1498), founder of the Ferrarese school of painting, was born at Ferrara and in his youth appears

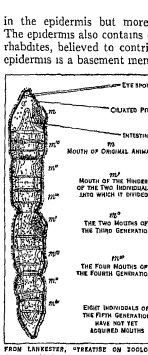
to have visited Padua and Venice He spent most of his life at Ferrara, where he was court painter to the dukes Bono and Ercole. Between 1465 and 1467 he decorated the library of the Palcos of Mirandola with allegorical figures. These works, now destroyed, were described at length by Lilius Gregorius Giraldus (*Ferrarensis Historiae Poetarum*, Basle 1580). The decorations of Duke Borso's chapel at Belriguardo have also perished. In 1469 he painted the organ shutters in the cathedral of Ferrara These two panels, representing an "Annunciation" and a "St. George slaying the Dragon" are still extant The Berlin museum has one of the most important works of the master, "The Virgin and Child Enthroned and saints" Another notable work is the "Madonna and Child enthroned surrounded by six angels playing on musical instruments" (National Gallery, London) This painting was the central panel of an altarpiece of which the lunette representing "the Pietà" is in the Louvre, and one of the wings representing "a monk kneeling and two saints" is in the Colonna collection. Rome. Other notable works are the "St. Jerome" (National Gallery, London), the "Pietà" in the Correr Museum, Venice, and a madonna at Bergamo.

See E. Gardner, *The Painters of the school of Ferrara* (1911).

TURBELLARIA, a class of flatworms or Platyhelminthes (*q v*) in which the body is unsegmented and covered with a ciliated epidermis, and an alimentary canal is generally present. Almost all the group are free-living.

General Morphology.—The body is either subcylindrical or flattened and leaflike or ribbonlike. In length the species range from a fraction of a millimetre to about 20 cm. (7.87 in) In many forms there is a flat creeping (ventral) surface. At or near the anterior end there may be a pair or more of tentacles, and a pair of eyes, or numerous eye spots The margins of the body, in some of the leaflike aquatic forms, are very mobile and can be thrown into undulations, enabling the animal to swim The dorsal surface of the body is often pigmented, and the colours and markings, especially in terrestrial forms, may be very striking and brilliant. In certain aquatic species a green or brown colour is produced by the presence in the tissues of symbiotic green or brown algae.

The body is clothed in a cellular or syncytial epidermis, which may be completely ciliated but often lacks dorsal cilia. It gives off a mucoid slime that comes from gland cells sometimes situated in the epidermis but more often located in the parenchyme. The epidermis also contains elongated densely staining bodies, the rhabdites, believed to contribute to slime formation. Below the epidermis is a basement membrane, and below this various layers of muscle fibres (circular, longitudinal and usually also diagonal). As in the other classes of Platyhelminthes, the internal organs are embedded in parenchymatous tissue.



FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK LTD.)

FIG 2.—RHABDOCOELAN TURBELLARIAN (MICROSTOMA LINEARE) UNDERGOING THE PROCESS OF REPRODUCTION BY DIVISION

The mouth may be located anywhere along the midventral line but is usually more or less central. It leads, usually through a muscular pharynx, often more or less protrusible, into the intestine, except in the order Acoela, which primitively lack an intestine and in which food is taken into the interior parenchymatous mass. The intestine may be a simple sac or may be lobed or highly branched and as a rule, has no opening to the exterior except the mouth.

The nervous system consists of paired anterior ganglia lying ventrally to the gut, and giving off various lateral, dorsal and ventral fibres which are interconnected by other fibres Tactile organs are generally distributed over the skin, and may take the form of special hairlike cilia Other sensory organs also occur in the form of statocysts, ciliated cephalic pits or grooves, and eyes The eyes are usually pigment cups containing the bulbous free ends of the retinal cells, notable for their rod border An excretory system of the platyhelminth type with flame cells is usually present. The ex-

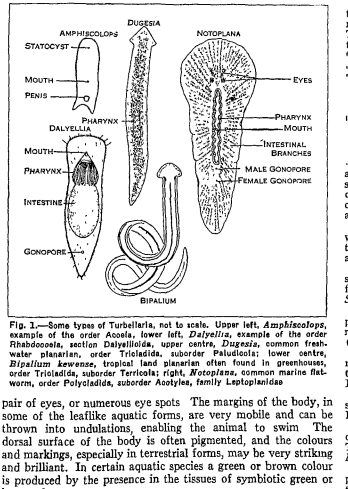


FIG. 1.—Some types of Turbellaria, not to scale. Upper left, *Amphiscolops*, example of the order Acoela, lower left, *Dalyellia*, example of the order Rhabdocoela, section Dalyellioida, upper centre, *Dugesia*, common freshwater planarian, order Tricladida, suborder Paludicola; lower centre, *Bipalium kewense*, tropical land planarian often found in greenhouses, order Tricladida, suborder Terricola; right, *Notoplana*, common marine flatworm, order Polycladida, suborder Acotylea, family Leptoplanidae

The body is clothed in a cellular or syncytial epidermis, which may be completely ciliated but often lacks dorsal cilia. It gives off a mucoid slime that comes from gland cells sometimes situated

Classification.

Acoela.

a frontal cluster of glands Without excretory system. Gonads consist of strands of differentiating sex cells not delimited from the parenchyme Oviducts absent but male ducts and simple penis present The chief families are the Proporidae without, and the Convolutidae with, a seminal bursa, *i.e.*, a sac for receiving the partner's sperm.

Order 2. **Rhabdocoela.**—Small worms, marine, brackish or freshwater with complete digestive tract; intestine a simple blind sac or tube With excretory system and usually with oviducts. Seldom with a statocyst Gonads few, mostly compact

Suborder 1 Catenulida.—Fresh-water forms with simple pharynx, single median nephridium, no yolk glands. Asexual reproduction by fission. One family, Catenulidae, represented by the very common *Stenostomum*

Suborder 2 Macrostomida.—Fresh-water or marine, with simple pharynx, paired nephridia, no yolk glands Two families, Macrostomidae without, and Microstomidae with, asexual reproduction by fission (fig. 2).

Suborder 3. Lecithophora.—Fresh-water, marine or terrestrial rhabdocoels with bulbous pharynx and yolk glands more or less distinctly separated from the ovaries Reproduction exclusively sexual Includes numerous families

Section 1 *Dalyelloida.*—Rhabdocoels with a dolniform (cask-shaped) pharynx, oriented parallel to body surfaces. Chief family, Dalyellidae, with complicated male apparatus.

Section 2 *Typhloplanoida.*—Rhabdocoels with a rosulate (spherical) pharynx oriented at right angles to body surfaces. Chief family, Typhloplanidae with genera *Mesostoma, Typhlopiana, Castrada, Phaenocora*, etc.

Section 3 *Kalyptorhynchia.*—Mostly marine rhabdocoels with a protrusible food-catching proboscis at the anterior tip (in addition to the usual pharynx). Represented by *Gyratrix, Polycystis, Acrorhynchus*, etc

Suborder 4. Temnocephalida.—Ectocommensal fresh-water rhabdocoels of dalyellioid affinities living on crayfish and other fresh-water animals. Found only in tropical and subtropical countries. The body

has 2 to 12 fingerlike tentacles and one or more adhesive disks.

Order 3. **Alloeocoela.**—Slightly larger worms mostly of plump, cylindroid form, with simple or slightly lobulated intestine. Mostly with two ovaries and numerous testes. Chiefly marine, a few in fresh water. Represented by *Prorhynchus, Plagiostomum, Cylindrostomum, Monoecha, Bothroplana*, etc.

Order 4. **Tricladida.**—Larger worms of flattened elongated form with phcate pharynx and three-branched intestine (fig. 3). With two ovaries, few to many testes, distinct yolk glands, copulatory sac for receiving sperm, and single gonopore behind the mouth.

Suborder 1. Maricola.—Marine planarians with copulatory sac behind the male apparatus. *Procerodes*, free-living, and *Bdelloura, Syncoelidium, Ectoplana* epizoic on the horseshoe crab, *Limulus*.

Suborder 2. Paludicola.—Fresh-water planarians with copulatory sac anterior to the penis. Familiar animals of ponds and streams; *Planaria, Phagocata, Dendrocoelum*, etc.

Suborder 3. Terricola.—Terrestrial planarians of tropical and subtropical jungles, sometimes reaching great lengths, often with bright colour patterns. *Geoplana, Bipalium, Rhynchodemus*, etc.

Order 5. **Polycladida.**—Marine, often large, much flattened and leaflike flatworms with numerous eyes and much-branched intestine radiating from the pharynx to the periphery.

Suborder 1. Acotylea.—Without a ventral sucker. Pharynx mostly rufiled, mouth not near anterior end Tentacles when present borne near the brain. Stylochidae, Leptoplanidae, Planoceridae, etc.

Suborder 2. Cotylea.—With a ventral sucker behind the genital pores. Pharynx rufiled or cylindrical. Mouth anterior. Tentacles when present occur on the anterior margin. Pseudoceridae, Euryleptidae, Prosthiostomidae, etc.

The classification proposed by Meixner (*Die Tierwelt der Nord-und Ostsee*, Teil iv b) differs in that the first three suborders of the Rhabdocoela are raised to the rank of orders and the Tricladida are made a suborder under Alloeocoela. While there are justifications for these changes, it seems best to adhere to the older classification.

Occurrence and Habits.—Most Turbellaria are aquatic. They are abundant on the seashore and in fresh water, where they lurk among weeds or under stones, and in the crannies of rock pools. They creep by a gliding movement caused in the smaller forms by ciliary action, in the larger ones by muscular waves; some are able to swim. Many species of triclads are terrestrial. These occur in damp localities and chiefly in tropical or subtropical countries, though a few are known in temperate latitudes. They are somewhat slughike in form and habits. A few Turbellaria, mostly dalyellioid rhabdocoels, are parasitic. These are marine, and are found in such animals as sea-urchins, holothurians and molluscs. The free-living forms are almost all carnivorous, feeding either on microscopic organisms or on worms, molluscs and insects. The protrusible pharynx is used either to engulf the prey whole or to pierce it and suck up its juices after it has been enveloped in a coating of mucus.

Development and Life History.—The development of most of the Turbellaria is direct (*i.e.* without metamorphosis). In certain polyclads, however, the embryo develops into a swimming larva ("Müller's larva") provided with eight ciliated lobes, and somewhat resembling the trochophore larvae of certain annelids. In the Rhabdocoela the eggs are generally enclosed in shells, each being provided with a number of separate yolk cells. In the Acoela and Polycladida the ova themselves may contain yolk granules, and the eggs are usually laid in clumps surrounded by a gelatinous envelope. The ova of triclads are laid, several together, surrounded by amoeboid yolk cells, in a cocoon.

A form of asexual multiplication occurs in certain rhabdocoels (Microstomidae) and triclads. In the former the body becomes constricted in the middle and forms two complete animals, each of which again subdivides, and so on, until a whole chain of individuals is formed, head to tail, eventually breaking up into separate organisms. In some of the triclads spontaneous fragmentation may occur, with regeneration of the parts to form complete animals. But even forms which at one season reproduce in this manner, do so at another by means of eggs. In certain rhabdocoels (*e.g. Mesostoma*) two distinct types of eggs are produced according to the season. During warm weather the eggs laid are thin-shelled "summer eggs" which develop rapidly, while thick-shelled "winter eggs," whose contents remain longer in a resting condition, are laid in cold weather. In other cases the eggs are apparently similar at all seasons, but develop more rapidly in warm water than in cold. Thus in shallow pools subject to sudden and frequent changes of temperature, the population increases rapidly during warm weather, while during cold spells the survival of the race is assured. (*See* Platyhelminthes.) (H. A. B.; L. H. H.)

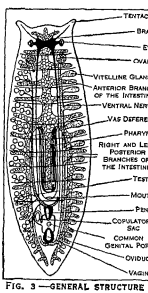


FIG. 3.—GENERAL STRUCTURE OF A TRICLADID TURBELLARIAN. THE THREE-BRANCHED INTESTINE IS CHARACTERISTIC OF THIS GROUP

TURBERVILLE (or Turbervile), **GEORGE** (1540?–1610?), English poet, second son of Nicholas Turberville of Whitchurch, Dorset, belonged to an old Dorsetshire family, the D'Urbervilles of Thomas Hardy's novel, *Tess*. He became a scholar of Winchester college in 1554, and in 1561 was made a fellow of New college, Oxford. In 1562 he began to study law in London, and gained a reputation, according to Anthony à Wood, as a poet and man of affairs. He accompanied Thomas Randolph in a special mission to Moscow to the court of Ivan the Terrible in 1568. Of his *Poems describing the Places and Manners of the Country and People of Russia* (1568) mentioned by Wood, only three metrical letters describing his adventures survive, and these were reprinted in Hakluyt's *Voyages* (1589). His *Epitaphs, Epigrams, Songs and Sonets* appeared "newly corrected with additions" in 1567. In the same year he published translations of the *Heroycall Epistles* of Ovid, and of the *Eglogs* of Mantuan (Gianbattista Spagnuoli, called Mantuanus), and in 1568 *A Plaine Path to Perfect Vertue* from Dominicus Mancinus. The *Book of Falconry or Hawkeing* and the *Noble Art of Venerie* (printed together in 1575) may both be assigned to Turberville. He probably died before 1611.

TURBET I HAIDARI, a town in the province of Khurasan in Iran, situated at an elevation of 4,400 ft., about 76 mi. S. of Meshed, on the motor road to Zahidan (Duzdab), via Qain and Birjand.

The town is a centre of many roads. In the northeast are the ruins of an old citadel, or the Ark of Ishaq Khan; but the principal feature of the town is its bazaar formed of four domevaulted streets radiating from a larger central dome. Before the famine of 1871, Turbet i Haidari was populous, but the population was, it seems, reduced by 20,000. The town had recuperated before World War I owing to increased trade between Russian Turkistan and Afghanistan; the population (est. 1944) is about 12,000, chiefly of Turki Qarai stock, who were settled there by Timur in the 14th century; but many of the merchants and artisans are Yazdis.

The surrounding district is very fertile and much wheat and barley are sent to other parts. The chief trading activities are wool buying, silk production (now greatly declining), carpet buying from the Baluch nomads round about, and the making of copper utensils.

The town, formerly known as Zavah, derives its name from the *turbeh*, or tomb, of a holy man named Qutb ud Din Haidar, the founder of the ascetic sect of dervishes known as Haidaris, who died *c.* 1230 and is buried in a domed building just outside the town.

TURBINE: STEAM. A turbine is a rotary motor in which the shaft is rotated steadily in its bearings, not by means of cranks as for example in a reciprocating engine (*see* Steam Engine), but by a current of water, air, steam or any other fluid. Thus a steam turbine is a "prime mover" which generates motive power in the same manner as the familiar country-side "wind mill," which is used for grinding corn or pumping water. Instead of a current of air being used to rotate the shaft by means of "sails" as in a "windmill," a current or blast of steam issuing from a number of fixed nozzles, is employed to rotate the shaft of a steam turbine by means of "vanes," "buckets" or "blades."

The relatively small power obtainable from the wind with a reasonable sail area, and the discontinuity of the breeze, render the windmill of comparatively little economic importance, but with the steam turbine on the other hand, the matter is very different. Not only is there the convenience of uniform rotary motion applied to a shaft direct, but also the powerful and unfailing steam blast generated with coal or oil fired boilers, and the enormous power output obtainable from a turbine of very moderate dimensions.

The economic value of the steam turbine has, therefore, been

the incentive to its development to the utmost, and its evolution has been carried out in the face of all obstacles,—a story worthy of an epic of mechanical engineering—for many years almost entirely owing to the efforts of the Hon. Sir Charles A. Parsons, O M , K C B , etc , and his associates and in more recent years by a host of other workers as well.

General Mechanical Features.—In the steam turbine, in which a pure twist or driving torque is the only force applied to the shaft, the entire mechanism may be described under the following six headings.

(1). The system of "blading" by means of which the motive power is produced. The term "blading" (as distinct from "blades") is used to denote collectively the fixed nozzles and the rotating "vanes" or "blades"

(2). The rotating shaft, or "rotor," which carries the rotating elements of the blading, and collects and transmits the driving torque.

(3). The casing, which carries the nozzles or fixed elements of the "blading," balances or provides the reaction to the driving torque (*see* torque tube in a motor car), and embodies the supports or bearings for the rotor

(4). The speed-regulating mechanism.

(5). The lubricating system for the bearings.

(6). The coupling between the rotor and the apparatus intended to be driven by it

The blading may consist of a set of fixed nozzles (*see* fig 1) directing high-velocity steam jets on to "vanes" or "blades" mounted round the rim of the wheel If there were no blades or other obstructions in front of the steam jets, the latter would travel forward in a straight line The curved surfaces of the blades, however, forcibly deflect the jets from the free path, the blades themselves receiving in consequence an "impulse" in the direction opposite to the deviation which they produce Hence the name "impulse turbine" applied to a turbine of this kind The steam jets in passing through the blade passages and doing work on the wheel, will be continuously slowed down and will leave the moving blades with a velocity much less than the initial

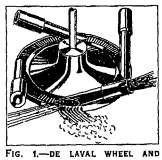


FIG. 1.—DE LAVAL WHEEL AND NOZZLES SHOWING DEVIATION OF THE STEAM JETS BY THE BUCKETS

Special Difficulty of the Problem.—Such a very simple arrangement (the counterpart of the well-known Pelton water wheel for utilizing waterfalls) although widely adopted for small powers, is not applicable to large powers

The underlying reason for the unsuitability of the simple steam-wheel as compared with the water wheel is to be found from a comparison of the physical properties of steam and water. Water is an in-elastic fluid; that is, it has practically the same density (weight per cubic foot) at all pressures, and in a water turbine, the water jet velocity generated by a given fall in pressure is determined from the static head corresponding to that pressure If h is the height of a column of water, the difference of pressure between the top and the base of the column is that due to the weight of the water in the column pressing on an area equal to the sectional area at the base. Denoting this sectional area by A then hA=the volume of the water, the weight of the column ρh A, and p, the pressure per unit area at the base, =ρh where ρ is the density or weight per unit volume.

The jet velocity due to such a head of water is the same as that acquired by a body falling freely through the height h under gravity viz., $\sqrt{2gh}$ thus $V^2=2gh=2g\left(\frac{p}{\rho}\right)$. Each pound of water coming in at the top of the column and discharged at the base with velocity V has lost potential energy gh and gained an equivalent amount of kinetic energy $\frac{1}{2}V^2$ This is the energy per pound which would be available for use in a water turbine.

The static head of water corresponding to a pressure of 265 lb. per sq. inch would be 610 feet and the velocity due to this head 198 feet per second.

With a fluid of less density, a longer column would be required in order to have the same pressure at the base. In other words the same pressure would then correspond to a greater static head Considering steam at, say, 265 lb per sq. inch and a temperature of 700° F, the density of the steam is $\frac{1}{160}$ of that of water and it would therefore require at that density a column 160 times the height to give the same pressure, or $160\times 610=97{,}600$ ft. But this is not all. Steam, in contrast with water, is a highly elastic fluid, and the effective head in steam would be even greater than 97,600 ft, because of the expansion in volume which takes place as the pressure falls. During this process, successive decrements of pressure, associated with successively decreased density, contribute increasing amounts to the static head (figure 2c.). As a consequence of the expansion the fluid cools down considerably, and the actual head is therefore the height of a column of steam at varying density (and temperature); the pressure at any point of the column is that due to the weight of the steam above it and the density at that point is the density corresponding to such pressure. Such a column of steam with a pressure at its base of 265 lb. per sq. inch and a pressure at the top of $\frac{1}{2}$ lb. per sq inch (measured from zero pressure or an absolute vacuum) would have a height of 365,000 feet. (It should be noted that pressures measured from zero pressure [or an absolute vacuum] are designated absolute pressures. A pressure below atmospheric is expressed either as an absolute pressure or as a vacuum, by which is meant the defect below atmospheric pressure. Thus if the barometer reading is 30″ of mercury then a perfect vacuum would be called a vacuum of 30″ of mercury; and a vacuum of, say, 28″ of mercury is less than a perfect vacuum by the pressure corresponding to 2″ head of mercury.) This therefore is the value of the effective static head of steam when allowed to expand between these pressures.

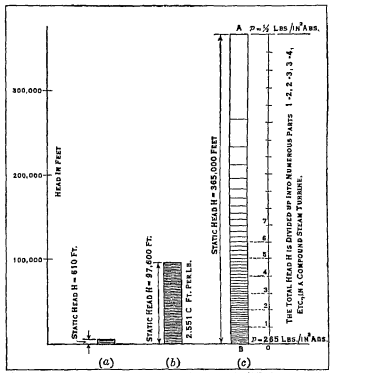


FIG 2.—COMPARISON OF WORKING "HEAD" FOR A WATER TURBINE AND A STEAM TURBINE RESPECTIVELY

Thus the static head h of an expanding fluid can be considered as the height of a column of the fluid at its natural density, that is to say, of a density diminishing from the base upwards just in the same manner as the atmospheric pressure decreases with altitude.

The potential energy gh is then available as before (*i e* , as in the water turbine) for conversion into kinetic energy $\frac{1}{2}V^2$ of the resulting steam jets. The velocity corresponding to a head of 365,000 feet, however, is 4,800 feet per second, and it can easily

be understood therefore that a construction suitable for utilizing the energy of water jets with a speed of 198 feet per second is not suitable for steam in which the available energy per pound corresponds to a jet speed of 4,800 feet per second

Figure (2) is a diagrammatic comparison of the effective static heads above considered, shown as columns of fluid having a pressure of 265 lb. per sq inch at the base. (a) shows the height of such a column of water, (b) that of a fluid at the uniform density which steam has at 265 lb per sq inch pressure, and (c) that for steam at its natural density.

Actually, of course, the head of steam for a steam turbine is not obtained by means of a vertical column, but by generating steam under pressure in a boiler.

This does not alter matters, however, for imagine a steam boiler, generating steam at 265 lb. per sq. inch absolute, to be connected to the base of the column (c) in figure (2) Then evidently the steam will rise up the column, falling gradually in pressure and temperature just as it would do in a turbine, and at an altitude of 365,000 feet it would leave the top of the column as exhaust steam at 4lb /in^2 absolute (assuming the external atmosphere absent) Where has the energy originally in the high pressure steam gone? Clearly it is in the gravitational potential energy of the steam raised to the top of the column In whatever manner the head is generated, the stored energy per pound of fluid is the same. This energy, namely Sum $\frac{P}{\rho}$ has been calculated for steam from an experimental knowledge of its properties, and is tabulated for the use of engineers. It is, however, usual to express it in heat units instead of mechanical units, the two being strictly equivalent (*See* THERMODYNAMICS)

Table I. gives the theoretical values for the velocity attainable by allowing high pressure steam to escape through a suitably shaped orifice or nozzle, to a place at lower pressure

TABLE I.—*Theoretical Velocity of Efflux of a Steam Jet*

Steam pressure lb./in.^{2} abs (dry saturated)	Velocity into atmosphere Ft /sec	Velocity into vacuum of 28″ mercury (baro. 30″) Ft /sec
10		2,677
15		2,900
30	2,602	3,263
50	2,208	3,510
75	2,425	3,671
100	2,645	3,804
125	2,777	3,905
150	2,900	3,983
175	3,000	4,050
200	3,075	4,100
250	3,207	4,190

The Simple Steam "Windmill" of de Laval.—The practical difficulty in utilizing such high velocity steam jets efficiently in a "simple" steam turbine will soon be apparent. Simple mathematical theory shows, and experiment confirms, that the proportion of energy in a jet of steam which can be converted into useful work on the turbine shaft, depends mainly on the relation which is made (by the designer) to exist between the linear velocity U of the "vanes" or "blades," and C_1 that of the jets impinging on them. In other words, the efficiency of a turbine depends mainly on the ratio called the "velocity-ratio," $\frac{U}{C_1}$, usually denoted by the symbol α. Figure 3 shows a curve (A) of the "blading" efficiency obtainable from a "simple" turbine of the type shown in figure (1). Losses due to windage, eddies and friction in the turbine itself, and to friction of bearings, etc., will absorb some of the power developed, so that the "brake" efficiency at the driving end of the shaft will be considerably less.

Here it may be noted that the expression "efficiency of a turbine" must be carefully understood, as it is liable to misinterpretation. If the energy of the steam jet is, say A units of work and out of this the turbine usefully delivers B units to the coupling at the driving end, then the brake efficiency of the turbine is $\left(\frac{B}{A}\right)$. A however, may have very different values, according to the steam conditions The more favourably chosen the steam conditions are, the greater fraction A may be made of the total latent energy E in a lb. of coal or oil fuel. In

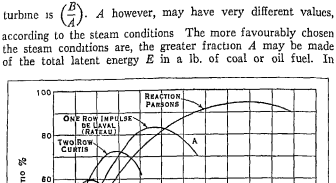


FIG. 3.—CURVES OF EFFICIENCY BLADING

other words, the net efficiency of the whole plant (boilers and turbine) is $\frac{A}{E} \times \frac{B}{A} = \frac{B}{E}$. The important point to be realized is that whilst $\frac{B}{A}$ may be and generally is, in a large modern turbine, about 85%, on the other hand $\frac{A}{E}$ does not even in the very best plants exceed about 36 o% so that the overall efficiency is about (0·36 × 0 85) × 100=30·5% from fuel to brake horse power. This comparatively low figure is not due to imperfections in the plant owing to incorrect design, but to a fundamental law of thermo-dynamics which places a limitation on the thermo-dynamic efficiency of any engine, however perfect, designed to convert the heat of fuel into motive power. For further information upon this aspect of the problem of the utilization of the heat energy in fuel, *see* THERMODYNAMICS

To resume, it will become apparent from fig 3 that the best efficiency for this type of blading is obtained at a "velocity-ratio" of about o 45, that is to say, when the velocity of the blades is about half the velocity of the steam jets. Referring to Table I. it will be observed that with an ordinary boiler pressure of, say, 175 lb /in.^{2} absolute, and a final exhaust pressure of 1 lb /in^2 absolute, the jet velocity is of the order of 4,000 feet per second If the blade velocity is to be o 45 of this, it will be about (o 45 × 4,000)=1,800 ft per sec

The centrifugal forces on a turbine wheel and blades operating at this mean blade velocity will be very great, and the consequent centrifugal stresses also A rim speed of 1,800 feet per sec. would be that of a 10″ wheel revolving at 41,000 revolutions per minute The maximum stress in a disc at this speed would be of an order which is not practicable so that a turbine consisting of a single wheel can only have o poor velocity ratio, and is only suitable for small outputs for which efficiency is of secondary importance. The speed of revolution is necessarily high, and such turbines have therefore to be coupled to the machines they drive through some form of speed-reducing gear, usually of the mechanical type, with double helical gear wheel teeth

The "simple" type of steam turbine or steam "windmill" was first perfected by the great Swedish Engineer Gustav C P. de Laval in 1887 after several years of preliminary work. It ranks as a great achievement inasmuch as, within the limitations just described, it is a perfectly practical solution of the problem, worked out moreover in days when reliable data on the proper-

ties of steam were practically non-existent

Velocity Compounding of Steam Turbines.—If the mean blade speed of a simple steam "windmill" such as the de Laval, is less than about half the circumferential velocity of the steam jets, the latter will not be slowed down sufficiently in the space following the moving blades, and some of their energy will be wasted. In other words, the velocity of the steam will not be a minimum. In order to provide means for recovering the energy in the residual velocity, about the year 1898, Curtis developed in the United States of America a system known as "velocity compounding" In this arrangement he fitted additional guide blades to re-direct the steam on to further rows of moving blades Figure 4 illustrates a series of such additional rows. The characteristic feature is that the fall in steam pressure is confined to the nozzles, the steam flowing through the remaining blades at constant pressure, but with ever diminishing velocity, because of the energy absorbed by the wheel and transmitted to the turbine coupling It might be supposed these rows could be made sufficiently numerous to extract the whole energy economically in a single pressure stage, *i.e.*, that pressure compounding would be unnecessary. Unfortunately, however, reversal of the direction of the motion of steam at high velocity is accompanied by loss of energy and this, together with frictional losses, soon imposes a limit to the number of reversals which can be efficiently employed The "two-row" Curtis wheel has been employed widely but the 3-row Curtis wheel is so inefficient that it is now seldom used except in small auxiliary turbines or sometimes in marine astern turbines where efficiency is less important.

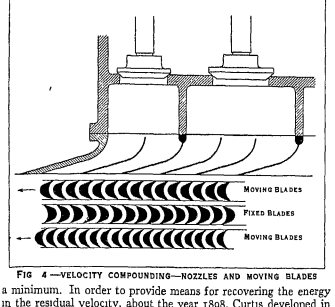


FIG 4.—VELOCITY COMPOUNDING—NOZZLES AND MOVING BLADES

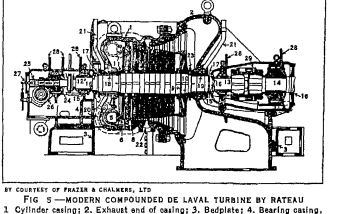
Parsons' Master Principle of "Pressure Compounding."—The application of steam turbines on these lines could never, owing to the limitations described above, become general, and the master invention which has opened up an unlimited field of utility was supplied in 1884 by Sir Charles A. Parsons

The high efficiency already attained by water turbines (*q.v.*) operating under very moderate "heads" of water, made it seem to him possible that if a number of "simple" one wheel steam turbines were placed in series on the same shaft, one turbine exhausting its steam into another, and so on, it would be practicable to divide up the energy of expansion of the steam over a number of such "elementary" turbines so that the effective "head" of steam (in other words, the amount of expansion) in each would be small.

Thus, since the velocity of efflux of the steam jets in each "simple" turbine of the series would be correspondingly reduced, the latter would operate under conditions more analogous to the water turbine, that is with moderate and practical blade speeds, in conjunction with high "velocity-ratio" and high efficiency

This fundamental concept was subjected to practical test by Parsons in a turbine of his own design at Gateshead-on-Tyne, England, in 1884, and has since proved to be the only solution. In fact, this principle of "pressure-compounding" or using several "simple" turbines in series is an essential feature of *all* modern steam turbines of large output and high economy, because it permits reasonable blade velocities to be adopted, without sacrifice of efficiency (Parsons' original 10 h p steam turbine and dynamo may be seen in the Science Museum, South Kensington, London.)

Application of Parsons' Principle.—The application of this principle may best be grasped by considering its application (at a later date) to the simple turbine of de Laval Figure 5 gives a diagram of a modern turbine of this kind, associated chiefly with the name of Rateau, who developed it from about the year 1896 The turbine consists of a series of de Laval wheels or steam "windmills" all mounted on the same shaft, each wheel being placed in a compartment. High pressure steam is admitted to the first wheel of the series through suitable nozzles. (Figure 6) In the partition dividing the first wheel from the second wheel there is a second set of nozzles so proportioned as to maintain a suitable back pressure in No 1 compartment and not allow the steam to escape from it too freely By thus limiting the drop of pressure from boiler pressure to that in the first compartment, the steam velocity generated in the first set of nozzles can be adjusted to any desired value and consequently also the resulting jet velocity



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FIG 5.—MODERN COMPOUNDED DE LAVAL TURBINE BY RATEAU

1 Cylinder casing; 2. Exhaust end of casing; 3. Backplate; 4. Bearing casing. 5. Steam inlet belt, 6 Nozzle ring; 7. Diaphragms; 8. Bladed wheels; 9. Shaft collar; 10. Distance piece; 11. Locking nut, 12. No. 1 bearing; 13. No. 2 bearing; 14 No. 3 bearing, 15, 16. Oil baffles; 17 Oil throwers; 18. No. 1 gland; 19. No 2 gland; 20. Leak off pipe from 18; 21. Vapour pipe; 22. Steam extracting belt; 23. Locking nut; 24. Segmental thrust and adjusting block; 25. Shaft runaway governor; 26 Worm and wormwheel for driving speed-regulating governor; 27 End gauge; 28. Oil temperature thermometer; 29. Flexible claw coupling

The passages which form the exhaust or exit ports from the first wheel are actually nozzles delivering the steam in the form of jets on the second wheel of the series In the succeeding wheels the same procedure is followed over and over again, the initial steam pressure being thus reduced by appropriate steps until finally the exhaust at exit pressure is reached in the last wheel. From a correct knowledge of the properties of steam and of the losses which occur due to friction and eddies, it is possible to choose the proportions of the nozzles so that every wheel of the series operates at a proper velocity-ratio.

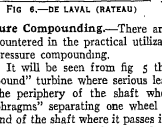


FIG 6.—DE LAVAL (RATEAU)

Difficulties Attending Pressure Compounding.—There are certain unavoidable losses encountered in the practical utilization of the Parsons principle of pressure compounding.

It will be seen from fig 5 that there are places in a "compound" turbine where serious leakage can take place, viz. round the periphery of the shaft where it passes through the "diaphragms" separating one wheel from another, and also at each end of the shaft where it passes into the outer atmosphere

The necessary surface speeds in successful steam turbines are so high that generally speaking leakage cannot be entirely stanched

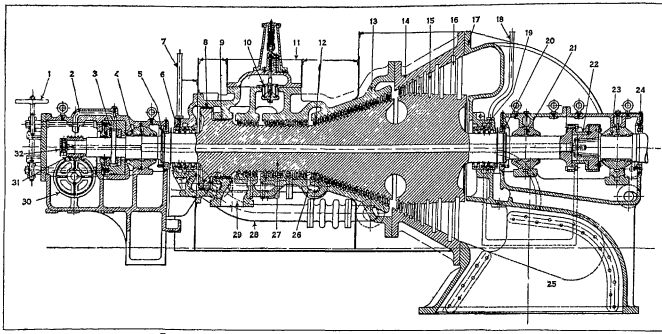


FIG. 7.—LONGITUDINAL SECTION THROUGH SINGLE CYLINDER REACTION TURBINE

1. Handwheel for cylinder thrust block adjusting gear; 2. Oil discharge from thrust to worm wheel; 3. Thrust block; 4. No. 1 bearing. 5. Oil baffles. 6. Carbon segment neck; 7. Vapour pipe. 8, 9 Dummy pistons; 10. Overload bypass D.B Valve (operated from steam chest); 11. Cylinder cleaning; 12. Reaction blading "End tightened" type with large radial clearance; 13 Cast steel centre portion of cylinder; 14. Cast iron portion of cylinder; 15. Reaction blading "ordinary" (radial clearance type); 16 Reaction blading "Ordinary" (special twisted); 17. Cast-iron exhaust portion; 18. Vapour pipe from no 2 gland; 19. Carbon segment neck gland No 2; 20 Oil baffles; 21. No 2 bearing; 22. Flexible claw coupling; 23. No 3 bearing; 24. Oil baffles; 25. Cylinder exhaust; 26. Equalising pipe from No. 1 dummy to blading; 27. Turbine shaft; 28 Equalising pipe from No. 2 dummy to blading; 29. Main steam inlet; 30. Worm for driving governor; also tachometer and oil pump through bevel gearing; 31 Worm driving No 29; 32 Shaft governor

by any form of packing which involves actual rubbing contact, on account of the great frictional heat that would be generated. It follows therefore, that such leakage, if it cannot be altogether suppressed, must be reduced to a minimum by the use of fine working clearances. Thus all compound turbines, of whatever design, have fine clearances in certain parts, such fine clearances being essential to steam economy

The early pioneer work of Sir Charles Parsons was carried out against considerable obstacles For 13 years after 1884, no notice whatever of his efforts was taken on the continent of Europe

In dealing with the problem of the reduction of steam leakage, Parsons originated two principles, namely, that where the relative motion between two surfaces is very great and it is desired to limit the fluid or gaseous leakage between them as between the rotating shaft and the fixed casing,

(1) One of the surfaces should be provided with thin edges or so-called "contacts";

(2) Both surfaces must be serrated, *i.e.*, given an interrupted contour in the direction of the pressure gradient.

The first is necessary in order to make it possible to limit the leakage area through which steam can escape, that is to say, to enable the two surfaces to be run close up to one another at suitable points, without danger of irreparable damage, in the event of accidental contact.

The second is necessary in order to limit further the leakage by compelling the steam to flow in a tortuous path.

In another well-known form of packing, which is said to have been originated much later in Germany, rings of graphite or carbon are placed round the shaft Each ring is cut up into several segments, and all are held together by a "garter" spring. A pin projects into the fixed turbine casing on one side in order to prevent the carbon ring being carried round with the rotating shaft. The carbon ring does not actually seal the shaft against all leakage; if it pressed sufficiently hard on the shaft to do so it would rapidly become overheated, as explained above. In practice, the length of the individual segments is made such that when they are pressed together butt and butt by the garter spring they are just clear of the shaft, and a thin film of leakage steam separates them from actual contact.

Parsons' Compound Reaction Steam Turbine.—Although Parsons' master principle of pressure compounding has since its introduction been applied to all types of modern efficient turbines, there is another distinctive feature of design which he introduced in 1884 and which renders his steam turbine different from all others, with the one exception of the Ljungstrom (1912) This feature (*see* fig 7) is the use of blades which give a nozzle shape to the spaces between them in both the fixed and rotating elements of the turbine (fig 8) In the modern "reaction" turbine, in fact, the efficiency of the "blading" is practically equal to that of well-formed nozzles It has therefore a higher intrinsic efficiency than "impulse" blading, because in the latter there are losses due to friction in the moving blades in addition to the losses in the nozzles.

As will be made evident later, in a Parsons reaction turbine, the function of the fixed nozzles is to bring the steam jets smoothly into the moving nozzles and the turbine is driven or rotated almost entirely by the reaction of the steam jets issuing from the moving nozzles Hence the name "reaction turbine." This reaction is analogous to that of machine guns. The moving blades themselves in a reaction turbine represent the guns which receive a continuous backward "kick" or "reaction" from the shots fired from them, causing them to recoil in the opposite direction

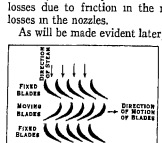


FIG. 8.—DIAGRAM SHOWING REACTION BLADING

Features of Reaction Blading.—A further source of leakage occurs in the reaction turbine from the fact that the rotating blades are themselves nozzles, so that there is a drop of pressure in them just as occurs in the fixed nozzles or "guides" Steam will therefore tend to leak past the clearances of each To minimize this, many makers prefer to use the Parsons practice of 1906, in which the tips of the blades are thinned down almost to a fine edge, so that fine radial clearances can be used without risk of serious damage in case of accidental contact (*see* figs. 9, 10)

The most modern form of Parsons reaction blading however is shown in fig 10. This is known as "end-tightened" or axial-clearance reaction blading. It will be seen that the clearance in the radial direction is large, giving mechanical safety. The blades are fitted with shrouding having an overhanging sharp edge in close proximity to the roots of the blades of the adjacent row. The axial clearances between the edge of the shrouding and the blade-roots are adjustable by endwise motion of the rotor, and because of the positive nature of the control of the end-position of the "rotor" by the thrust block, the axial clearances can be made small with greater safety

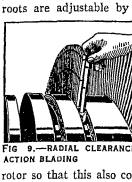


FIG 9.—RADIAL CLEARANCE—REACTION BLADING

Another feature of reaction blading, due to the pressure drop over the moving blades, is the evident existence of an unbalanced steam thrust on every row of the latter. There is also a steam pressure gradient along the rotor so that this also contributes to a resultant steam thrust on the rotor and its blading of considerable magnitude in a direction down the turbine, *i.e.*, towards the exhaust end This resultant thrust may amount to several tons and may be too heavy to carry entirely on the thrust bearing. Parsons therefore uses dummy pistons to balance the end thrust by receiving steam pressure in the opposite direction. One such piston could be made to balance the whole, but in order to ensure proper control of the end pressure at all loads and under all conditions it is usual to use two or more dummy pistons, each connected to that portion of the rotor blading which it balances, by means of large bore equalizing pipes. Sometimes the low pressure dummy piston is omitted and the residual end thrust carried by the thrust bearing. This practice saves the steam leakage past the low pressure piston and thus improves the economy.

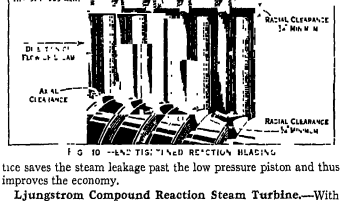


FIG 10.—END TIGHTENED REACTION BLADING

Ljungstrom Compound Reaction Steam Turbine.—With few exceptions, modern turbines are built as axial-flow turbines with horizontal shafts. In the Ljungstrom turbine, a constructional peculiarity is that the steam is made to flow radially outwards. In addition, instead of having alternate rows of fixed and moving blades, the guide nozzles are themselves allowed to rotate, but in the opposite direction, so that it is the same in effect as if the casing of a Parsons turbine were allowed to revolve in a direction opposite to that of the shaft or rotor. The blades are attached in concentric rings to two discs, mounted on shafts with a common horizontal axis, revolving in opposite directions, and driving separate dynamos.

Differences Between Impulse and Reaction Turbines.—The names "impulse" and "reaction" turbines mentioned above, are more popular than scientific, and it is important to possess a clear idea of the fundamental constructional difference in design which places a turbine in one or other category.

A comparison of the longitudinal section of a modern axial-flow horizontal impulse turbine (fig. 5) with that of a similar modern reaction turbine (fig. 7) shows that speaking generally the former is characterized by the presence of definite compartments or cells in which each row of blades revolves, while in the latter the compartments are virtually non-existent. This difference, however, is a matter of expediency for the particular type of blading adopted, and is not a matter of fundamental design There is no theoretical reason why impulse blading should not be arranged on a barrel like the reaction blading in fig. 7, or why reaction blading should not be arranged with diaphragms and wheels like the impulse blading in fig. 5. This is an important point to be borne in mind

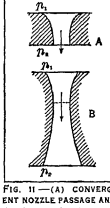


FIG. 11.—(A) CONVERGENT NOZZLE PASSAGE AND (B) WITH DIVERGENT OR TRUMPET-SHAPED MOUTHPIECE ADDED

It is not enough merely to say: "this turbine has nozzles in diaphragms followed by a row of buckets, therefore it is an impulse turbine," and "that turbine has no diaphragms but has nozzles in both fixed and moving elements, therefore it is a reaction turbine." The further question arises. "What are the essential characteristics of nozzles, and in what way do buckets or vanes or blades differ from them?"

The fundamental constructional difference lies in the shape of the steam passages or paths between the blades or vanes which are used. The nozzles used in steam turbines to produce the propelling steam jets are always the same in principle, although they may differ considerably in their proportions. There is, that is to say, always a narrowing or "convergent" passage connecting a region of higher steam pressure with a region of lower steam pressure, the change in cross section of the passage (fig. 11a) being made gradual in order to obtain high efficiency of conversion of pressure-energy into kinetic or velocity energy.

The nozzle may have a divergent extension or "mouthpiece" as in fig. 11b and in turbine design has to be "skewed" at an angle to the plane of the wheel, as in figs. 12a and 12b, but in every case the primary intent is to create a drop in pressure over the two sides of the boundary plate containing the nozzles, and to utilize that pressure drop to produce a steam jet. Having obtained the requisite steam jets, however, the buckets or blades on the rotating wheels are made with the fundamental distinction corresponding to "impulse" or "reaction" design respectively. If the blade-passages of the rotating wheels are "parallel" or nearly parallel (*i.e.*, non-convergent) as in fig. 13 the blading is of the "impulse" type, *i.e.*, nozzles followed by buckets. If they are passages of diminishing cross-sectional area (*i.e.*, convergent) the blading is of the "reaction" type, fig. 8.

Velocity Diagrams.—As a further aid to an understanding of these fundamental differences, study may be made of a useful graphic representation of the velocity and trajectory of the steam jets in their passage through the nozzles and blades.

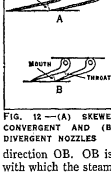


FIG. 12.—(A) SKEWED CONVERGENT AND (B) DIVERGENT NOZZLES

Figure 14a is what is known as a "velocity diagram" for impulse blading, in which "U," the mean circumferential velocity with which the blades are moving in front of the nozzles, is represented by BA. OA is the velocity "C," of the steam jet issuing from the nozzles. It will be seen that the blades are running away from the steam jets, so that if it were possible for an observer to be stationed at B (*i.e.*, going round with the blades) he would see the steam jets apparently coming in the direction OB. OB is, in fact, the relative velocity of approach with which the steam impinges on the blades, and the blade inlet angle at B would be made suitable to receive the steam approaching the blades in this direction.

Passing over the blade-surfaces, the steam jets are deflected out of their paths OA, and shoot off the tails of the blades with velocity CD relative to the blades, which, if frictional losses are neglected, is equal to the relative velocity of entry OB. But as the blades are themselves moving with velocity "U" or ED, the actual path taken by the steam jets at exit, relative to the fixed turbine

casing, will be CE

It was mentioned previously that the best velocity-ratio for this type of blading is about 0·45, in other words the steam-jet velocity OA must be rather more than twice the mean blade-velocity BA. When this is the case, as will be seen from the diagram the steam finally leaves the wheel with axial velocity CE, which is evidently the minimum, for if it left in the direction C'E' (fig 14b), it would evidently be greater When CE is a minimum it is evident that the maximum energy has been extracted from the steam jets, and this occurs when $\frac{U}{C_1}$ is slightly less than one-half.

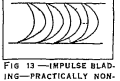


FIG 13.—IMPULSE BLADING—PRACTICALLY NON-CONVERGENT

In Parsons' reaction blading, on the other hand, the best velocity ratio is about unity, that is to say, the mean blade-speed has to be nearly equal to the velocity of the steam jets Thus OA (fig 15a) represents the steam velocity Circumferentially, this is equal to BA, the velocity with which the blades are running away from the steam-jets. To an observer at B therefore (moving round with the blades), the steam jets would appear to approach along OB, which is parallel to the axis of the turbine Now this apparent or relative velocity of approach OB of the steam jets is quite small and further, being axial in direction, exerts no driving force on the moving blades Hence the statement made that the function of the fixed nozzles is to bring the steam into the moving nozzles smoothly and without shock Figure 15b shows the diagram when the velocity-ratio is too low

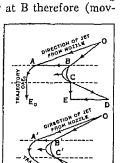


FIG. 14.—VELOCITY DIAGRAMS FOR DE LAVAL OR RATEAU BLADING
(A) Correct velocity
(B) Underspeeded

With either type of blading ("impulse" or "reaction") the ideal condition for theoretical maximum efficiency is reached when the steam leaves the moving blades with a relative circumferential velocity ED equal to the mean blade-speed BA, so that in relation to the turbine casing itself the actual velocity is a minimum, and the maximum energy has been extracted from the steam jets.

Combined Types of Turbines.—The velocity-compounded wheel of Curtis is frequently used for the first pressure stage of a turbine of which the succeeding stages are either of the compound impulse or of the compound reaction type A two row Curtis wheel displaces three or four de Laval wheels in series, or alternatively seven or eight pairs of nozzle rings of the Parsons reaction type. Although it has an inherently lower efficiency than single-row de Laval wheels or than reaction blading, its use has been justified by some designers on the grounds that at the high-pressure end of a turbine the efficiency of the latter is considerably reduced by steam leakages or windage losses, or both so that the net efficiency of the two-row Curtis is not much inferior.

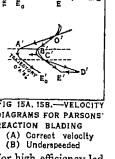


FIG 15A, 15B.—VELOCITY DIAGRAMS FOR PARSONS' REACTION BLADING
(A) Correct velocity
(B) Underspeeded

Recently, however, in land turbines there has been a return to the use of the Parsons principle alone, the whole turbine, that is to say, being built up of simple pressure stages only (either of the de Laval or of the Parsons type), without any velocity-compounding.

The large number of such stages required for high efficiency led Parsons as long ago as 1899 to divide up the casing into two separate "cylinders" or separate turbines, coupled together in line and driving the same dynamo. Parsons used three separate cylinders in series on the steam-flow for the triple-shaft steam yacht "Turbinia" in 1897 (to be seen in the Science Museum, South Kensington, London).

In modern land practice for the generation of electricity on a large scale in central power-stations, the two-, or even three-cylinder turbine is widely used and in some continental examples even four separate cylinders have recently been adopted as a means of securing the highest efficiency, having regard to the ever increasing initial steam pressures and temperatures that are now being favoured

Present Position of the Steam Turbine.—Essentially a high-speed prime-mover, the steam turbine in the early days of its development was unsuited to drive machinery which must run at a moderate or low speed of revolution Such machinery might be grouped under the following headings —

(1) Direct current dynamos.
(2) Paper mills, Jute mills, Textile mills.
(3) Screw propellers for marine propulsion.

The development by Parsons in 1910 of the small double-helical speed-reducing gears of de Laval, so as to be suitable for transmitting large powers, has permitted complete freedom of choice with regard to speeds, so that the steam turbine can now be applied to the driving of anything in which continuous rotary motion is required The design of the earlier marine installations was largely a matter of compromise between the high speed of revolution required for the turbine and the much lower speed which was more suitable for the propeller Since the introduction of mechanical gearing, the marine turbine has tended to become assimilated in type to the land turbine, the same conditions for high thermal efficiency, namely, high velocity ratios, high steam pressures and temperatures, and lowest possible exhaust steam pressures being equally applicable

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For those readers who desire to study the subject more closely the following papers are recommended —K Baumann, "Recent Steam Turbine Practice" and "Some Recent Developments in Large Steam Turbines," *Jrnl Inst Elec Engineers*, 1912, Vol. 48, p 768 and Vol 50, p. 565, Hon C A Parsons, C B , F R S and G Gerald Stoney, B A., "The Steam Turbine," *Proc. Inst Civil Engineers* (1906); Hon Sir C A Parsons, K.C.B., etc., "Steam Turbines," *Trans. 1st World Power Conference*, 1924 Vol 2, page 1477, Hon. Sir C. A Parsons, K C B , etc , R J Walker, C B E , and S S. Cook, B A , "Progress in Economy of Turbine Machinery on Land and Sea," *Trans* N.E Coast Inst of Engineers & Shipbuilders, Newcastle-on-Tyne, Jan. 1927; H. L Guy, "The Economic Value of Increased Steam Pressure," *Proc. Inst Mech Engineers*, 1927, No. 1, A H. Law and J P Chittenden, "Higher Steam Pressures and Their Application," *Jrnl Inst Elec. Eng*, Vol 66, No 373, p. 89.

The following textbooks are standard works on the theory of steam turbine design and construction'—Prof W J. Goudie, D Sc , *Steam Turbines*, and ed (1922); Prof. A Stodola, *Steam and Gas Turbines* 2 Vols., Eng. trans by Louis Lowenstein from 6th German ed. (1927)

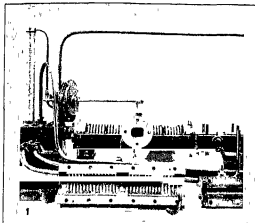
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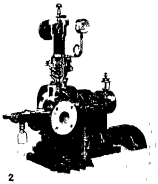
TURBINE: WATER. Modern hydraulic turbines may be divided into two classes, impulse, and pressure or reaction turbines. Of the former the Pelton wheel, and of the latter the Francis turbine or one of its modifications, are the only types used in recent important installations.

In an impulse turbine, the whole head of the supply water is converted into kinetic energy before the wheel is reached. The water is supplied to the wheel through a nozzle which delivers a high velocity jet at atmospheric pressure on to the vanes or buckets mounted on the periphery of the wheel.

In the pressure or reaction turbine, the wheel or runner is provided with vanes into which water is directed by a series of guide vanes extending around the whole periphery. The water on leaving these guide vanes is under pressure, and supplies energy partly in the kinetic and partly in the pressure form. In its passage through the runner the pressure energy is utilized in increasing the relative velocity of flow between the vanes, and the water finally leaves the runner at the pressure obtaining in the discharge pipe or draft tube

In the earliest of these turbines, the Fourneyron, the guide vanes were inside the runner, and the water flowed outward This was followed by the Jonval turbine, in which the guide vanes are


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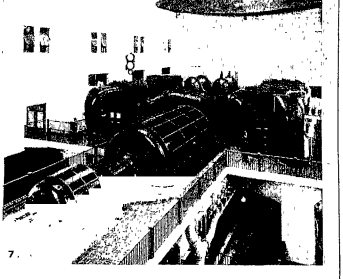

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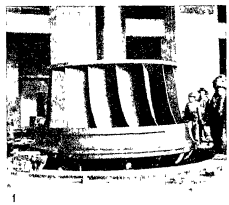

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BY COURTESY OF (1) SIR CHARLES A PARSONS, K C B., F R S , (2, 3) THE SCIENCE MUSEUM, LONDON, (4, 5) THE MARINE ENGINEERING AND SHIPPING AGE, (6, 7) THE GENERAL ELECTRIC COMPANY (U.S.A.)

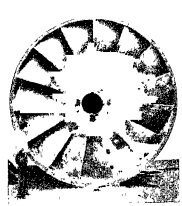
DEVELOPMENT OF THE STEAM TURBINE

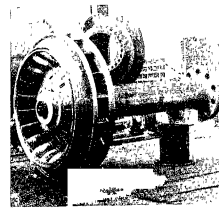
1. Parsons' original 10 h.p steam turbine with top of casing removed. Built in 1884, this type, by the utilization of Parsons' principle of "pressure compounding," opened up an unlimited field of utility for the steam turbine. The original is in the Science Museum, London
2. De Laval's steam turbine built in 1889, after several years of preliminary research. Sectional view reveals the single wheel, about 5 in in diameter, which rotated at approximately 30,000 revolutions per minute
3. Model of Rateau steam turbine built in 1896. Section shows internal construction
4. Engine of S S. "Scythia," and the double reduction geared turbine unit with top housing removed to show turbine rotors and gears. It is designed to develop 6,250 h.p. at the shaft
5. Turbine rotors in process of assembly at a large plant
6. General Electric 94,000 kilowatt tandem compound turbo-generator set at the Long Beach station of the Southern California Edison Company, Los Angeles. This view shows the high-pressure unit in the foreground with the low-pressure unit towards the rear, connection from one to the other being effected by means of the two steam headers shown
7. The turbo-generator of fig. 6 viewed from the generator end. The space underneath the unit houses the auxiliary equipment

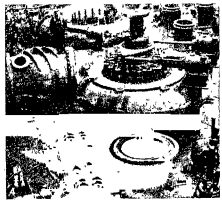
TURBINE: WATER

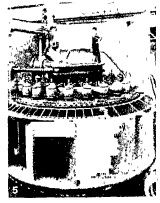


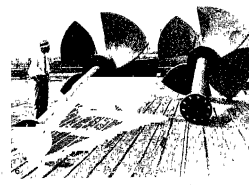
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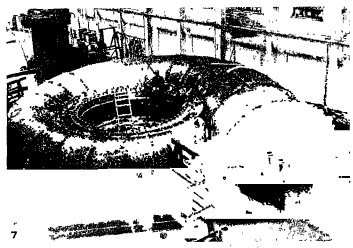




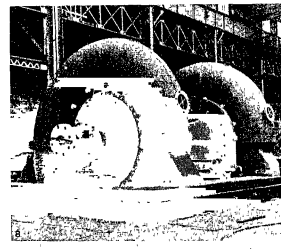








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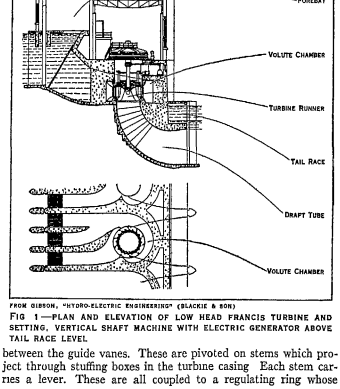
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WATER TURBINE

1. Rotor for 35,000 h p medium-head turbine at Muscle Shoals, Alabama. Head, 92 feet Speed 100 revolutions per minute Built in 1925
2. Discharge end of medium speed turbine runner
3. Runner for 35,000 h p., high-head turbine of the Southern California Edison Company. Head, 740 feet Speed, 428 revolutions per minute. Built in 1923
4. Shop assembly of the turbine to which the runner of fig. 3 belongs, showing steel plate spiral casing
5. Shop assembly of turbine to which runner of fig. 1 belongs, with concrete spiral casing removed, showing stationary vanes
6. Propeller type, low-head, 4,800 h p runners of the West Florida Power Company's plant. Head, 32 feet Speed, 150 revolutions per minute. Built in 1928
7. Shop assembly of a steel plate, spiral casing for a 22,000 h p., medium-head turbine of the Rochester Gas and Electric Company, Rochester, N.Y. Head, 130 feet Built in 1927
8. Twin horizontal medium-head 13,400 h p turbine with cast-iron spirals. Head, 180 feet. Speed, 187 5 revolutions per minute Built in 1913

above the runner and the water flows axially into and through the wheel. Both types are now obsolete, and one or other modification of the Francis or inward-flow turbine, in which the guide vanes surround the outer periphery of the runner, is now in general use.

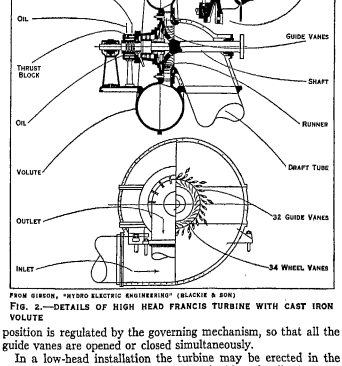
The supply of water to the runner depends upon the opening



FROM GIBSON, "HYDRO-ELECTRIC ENGINEERING" (BLACKIE & SON)

FIG 1.—PLAN AND ELEVATION OF LOW HEAD FRANCIS TURBINE AND SETTING, VERTICAL SHAFT MACHINE WITH ELECTRIC GENERATOR ABOVE TAIL RACE LEVEL

between the guide vanes. These are pivoted on stems which project through stuffing boxes in the turbine casing Each stem carries a lever. These are all coupled to a regulating ring whose

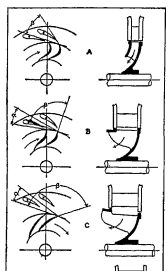


FROM GIBSON, "HYDRO ELECTRIC ENGINEERING" (BLACKIE & SON)

FIG. 2.—DETAILS OF HIGH HEAD FRANCIS TURBINE WITH CAST IRON VOLUTE

position is regulated by the governing mechanism, so that all the guide vanes are opened or closed simultaneously.

In a low-head installation the turbine may be erected in the open forebay or supply canal. This method has the disadvantage that the guide-vane mechanism is submerged and cannot be inspected or repaired without draining the wheel pit, and in most recent installations, even of the low-head type, the guide-vane ring is surrounded by a spiral volute chamber, from which the pressure water is delivered with uniform velocity around the entire periphery of the guide ring. For heads not exceeding about 100 ft., modern practice favours the moulding of the volute chamber in the concrete of the substructure (fig 1). For higher heads, considerations of strength necessitate a metal casing, to which the water is supplied through a pressure pipe line (fig 2) The turbine runner is usually of cast iron, although where corrosion or erosion is to be anticipated, it may be made of cast steel if large, and of phosphor bronze if small.



FROM GIBSON, "HYDRO ELECTRIC ENGINEERING" (BLACKIE & SON)

FIG 3.—TYPES OF TURBINE RUNNER

A. For high heads and comparatively low speeds. B. For medium heads and moderate speeds. C. For medium heads and high speeds. D. For low heads and high speeds

The general changes in the shape and proportions of the runner which have accompanied recent development of the low head high-speed turbine are indicated in fig. 3. The change has been generally in the direction of increasing the axial depth of the buckets, and at the same time of maintaining or increasing the ratio of the discharge area at exit to that at entrance At the same time the width of the buckets in the direction of flow has been reduced An extreme example is shown in fig 3D, in which flow through the wheel itself is almost axial. In many recent low-head turbines the runners are of the propeller type. They are characterized by the fewness of the vanes, as few as three or four in many cases, and are in appearance very like the ordinary ship's propeller.

The Draft Tube.—In order to avoid the flooding of the turbine house by any raising of the tail race level in time of floods it is usually necessary to instal the turbines at some higher elevation, and if the turbines were provided with open discharge pipes, freely discharging into the atmosphere, the proportion of head represented by the elevation above tail water level would be lost By arranging the discharge, or draft tube, so that the outlet is always submerged, it becomes possible, however, to place the turbine above tail water level without loss of head The pressure at the point of discharge from the runner into the draft tube is now less than atmospheric by an amount which depends upon the elevation above tail water level.

The draft tube also, if well designed, serves a further purpose in that it enables a large proportion of the kinetic energy of discharge from the runner to be converted into pressure head, and so to be utilized. For this the tube must be designed with a gradually increasing diameter, so that the velocity is gradually reduced from v_1 to v_2 before discharge (fig 4). The velocity of discharge from the draft tube should not exceed about 4 f s

Hydraulics of the Reaction Turbine.—In the following discussion let ω = angular velocity of the runner in radians per second ($\omega = 2\pi N \div 60$ where N = revolutions per minute); $u = \omega v$ = velocity of wheel at point indicated by a suffix; v = absolute velocity of water; w = tangential component of v; f = radial component of v; v = relative velocity of water and vane; α = guide vane angle, β = wheel vane angle at entrance; γ = wheel vane angle at exit; Q = flow in c.f.s.; W = weight of 1 cu.ft. of water; suffix (2) refer to inlet to wheel vanes; suffix (3) refer to exit from wheel vanes

For entry without shock, the direction of the relative velocity

of water and vane at the entrance to the wheel must be parallel to the vane tips, and a consideration of the diagram of velocities (fig. 4) shows that if the angles are correctly proportioned:

$$f_2 = w_2 \tan\alpha = (w_2 - u_2)\tan\beta, \quad \therefore\ u_2 = w_2\left(1 - \frac{\tan\alpha}{\tan\beta}\right).$$

$$f_3 = (u_3 - w_3)\tan\gamma; \quad 3v_r = f_2 \operatorname{cosec}\beta,\ 3v_r = f_3 \operatorname{cosec}\gamma$$

The change of the moment of momentum in the wheel = turning moment $= \frac{WQ}{g}(w_2 r_2 - w_3 r_3)$ ft. lb.

$\therefore$ Work done per second on runner $= \frac{WQ}{g}(w_2 u_2 - w_3 u_3)$ ft. lb.

In an ideal wheel, with no friction or eddy losses, neglecting changes of level in the wheel, we should have

$$\frac{p_2}{W} + \frac{v_2^2}{2g} = \frac{p_3}{W} + \frac{v_3^2}{2g} + \text{work done per pound between (2) and (3)}$$

The efficiency will be a maximum when the energy rejected in the discharge is a minimum, *i.e.*, when v_3 is a minimum, or when w_3 is zero, in which case $v_3 = f_3$. Assuming the wheel to be designed for this state of affairs,

$$\frac{p_2}{W} + \frac{v_2^2}{2g} = \frac{p_3}{W} + \frac{f_3^2}{2g} + \frac{w_2 u_2}{g}.$$

Writing H as the head available to produce flow through the wheel, so that

$$H = \frac{p_2}{W} + \frac{v_2^2}{2g} - \frac{p_3}{W}, \text{ we have } H = \frac{f_3^2}{2g} + \frac{w_2 u_2}{g},$$

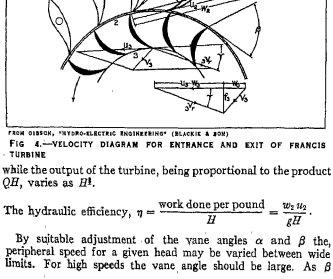
from which, writing $f_3 = f_2 \frac{b_2 r_2}{b_3 r_3} = w_2 \tan\alpha \frac{b_2 r_2}{b_3 r_3}$,

where b and r are the breadth and radius of the wheel, we get, on substitution,

$$w_2 = \sqrt{\left[\frac{2gH}{2 + \left(\frac{b_2 r_2}{b_3 r_3}\tan\alpha\right)^2 - 2\frac{\tan\alpha}{\tan\beta}}\right]}$$

while $u_2 = w_2\left(1 - \frac{\tan\alpha}{\tan\beta}\right)$, and $Q = A_2 v_2 = A_2 w_2 \tan\alpha$.

Thus in a wheel of given design, the peripheral speed for maximum efficiency, and the volume of discharge, each vary as $\sqrt{H}$,



FROM GIBSON, "HYDRO-ELECTRIC ENGINEERING" (BLACKIE & SON)

FIG. 4.—VELOCITY DIAGRAM FOR ENTRANCE AND EXIT OF FRANCIS TURBINE

while the output of the turbine, being proportional to the product QH, varies as $H^{\frac{3}{2}}$.

The hydraulic efficiency, $\eta = \frac{\text{work done per pound}}{H} = \frac{w_2 u_2}{gH}$.

By suitable adjustment of the vane angles α and β the, peripheral speed for a given head may be varied between wide limits. For high speeds the vane angle should be large. As β is increased the value of f_2 and hence the volume of water passing a wheel of given size diminishes, so that to obtain the same output the size of the wheel must be increased If, as is usually the case in low-head plants, a high rotative speed is required, the inlet area is increased by increasing the depth of the runner. Such a turbine has a comparatively large ratio of inlet area to discharge area, and the velocities of discharge are relatively high For high heads β may be between 60° and 90°, and, for medium and low heads, between 90° and 135°. Similarly, while the hydraulic efficiency decreases as α increases, the volume of flow increases with α, and the maximum output is obtained when the product of Q and η is a maximum For high efficiency α should be as small as mechanical considerations permit, generally between 12° and 18°.

In one modern turbine, the Kaplan, the wheel vanes are not fixed but are pivoted on a central drum, and their leading angle β can be adjusted while running so as to suit any variations in the working head or discharge In this way a very high efficiency may be maintained at all loads

Specific Speed of a Turbine.—In order to afford a basis of comparison of turbines of different diameters and proportions operating under different heads, the term known as "specific speed" has been introduced. This may be defined as the speed at which a runner would operate if reduced geometrically to such a size that it would develop 1 h.p. under unit working head The figures for specific speed given below refer to a unit head of 1 foot If the metre be adopted as the unit, these figures require to be multiplied by 4·45.

If N be the number of revolutions per minute,
" P " " horsepower of the turbine,
" H " " working head in feet,

the specific speed $N_s = \frac{N\sqrt{P}}{H^{\frac{5}{4}}}$ revs. per minute.

The specific speed of a reaction turbine may be varied by varying the diameter of the runner, the angle of the gude vanes and the angle of the wheel vanes. By modifying the design as indicated in the sketches of fig 3 it is possible, while maintaining high efficiencies at full load, to increase the specific speed from about 15, its minimum value with the type shown in fig 3A, to about 125 with the type shown in fig. 3D Specific speeds as high as 150 are possible with some sacrifice in efficiency, and it is probable that further developments will see the value increased still farther These high specific speeds are extremely valuable for low-head installations since they enable the size and cost of the turbine and of the generator to be greatly reduced In fact, many existing low-head installations would have been commercially impracticable but for the development during recent years of the high-speed turbine.

High specific speeds are, however, attended by some disadvantages The part-gate efficiency in general falls off as the specific speed increases. Also if the speed is unduly high it becomes very difficult to avoid very high local velocities and centres of low pressure in the runner, which invariably give rise to severe corrosion At the present stage of design, the maximum specific speeds to be used under normal circumstances with various heads are approximately as follows:

Head (feet)	20	40	60	80	100	150	200	300	400	600
Specific speed r.p.m.	125	100	85	75	65	50	43	33	30	25

The reaction turbine may be built either as a horizontal or vertical shaft machine. The latter type, having the weight of the rotating parts supported by a thrust bearing of the Michell or Kingsbury type, has been gaining in popularity of recent years.

The Pelton Wheel.—This is usually built as a horizontal shaft machine and consists of a runner carrying a series of buckets around its periphery on which impinge one—or in exceptional cases two—high velocity jets from a nozzle or nozzles at the end of the supply pipe line (fig 5). The buckets are spoon shaped and have a central sharp ridge which divides the impinging jet into

two halves which are deflected backwards by the buckets through about 165°. The modern Pelton wheel is always fitted with a circular nozzle, with an axial needle or spear for regulating the size of the jet. The maximum diameter of jet as yet adopted is about 12 inches. The axial position of the needle in the nozzle is regulated by the governing mechanism in all important installations.

The Pelton wheel, being essentially a high head turbine, is usually supplied through a comparatively long pipe line, and any

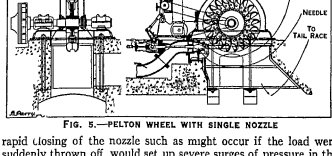


FIG. 5.—PELTON WHEEL WITH SINGLE NOZZLE

rapid closing of the nozzle such as might occur if the load were suddenly thrown off, would set up severe surges of pressure in the pipe line which would not only prevent close speed regulation but might be dangerous. To prevent this, modern Pelton wheels are also fitted with a jet deflector, consisting of a curved plate pivoted between the nozzle and the buckets, which is operated by the governor and which when in action cuts into the jet and deflects it either wholly or partially into the tail race. The governing mechanism is so arranged that when load is thrown off the wheel, the deflector at once comes into play, deflecting the jet from the buckets. The needle then begins to move slowly towards the closed position, and at the same time the deflector moves slowly back towards its idle position. Ultimately both come to rest with the deflector just clear of the jet, and with the diameter of the latter so adjusted as to give the required supply of water to the wheel.

Hydraulics of the Pelton Wheel.—If H be the pressure head behind the nozzle, in feet, the velocity of efflux is $C_v\sqrt{2gH}$ ft. per second, where C_v, the coefficient of velocity, in a well-formed needle nozzle is approximately ·99. Calling this velocity V_1, the horsepower of the jet is equal to

$$\frac{62{\cdot}4aV_1^3}{550\times 2g}$$

where a is the area of the jet in square feet.

Let u = peripheral speed of buckets at pitch circle, in ft. per second.
" V_2 = final absolute velocity of water leaving the buckets.
" $_1v_r$ = relative velocity of jet and bucket at entrance.
" $_2v_r$ = relative velocity of jet and bucket at discharge.
" α = mean angle between jet and tangent at point of contact.
" γ = total angle of deflection of buckets.

Then the initial velocity of jet in direction of tangent at point of impact $\Big\}$ $= V_1\cos\alpha$.

The component, parallel to the tangent at discharge, of final velocity relative to bucket $\Big\}$ $= {}_2v_r\cos\gamma$.

$\therefore$ Absolute velocity in this direction at discharge $= u + {}_2v_r\cos\gamma$.

$\therefore$ Change of tangential momentum per second per pound

$$= \frac{1}{g}(V_1\cos\alpha - u - {}_2v_r\cos\gamma).$$

$\therefore$ Work done per pound of water per second

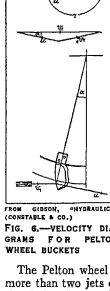
$$= \frac{u}{g}(V_1\cos\alpha - u - {}_2v_r\cos\gamma) \text{ ft. lb.}$$

$\therefore$ Efficiency $= \dfrac{u}{gH}(V_1\cos\alpha - u - {}_2v_r\cos\gamma)$.

The loss due to friction and eddies in the buckets $= \dfrac{{}_2v_r^2 - {}_2v_1^2}{2g}$ ft. lb. per pound, where ${}_2v_r^2 = V_1^2 + u^2 - 2V_1u\cos\alpha$.

The loss due to rejection of kinetic energy in the discharge $= \dfrac{V_2^2}{2g}$ ft. lb. per pound, where $V_2^2 = u^2 + {}_2v_r^2 + 2u{}_2v_r\cos\gamma$.

Tests show that in an average wheel ${}_2v_r$ may be as low as from ·5 to 6 ${}_1v_r$. In a well-designed bucket, however, having a ratio of bucket width to jet diameter not less than about 3·3, this ratio approximates to ·75 or even ·8. If the angle of deflection were 180°, and if the buckets were frictionless, the value of the peripheral speed of the wheel for maximum efficiency would be $V_1\cos\alpha \div 2$, or approximately $V_1 \div 2$, since α is small. When account is taken of the various losses and of the fact that γ is less than 180°, the best peripheral speed lies between ·44 and ·48 V_1.



FROM GIBSON, "HYDRAULICS" (CONSTABLE & CO.)

FIG. 6.—VELOCITY DIAGRAMS FOR PELTON WHEEL BUCKETS

Comparison of Impulse and Reaction Turbines.—The peripheral velocity of a Pelton wheel for maximum efficiency is slightly less than one-half the velocity of the jet (usually approximately $\cdot 46\sqrt{2gH}$, where H is the head), while that of the reaction turbine varies from about $\cdot 65\sqrt{2gH}$ to $1{\cdot}05\sqrt{2gH}$, depending on the design. Because of this, the Pelton wheel is well adapted for very high heads, which may then be utilized with moderate speeds of rotation. On the other hand the relatively high speed of the reaction turbine enables reasonably high rotative speeds to be obtained with low heads.

The Pelton wheel cannot well be designed to utilize efficiently more than two jets on a single wheel, and as the maximum practicable jet diameter is not large, the volume of water which can be handled and the output of the turbine become small under low heads. The reaction turbine with its full peripheral admission on the other hand is well adapted for large volumes. It is not suited for small powers under high heads, since the volume of water is then small, the waterways are of very small sectional area and easily become choked by floating debris, and the fluid friction losses become relatively high.

The Pelton wheel cannot easily be adapted to the use of a suction or draft tube, and, where the tail-race level may vary appreciably, must be installed above the highest probable tail-water level with some sacrifice of head. The efficiency of the reaction turbine is not so sensitive to changes of head as that of the Pelton wheel, but if operated under constant head and at constant speed, the efficiency of the Pelton wheel does not fall off so rapidly at part loads as that of the reaction turbine. On the other hand, the modern reaction turbine has a slightly higher full-load efficiency, so that the average efficiency from half to full load is sensibly the same in a well-designed machine of either type. The following table shows typical values of the part-load efficiencies of modern turbines of both types of large size, installed under equally favourable conditions.

Proportion of maximum discharge	·2	·3	4	·5	·6	·7	8	9	1·0
Efficiency of reaction turbine	·60	·70	·75	·79	82	·87	90	91	·89
Efficiency of Pelton wheel	·70	·78	·82	83	·84	·85	·86	·85	·83

The possibilities of accurate speed regulation are about equal in the two types.

For large units the reaction turbine is generally preferable for heads up to 400 feet. For heads above 750 ft. the Pelton wheel is more suitable, while between these limits the choice depends largely upon local circumstances and on the power required. The greater simplicity and accessibility of the parts requiring replacement due to natural wear and tear renders the Pelton wheel more

suitable when the supply is taken from a stream carrying an appreciable amount of grit

The reaction turbine has been built in units capable of developing 65,000 H P. The most powerful Pelton wheel yet constructed develops about 30,000 H P., but these outputs could be largely extended if necessary.

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TURBOT (*Rhombus maximus*), a flat fish of the Mediterranean and the Atlantic coast of Europe, is distinguished by a large terminal mouth, eyes on the left side, a very deep body and a naked skin, with conical bony tubercles scattered on the eyed side. The brill, a related species, is not so deep and is scaly The turbot is a valued food-fish; it feeds mainly on other fishes; it attains a weight of 30 lb. It has a longer larval life than most flat fishes; and specimens nearly an inch in length, with an eye on each side, may be found swimming at the surface.

TURBULENCE, ATMOSPHERIC. *Turbulence*, in sciences relating to fluids, means unsteady and irregular motion It contrasts with still conditions and steady motion and with wave motion. The last is unsteady but regular and periodic. Turbulence is very common in the lower atmosphere, being visible in the irregular shapes assumed by smoke from the stack of a ship or factory, in the fluctuating paths of falling snow and in the forms assumed by tobacco smoke.

Atmospheric turbulence is directly felt in the variable pressure and cooling effect of the wind. The variations consist of *gusts*, which are periods of wind speed above average, and *lulls*, which are periods of wind speed below average The more noticeable gusts and lulls last one second or more each. These changes in wind speed are always accompanied by changes in direction as well.

One aspect of atmospheric turbulence is represented by the *gustiness*. Various specific definitions have been suggested in order to make a numerical evaluation possible. One of the simpler definitions in use gives the gustiness G in terms of the mean wind speed V_{mean}, the maximum V_{max} and the minimum V_{min}, all measured within a suitable interval such as 10 min.,

$$G = \frac{V_{max} - V_{min}}{V_{mean}}.$$

Within some 50 m. of the ground the gustiness found from this formula is usually between 0.25 and 1.00, meaning that the range in wind speed is between 25% and 100% of the mean wind speed.

Any individual turbulent fluctuation can be ascribed, in theory if not in practice, to a disturbance or *eddy* of a certain rough dimension. This dimension may be called the *scale* of the turbulence. The larger the scale, the less frequently a given type of disturbance passes a fixed point; so there is a direct relation, other factors being the same, between the scale of turbulence and its "period."

There is a wide range in the scale of atmospheric turbulence. Of the small-scale phenomena, the forms visible in tobacco smoke have already been mentioned; but fluctuations too rapid for the eye to follow exist close to the ground or near other solid objects past which a wind blows. The shapes assumed by smoke from a stack show eddies ranging in size from about 10 cm. up to 10 or 100 m. The updrafts revealed by cumulus clouds may be 100 or 1,000 m. or more in both horizontal and vertical extent. There is reason to believe that slowly moving eddies having a horizontal extent of between 10 and 100 km. are prevalent in the atmosphere, but the existence of these very large atmospheric eddies has not been demonstrated by direct evidence.

Two distinct mechanisms produce atmospheric turbulence. What is called *mechanical turbulence* derives its energy from the wind and results from the fact that the wind passing any fixed object is inherently unsteady. Even if the approaching air is in steady motion, it becomes turbulent in passing an obstacle unless the obstacle is of very small size. In any air current as fast as a light breeze the obstacle would have to be less than a millimetre in diameter to permit steady flow past it One effect of the unsteady nature of the flow past small obstacles is the singing of wires and whistling of branches in the wind. While the ground's roughness and the trees and buildings protruding above it add to the turbulence in the wind, the wind near the ground is turbulent, no matter how smooth and flat the ground may be.

To understand the last phenomenon, one should first realize that, since air, like all other fluids, has a certain degree of viscosity, as the ground is approached the wind velocity must gradually come to zero Now suppose a steady horizontal flow of the wind, with the velocity increasing upward from zero at the ground, exists at a certain instant It turns out that even very minor disturbances in this steady flow produce forces which cause the disturbances to grow into fully developed turbulence. Since very minor disturbances are never lacking, the flow is always turbulent.

The other mechanism is thermal instability, which produces *thermal turbulence* This kind of turbulence occurs next to the ground when the latter is considerably warmer than the air, and it occurs at any higher levels where such thermal instability exists. The thermal instability produces overturning, warm air rising and cold air sinking. This leads to an irregular, turbulent motion which gains its energy from the unstable distribution of mass Visible effects of thermal turbulence are the apparent dancing motion of objects seen across a hot pavement, the shimmering of a mirage caused by a warm surface and cumulus clouds All these result from masses of air rising through colder surrounding air.

Just as thermal instability produces turbulence, thermal stability impedes vertical turbulence When the air temperature increases upward, a parcel of air displaced upward is heavier than its surroundings and tends to sink back, while one displaced downward is lighter than its surroundings and tends to rise back to its origin. With such a stable temperature distribution, more energy is required to maintain a given degree of turbulence than would be needed in the absence of stability. Under otherwise similar conditions, turbulence is therefore less strong when thermal stability exists.

In the absence of either thermal stability or instability, the degree of mechanical turbulence has a small value at the ground and increases with height to a maximum, then decreases with further increase in height. The turbulence at any level, as well as the height of the maximum, increases with the wind speed and with the roughness of the ground With a fresh wind this mechanical turbulence can be quite noticeable in aircraft less than 500 m. above the ground. When the temperature distribution is stable, the degree of turbulence may be greatly reduced. On the other hand, when it is unstable, thermal energy as well as mechanical goes into turbulence, which therefore becomes more intense. Conditions of extreme turbulence are often found in large cumulus and cumulonimbus clouds.

While extremely large-scale turbulence has no direct effect on aircraft, mechanical turbulence due to ground friction or to fronts, and thermal turbulence due to heating from the ground or to heating by cloud formation, are frequently of a suitable scale and sufficient intensity to form *rough air* Extremely small-scale turbulence, much smaller than the aircraft, does not produce any effect of this sort but is very significant in determining the drag and hence the performance of the craft.

Rough air is made manifest to the aviator by accelerations of his airplane, airship or other craft. In general these accelerations may be vertical, sideways, positive or negative in the forward direction or a turning or tilting effect. In the case of an airplane, which travels forward swiftly, a sudden acceleration is experienced on passing from air of one velocity to air of another velocity. Furthermore, due to its shape and direction of flight, the vertical accelerations of a plane are much larger than the horizontal ones. If they are not uniformly distributed, tilting results as well as bumps and drops of the entire plane. Since a plane depends on its air speed for support, the vertical accel-

tions can result either from vertical currents or from a change in wind speed, and the effects of these two basically different causes are not commonly distinguishable. An upward acceleration, or bump, is experienced both on entering air which is rising more rapidly than the air through which the plane has been flying, a true updraft, and on entering air which is moving horizontally toward the plane more rapidly so that the air speed and lift are suddenly increased A downward acceleration, or drop, is experienced on entering a true downdraft and on entering air which is moving horizontally toward the plane less rapidly. Hence a bump does not necessarily indicate an updraft, nor does a drop necessarily indicate a downdraft.

Bumps and drops occur not only in turbulent air. An inversion of temperature sometimes lies a few hundred ft. above the ground or water and sharply separates nearly calm air in the surface layer from stronger wind above If a plane climbs on a course opposing the upper wind, on passing through the inversion it experiences a bump similar to that encountered on entering an updraft. If it flies downward through the inversion on the same course, as is normal in landing, the plane experiences a drop similar to the effect of a downdraft. If the latter occurs close to the ground, it may be alarming to the pilot. To guard against serious consequences, he should realize that such drops can occur without downdrafts and without turbulence

It is seen that all ground and water surfaces are covered by a layer of turbulent air, whose thickness may be as small as a few metres or as large as 1,000 m. or more. Nearly all phases of the meteorology and climatology of this layer are intimately associated with its turbulence. Atmospheric turbulence therefore plays an important part in all agricultural activities, having a marked effect, for instance, on the temperature of the ground and of leaves and on the rate of evaporation from them. One has difficulty, indeed, in calling to mind any activity on land or at sea which is not affected by it.

No discussion of atmospheric turbulence would be complete without mention that our knowledge of it has benefited from studies of oceanic turbulence, in many respects the studies of meteorology and oceanography have gone hand in hand to the advantage of both. Turbulent flow in all gases and liquids and in all sorts of models has basic features in common; as a consequence, meteorologists have taken over much that was learned about turbulence in aeronautics and hydraulics.

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TURDIDAE: *see* THRUSH.

TURENNE, HENRI DE LA TOUR D'AUVERGNE, VICOMTE DE (1611–1675), marshal of France, second son of Henri, duke of Bouillon and sovereign prince of Sedan, by his second wife Elizabeth, daughter of William the Silent, prince of Orange, was born at Sedan on Sept. 11, 1611. He was educated in the doctrines of the Reformed religion and received the usual training of a young noble of the time; but physical infirmity, and particularly an impediment of speech (which he never lost), hampered his progress, though he showed a marked partiality for history and geography and especial admiration of the exploits of Alexander the Great and Caesar. After his father's death in 1623, he devoted himself to bodily exercises and in a great measure overcame his natural weakness. At the age of 14 he went to learn war in the camp of his uncle, Maurice of Nassau, and began his military career (as a private soldier in that prince's bodyguard) in the Dutch War of Independence Frederick Henry of Nassau, who succeeded his brother Maurice in 1625, gave Turenne a captaincy in 1626 The young officer took his part in the siege warfare of the period and won special commendation from his uncle, who was one of the foremost commanders of the time, for his skill and courage at the celebrated siege of Hertogenbosch (Bois-le-Duc) in 1629. In 1630 Turenne left Holland and entered the service of France. Cardinal Richelieu at once made him colonel of an infantry regiment. He still continued to serve at frequent intervals with the prince of Orange, who was the ally of France. In 1635 Turenne served under Cardinal de la Valette in Lorraine and on the Rhine. The siege of Mainz was raised, but the French army had to fall back on Metz from want of provisions. In the retreat Turenne measured swords with the famous imperialist, General Gallas, and distinguished himself greatly by his courage and skill. The reorganized army took the field again in 1636 and captured Saverne (Zabern), at the storming of which place Turenne was seriously wounded. In 1637 he took part in the campaign of Flanders and was present at the capture of Landrecies (July 26) and in the latter part of 1638, under Duke Bernhard of Saxe-Weimar (1608–39), he directed the assault of Breisach (reputed the strongest fortress on the upper Rhine), which surrendered on Dec. 17. He had now gained a reputation as one of the foremost of the younger generals of France, and Richelieu next employed him in the Italian campaign of 1639–40 under "Cadet la Perle," Henri de Lorraine, count of Harcourt (1601–66). On Nov. 19, 1639, he fought in the famous rearguard action called the battle of the "Route de Quiers" and during the winter revictualled the citadel of Turin held by the French against the forces of Prince Thomas of Savoy. In 1640 Harcourt saved Casale and besieged Prince Thomas's forces in Turin, which were besieging in their turn another French force in the citadel. The latter held out, while Prince Thomas was forced to surrender on Sept. 17, 1640, a fourth army which was investing Harcourt's lines being at the same time forced to retire. The favourable result of the complicated operations of this campaign was largely due to Turenne, who had by now become a lieutenant-general He himself commanded during the campaign of 1641 and took Coni (Cuneo), Ceva and Mondovi. In 1642 he was second in command of the French troops which conquered Roussillon. At this time the conspiracy of Cinq Mars (*see* FRANCE. *History*) in which Turenne's elder brother, the duke of Bouillon, was implicated, was discovered.

The earlier career of Turenne was influenced by the relations of the principality of Sedan to the French crown; moreover his steady adherence to the Protestant religion was an element of difficulty in Turenne's relations with the ministers. Cardinal Richelieu nevertheless entrusted him with the command in Italy in 1643 under Prince Thomas (who had changed sides in the quarrel). Turenne took Trino in a few weeks but was recalled to France towards the end of the year. He was made a marshal of France (Dec 19) and was soon sent to Alsace to reorganize the "Army of Weimar"—the remnant of Duke Bernhard of Saxe-Weimar's troops—which had just been severely defeated at Tüttlingen (Nov. 24–25, 1643). He was 32 years old at this time and had served under four famous commanders. The methodical prince of Orange, the fiery Bernhard, the soldierly Cardinal de la Valette and the stubborn and astute Harcourt had each contributed much to the completeness of Turenne's training, and he took the field in 1644 prepared by genius and education for the responsibilities of high command.

The work of reorganization over, Marshal Turenne began the campaign in June by crossing the Rhine at Breisach but was almost instantly joined by an army under the duc d'Enghien (afterwards the great Condé), who, as a prince of the royal house, took the chief command of the united armies of "France" and "Weimar." The four famous campaigns which followed brought to an end the Thirty Years' War (*q.v.*) The chief event of the first of these was the desperately-fought battle of Freiburg against Count Mercy's Bavarians (Aug. 3, 5 and 9, 1644), after which Philipsburg was successfully besieged. Before the capitulation Enghien withdrew and left Turenne in command. The marshal opened the campaign of 1645 with a strong forward movement but was surprised and defeated by Mercy at Mergentheim (Marienthal) on May 2. Enghien was again sent to the front with the army of France, and Turenne's army was greatly increased by the arrival of a Swedish force and a contingent from Hesse-Cassel The Swedes soon departed, but Enghien was at the head of 20,000 men when he met the Bavarians in a battle even more stubbornly contested than Freiburg. Mercy was killed and his army beaten at Allerheim near Nordlingen (Aug. 3, 1645).

Ill-health forced Enghien to retire soon afterwards, and Turenne was for the third time left in command of the French army. He was again unfortunate against the larger forces of the imperialists, but the campaign ended with a gleam of success in his capture of Trier (Trèves). In the following year (1646) he obtained more decided successes and, by separating the Austrians from the Bavarians, compelled the elector of Bavaria to make peace (signed March 14, 1647). In 1647 he proposed to attack the thus weakened army of the emperor but was ordered into Flanders instead. Not only was the opportunity thus lost but a serious mutiny broke out among the Weimar troops, whose pay was many months in arrear The marshal's tact and firmness were never more severely tried nor more conspicuously displayed than in his treatment of the disaffected regiments, among whom in the end he succeeded in restoring order with little bloodshed. He then marched into Luxemburg but was soon recalled to the Rhine, for in 1648 Bavaria had returned to her Austrian alliance and was again in arms. Turenne and his Swedish allies made a brilliant campaign, which was decided by the action of Zusmarshausen (May 17), Bavaria being subsequently wasted with fire and sword until a more secure pacification was obtained.

The peace of Westphalia (1648) was no peace for France, which was soon involved in the civil war of the Fronde. (*See* FRANCE: *History*.) Few of Turenne's actions have been more sharply criticized than his adhesion to the party of revolt. The army of Weimar refused to follow its leader and he had to flee into the Spanish Netherlands, where he remained until the treaty of Rueil put an end to the first war of the Fronde. The second war began with the arrest of Condé and others (Jan. 1650), among whom Turenne was to have been included; but he escaped in time and with the duchesse de Longueville held Stenay for the cause of the "Princes"—Condé, his brother Conti and his brother-in-law the duc de Longueville. Love for the duchess seems to have ruled Turenne's action, both in the first war and, now in seeking Spanish aid for the princes. In this war Turenne sustained one of his few reverses at Rethel (Dec. 15, 1650); but the second conflict ended in the early months of 1651 with the collapse of the court party and the release of the princes

Turenne became reconciled and returned to Paris in May, but the trouble soon revived and before long Condé again raised the standard of revolt in the south of France. In this, the third war of the Fronde, Turenne and Condé were opposed to each other, the marshal commanding the royal armies, the prince that of the Frondeurs and their Spanish allies Turenne displayed the personal bravery of a young soldier at Jargeau (March 28, 1652), the skill and wariness of a veteran general at Gien (April 7), and he practically crushed the civil war in the battle of the Faubourg St. Denis (July 2) and the reoccupation of Paris (Oct. 21). Condé and the Spaniards, however, still remained to be dealt with, and the long drawn out campaigns of the "Spanish Fronde" gave ample scope for the display of scientific generalship on the part of both the famous captains. In 1653 the advantage was with Turenne, who captured Rethel, St. Menehould and Muzon, while Condé's sole prize was Rocroy. The short campaign of 1654 was again to the advantage of the French; on July 25, the Spanish were defeated at Arras. In 1655 more ground was gained, but in 1656 Turenne was defeated at Valenciennes in the same way as he had beaten Condé at Arras. The war was eventually concluded in 1658 by Turenne's victory at the Dunes near Dunkirk, in which a corps of English veterans sent by Cromwell played a notable part (June 3–14); a victory which, followed by another successful campaign in 1658, led to the peace of the Pyrenees in 1659.

On the death of Cardinal Mazarin in 1661 Louis XIV took the reins of government into his own hands and one of his first acts was to appoint Turenne "marshal-general of the camps and armies of the king." He had offered to revive the office of constable of France (suppressed in 1627) in Turenne's favour if the marshal would become a Roman Catholic. Turenne declined Born of Calvinist parents and educated a Protestant, he had refused to marry one of Richelieu's nieces in 1639 and subsequently rejected a similar proposal of Mazarin. He had [illegible] married a daughter of the Protestant Marshal de la Force, to whom he was deeply attached. But he sincerely deplored the division of the Christian church into two hostile camps. How closely both he and his wife studied such evidence as was available is shown by their correspondence, and, in the end, two years after her death, he was prevailed upon by the eloquence of Bossuet and the persuasions of his nephew, the abbé de Bouillon, to give in his adhesion to the Orthodox faith (Oct. 1668). In 1667 he had returned to the more congenial air of the "Camps and Armies of the King," directing, nominally under Louis XIV, the famous "Promenade militaire" in which the French overran the Spanish Netherlands. Soon afterwards Condé, now reconciled with the king, rivalled Turenne's success by the rapid conquest of Franche Comté, which brought to an end the War of Devolution in Feb. 1668.

In Louis XIV's Dutch War of 1672 (*see* DUTCH WARS) Turenne was with the army commanded by the king which overran Holland up to the gates of Amsterdam. The dikes were opened and the country round Amsterdam flooded. This heroic measure completely checked Turenne, whom the king had left in command Turenne now fought a successful war of manoeuvre on the middle Rhine while Condé covered Alsace. In Jan. 1673 Turenne assumed the offensive, penetrated far into Germany and forced the Great Elector of Brandenburg to make peace; later in the year, however, he was completely outmanoeuvred by the famous imperial general, Montecuculli, who evaded his opponent, joined the Dutch and took the important place of Bonn. In June 1674, however, Turenne won the battle of Sinzheim, which made him master of the Palatinate. Under orders from Paris the French wasted the country far and wide. In the autumn the allies again advanced, and though Turenne was again outmanoeuvred, his failure on this occasion was due to the action of the neutral city of Strasbourg in permitting the enemy to cross the Rhine by the bridge at that place. The battle of Enzheim followed; this was a tactical victory but hardly affected the situation, and at the beginning of December the allies were still in Alsace. The old marshal now made the most daring campaign of his career. A swift and secret march in mid-winter from one end of the Vosges to the other took the allies by surprise. Sharply following up his first successes, Turenne drove the enemy to Turkheim, and there inflicted upon them a heavy defeat (Jan. 5, 1675). In a few weeks he had completely recovered Alsace. In the summer campaign he was once more opposed to Montecuculli, and after the highest display of "strategic chess-moves" by both commanders, Turenne finally compelled his opponent to offer battle at a disadvantage at Sassbach. Here, on July 27, 1675, he was killed by almost the first shot fired The news of his death was received with universal sorrow. Turenne's most eloquent countrymen wrote his *éloges*, and Montecuculli himself exclaimed: "Il est mort aujourd'hui un homme qui faisait honneur à l'homme." His body was taken to St. Denis and buried with the kings of France. Even the extreme revolutionists of 1793 respected it; and, when the bones of the sovereigns were thrown to the winds, the remains of Turenne were preserved at the Jardin des Plantes until Sept. 22, 1800, when they were removed by order of Napoleon to the Church of the Invalides at Paris, where they still rest.

Turenne was one of the great captains whose campaigns Napoleon recommended all soldiers to "read and re-read" His fame as a general was the highest in Europe at a period when war was studied more critically than ever before, for his military character epitomized the art of war of his time (Prince de Ligne) Strategic caution and logistic accuracy, combined with brilliant dash in small combats and constancy under all circumstances of success or failure may perhaps be considered the salient points of Turenne's genius for war. Great battles he avoided. "Few sieges and many combats" was his own maxim. And, unlike his great rival Condé, who was as brilliant in his first battle as in his last, Turenne improved day by day. Napoleon said of him that his genius grew bolder as it grew older; and a modern author, the duc d'Aumâle (*Histoire des princes de la maison de Condé*), takes [illegible]

jusqua'à Sulzbach. Chez lui chaque jour marque un progrès" In his personal character Turenne was little more than a simple and honourable soldier, endowed with much tact, but in the world of politics and intellect almost helpless in the hands of a skilful intriguer or casuist. His morals, if not beyond reproach, were at least more austere than those prevalent in the age in which he lived He was essentially a commander of regular armies His life was spent with the troops; he knew how to win their affection, he tempered a severe discipline with rare generosity and his men loved him as a comrade no less than they admired him as a commander. Thus, though Condé's genius was far more versatile, it is Turenne whose career best represents the art of war in the 17th century. For the small, costly and highly trained regular armies and the dynastic warfare of the age of Louis XIV, Turenne was the ideal army leader.

The most notable of the numerous portraits of Turenne are these of P de Champagne at Versailles and of Senn (dated 1670) in the Jones collection at South Kensington, London. Of the older memoirs of Turenne the most important are those of "Du Busson," *La Vie du vicomte de Turenne*—the author is apparently Gatien de Sandraz de Courtilz (Paris, the Hague and Cologne, 1688–95), Abbé Raguenet, *Histoire du vicomte de Turenne* (Paris 1741) and especially Ramsay, *Histoire d'Henri de la Tour d'Auvergne, vicomte de Turenne* (Paris 1735), the second volume of which contains the marshal's memoirs of 1643–58 These memoirs, of which the Prince de Ligne wrote that "ce ne sont pas de conseils, ce sont des ordres . . 'faites' . . . 'allez,' etc."—were written in 1665, but were first published (*Mémoires sur la guerre, tirés des originaux*, etc.) in 1738, reprinted in Michaud, *Mémoires sur l'histoire de France*, 31d series, vol iii, and Laskenne and Sauvan's *Bibliothèque historique et militaire*, vol. iv (Paris 1846) A manuscript, *Maximes de M de Turenne* (1644), exists in the Staff archives at Vienna; and of other documentary collections may be mentioned Grimoard, *Collections de lettres et mémoires trouvés dans le portefeuille de M. de Turenne* (Paris, 1782); *Recueil de lettres écrites au vicomte de Turenne par Louis XIV. et ses ministres*, etc (Paris 1791); *Correspondance inédite de Turenne avec Le Tellier et Louvois*, ed. Barthélemy (Paris 1874). *See* also the *Observations on the Wars of Marshal Turenne*, dictated by Napoleon at St Helena (1823), Puységur, *La Guerre par principes et règles* (Paris 1748); Précis in *Bibliothèque internationale d'écol. milit.* (Brussels 1883), Duruy, *Histoire de Turenne* (Paris 1880); Roy, *Turenne, sa vie et les institutions militaires de son temps* (Paris 1884); Hardy de Perini, *Turenne et Condé* (Paris 1907); Neuber, *Turenne als Kriegstheoretiker und Feldherr* (Vienna 1869); Sir E. Cust, *Lives of the Warriors of the 17th Century* (London, 1867); T. O. Cockayne, *Life of M de Turenne* (founded on Ramsay's work; London, 1853); G B. Malleson, *Turenne Marshal Turenne*, by "the author of the Life of Sir Kenelm Digby" (London 1907), is a valuable work by a civilian and is based in the main on Ramsay's work, the memoirs of Cardinal de Retz, James, duke of York, etc, and on Napoleon's commentaries. A remarkable parallel between Turenne and Condé, in Saint-Evremond's *éloge* of the latter, will be found in Carrion-Nisas, *Essai sur l'histoire général de l'art militaire*, ii, 83 (Paris 1824); C. G Picavet, *Les dernières années de Turenne 1660–1675* (1912), p. 513; General Weygand, *Turenne* (1929). (C. F. A.)

TURFAN, the name of a remarkable depression in the Tarim region south of the Tien-shan, here over 10,000 ft. in height. This is said to be 426 ft below sea level at the lowest point. The town of Turfan, just 30 mi. to the north, stands some 250 ft. above sea level, and the general level around the depression rapidly reaches over 2,500 feet. The depression is loess covered and would be fertile if it could be irrigated The town of Turfan is a double settlement, part Chinese and part Turki, with a population of 15–20 thousand. In the depression, the temperature varies from 90° for July, calculated at Lukchun, to 13° in January and the daily fluctuations are very great

TURGAI, a former province of Russian central Asia, now included in the Kazakstan (*q v.*) A.S.S R.; *see* also Aktubinsk.

The Turgai strait, a narrow passage over the watershed separating the Tobol and the Irgiz, between the east of the southern Urals and the west of the plateau region of the Kirghiz steppe, is of great structural importance. Through it came the marine transgressions of previous geological epochs; the upper Cretaceous advanced into the southwest only, but those of the upper Eocene and Oligocene extended along the east of the Urals and the Lower Oligocene sea of Germany reached the Arctic ocean During the age of the amber forests the Strait of Turgai was closed, and no sea again entered Siberia by that route The course of the Tobol river marks the direction of the ancient marine connection. At a recent epoch the present Turgai river, which enters Lake Chalkar-tenız and which receives the Irgiz as a tributary, flowed into the Sea of Aral, its volume being then much increased by tributaries which now lose themselves in the sand before reaching it.

See Suess *The Face of the Earth*, vol. III (1908).

TURGENEV, IVAN SERGEYEVICH (tōōr-gān'yĕv) (1818–1883), Russian novelist, was born at Orel of a family of provincial gentry. His father had married for money a woman older than himself, who made up for her thwarted affections by making herself a domestic tyrant to her children, as well as to her serfs. Turgenev was educated at home, at the Universities of Moscow and St Petersburg and finally (1839–40) at Berlin, where, in contact with young Russian intellectuals, he became a Westerniser In 1843 he published *Parasha*, a tale in verse, which was favourably reviewed by Belinsky. Turgenev deserted the civil service for letters and was infatuated with the famous singer, Paulne Garcia (Mme Viardot), this caused a breach with his mother, who cut off his allowance. He lived as a Bohemian until her death (1850) made him a rich man His lifelong affection for Mme Viardot, who merely tolerated his presence, met with no response but left a deep impress on his work. Turgenev abandoned poetry for the drama (which he also abandoned after 1852) and for prose fiction. His first great success was *A Sportsman's Sketches* (started 1847, in book form 1852), in which the peasants appeared more attractive than their masters. It was received as a protest against serfdom In 1852 Turgenev was exiled to his estate for a while because of his laudatory obituary on Gogol.

His masterpieces included short stories like *The Backwater*, *Asya*, *First Love* and the more ambitious novels *Rudin* (1856), *A Nest of Gentlefolk* (1858), *On the Eve* (1860) and *Fathers and Sons* (1862), in which the love plot was interwoven with current social issues. All were commented on at great length by the leading critics. His attempt, however, to draw a strong man in the person of the agnostic and materialist—"nihilist"—Bazarov was resented by the Radical press as a caricature Turgenev, being sensitive to criticism, was embittered against his countrymen and settled abroad, and his later works are mainly retrospective. The two novels in which he tried to deal with actuality, *Smoke* (1867) and *Virgin Soil* (1877), only show the depth of his bitterness and his complete loss of touch with contemporary Russia. However, his last visit to Russia (1880) was a triumphant progress. He died in 1883, at Bougival, near Paris

Turgenev was the first Russian author to be read and admired by Europe. During his last years he lived in close touch with the French literary world, contracted intimate friendships (especially with Flaubert) and was regarded as a master by younger men like Maupassant He was very popular in this French circle, but much less so among his Russian compeers: Tolstoy, Dostoyevsky and Nekrasov all sooner or later came to detest him.

Turgenev is the most poetical (in the 19th century acceptance of the word) of the Russian realists. He had undergone the profound influence of Pushkin (as well as of Lermontov and George Sand). His novels are largely variations on the theme of *Eugene Onegin*. His character drawing does not depend on analysis and psychology but on a subtly-woven poetic atmosphere that accompanies the characters like an aura. This applies mainly to his women; they are invariably stronger and more attractive than his men, who (with the single exception of Bazarov) are neurasthenic weaklings. His style is marked by a careful simplicity and elaborate naturalness that answered to the highest ideals of 19th century taste. Delicately-drawn landscape passages are among its most outstanding features.

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TURGEON, PIERRE FLAVIEN (1787–1867), archbishop of Quebec, was born in Quebec on Nov. 12, 1787. He was ordained in 1810 and became director of the Quebec seminary in

1821 after visiting England and Rome, 1819–20 He was instrumental in obtaining settlement of the status of the Catholic church in Canada. After serving as administrator from Nov. 1849, he became archbishop of Quebec in Oct 1850 and in that capacity brought about the organization of the province, and under him the first and second councils of Quebec convened in 1851 and 1854, respectively. He was the founder of Laval university, which opened on Sept. 1, 1852, and of La Maison du Bon Pasteur He held office until 1855 when ill health compelled him to resign. He died on Aug 25, 1867.

TURGOT, ANNE ROBERT JACQUES, Baron de Laune (1727–1781), French statesman and economist, was born in Paris on May 10, 1727, the youngest son of Michel Étienne Turgot, "provost of the merchants" of Paris. He was educated for the church, and at the Sorbonne, to which he was admitted in 1749 (being then styled abbé de Brucourt), he delivered two remarkable Latin dissertations, *On the Benefits which the Christian Religion has conferred on Mankind* and *On the Historical Progress of the Human Mind*. In 1750 he decided not to take holy orders, giving as his reason, according to Dupont de Nemours, "that he could not bear to wear a mask all his life." In 1752 he became *substitut* and later *conseiller* in the parlement of Paris, and in 1753 *maîtres des requêtes*. In 1754 he was a member of the *chambre royale* which sat during an exile of the parlement; in 1755 and 1756 he accompanied Gournay, then intendant of commerce, in his tours of inspection in the provinces and in 1760, while traveling in the east of France and Switzerland, visited Voltaire, who became one of his chief supporters. In Paris he frequented the salons, especially those of Mme Graffigny—whose niece, Mille de Ligniville, afterwards Mme. Helvétius, became his lifelong friend—Mme. Geoffrin, Mme. du Deffand, Mlle. de Lespinasse and the duchesse d'Enville. It was during this period that he met the leaders of the "physocratic" school, Quesnay and Gournay, and with them Dupont de Nemours, the abbé Mordellet and other economists All this time he was studying various branches of science and languages, both ancient and modern. In 1753 he translated the *Questions sur la commerce* from the English of Josias Tucker and wrote his *Lettre sur la tolérance* and a pamphlet, *Le Conciliateur*, in support of religious tolerance. Between 1755 and 1756 he composed various articles for the *Encyclopédie* and between 1757 and 1760 an article on *Valeurs et monnaies*, probably for the *Dictionnaire du commerce* of the abbé Morellet In 1759 appeared his *Éloge de Gournay*.

In August 1761 Turgot was appointed intendant of the *généralité* of Limoges, which included some of the poorest and most over-taxed parts of France; here he remained for 13 years. He was already deeply imbued with the theories of Quesnay and Gournay (*see* Physiocratic School) and set to work to apply them as far as possible in his province. He continued the work on the *cadastre*, or new official survey, begun by his predecessor Tourny in order to arrive at a juster assessment of the *taille;* he also obtained a large reduction in the contribution of the province He published his *Avis sur l'assiette et la répartition de la taille* (1762–70) and as president of the *Société d'agriculture de Limoges* offered prizes for essays on the principles of taxation. Quesnay and Mirabeau had advocated a proportional tax (*impôt de quotité*), but Turgot, a distributive tax (*impôt de répartition*). Another reform was the substitution for the *corvée* of a tax in money levied on the whole province, the construction of roads being handed over to contractors. In 1769 he wrote his *Mémoire sur les prêts à intérêt*, in which the question of lending money at interest was for the first time treated from a scientific, not from a moral standpoint. Among other works written during Turgot's intendancy were the *Mémoire sur les mines et carrières* and the *Mémoire sur la marque des fers*, in which he protested against state interference and advocated free competition.

During the famine of 1770–71 he enforced on landowners "the obligation of relieving the poor" and especially the *métayers* dependent upon them and organized in every province *ateliers* and *bureaux de charité* for providing work for the able-bodied and relief for the infirm. Turgot made the *curés* the agents of his charities and reforms when possible. In 1770 he wrote his famous *Lettres sur la liberté du commerce des grains* addressed to the comptroller-general, the abbé Terray. Three of these letters have disappeared, having been sent to Louis XVI by Turgot at a later date and never recovered

Turgot's best known work, *Réflexions sur la formation et la distribution des richesses*, written in 1766 for the benefit of two young Chinese students, appeared in 1769–70 in Dupont's journal, the *Éphémérides du citoyen*, and was published separately in 1776 After tracing the origin of commerce, Turgot develops Quesnay's theory that the land is the only source of wealth and divides society into three classes, the productive or agricultural, the salaried (*stipendée*) or artisan class and the land-owning class (*classe disponible*). He advocates the *impôt unique; i e*, that only the *produit net* of the land should be taxed, and the complete freedom of commerce and industry

On July 20, 1774, Turgot was appointed minister of marine through the influence of Maurepas; and on Aug 24 he became comptroller-general His first act was to submit to Louis XVI his guiding principles: "No bankruptcy, no increase of taxation, no borrowing" Turgot's policy, in face of the desperate financial position, was one of rigid economy in all departments. He contemplated a thorough-going reform of the *ferme générale* and, meanwhile, imposed certain conditions on the leases as they were renewed—such as a more efficient personnel and the abolition for the future of the abuse of the *croupes* (the name given to a class of pensions) and annulling certain leases, such as those of the manufacture of gunpowder and the administration of the *messageries*, the former of which was handed over to a company with Lavoisier as one of its advisers and the latter superseded by a better service of diligences which were nicknamed "turgotines." He also prepared a regular budget.

Turgot's measures reduced the deficit and raised the national credit to such an extent that in 1776, just before his fall, he was able to negotiate a loan with some Dutch bankers at 4%; but the deficit was still so large as to prevent him from attempting to realize his scheme of substituting for indirect taxation a single tax on land. He suppressed, however, a number of *octrois* and minor duties.

Turgot's edict for free trade in corn signed on Sept. 13, 1774, was strongly opposed in the *conseil du roi*. Turgot was hated by many in high places who had been interested in the speculations in corn and was opposed by Linguet and by Necker, who in 1775 published his treatise, *Sur la législation et le commerce des grains* But Turgot's worst enemy was the poor harvest of 1774, which led to a slight rise in the price of bread in the winter and early spring of 1774–75 and to those extraordinary bread-riots known as the "guerre des farines." Turgot showed great firmness and decision in repressing the riots and was loyally supported by the king throughout.

Turgot's famous "Six Edicts" were finally presented to the *conseil du roi* (Jan. 1776). The two which met with violent opposition were, firstly, the edict suppressing the *corvées*, and secondly, that suppressing the *jurandes* and *maîtrises*, the privileged trade corporations Turgot announced in the preambles to these his intention to subject the noblesse to taxation and to establish as a principle the right of every man to work without restriction.

He obtained the registration of the edicts by the *lit de justice* of March 12; but by that time he had won the hatred of the nobles and the parlements, the court, the "financiers," the clergy, the rich bourgeoisie of Paris and others. The queen disliked him for opposing the grant of favours to her protégés, and he had offended Mme de Polignac in a similar manner. Malesherbes and Maurepas ceased to support him, and Maurepas became reconciled with the queen and her party. About this time, too, appeared a pamphlet, *Le Songe de M Maurepas*, generally ascribed to the comte de Provence (Louis XVIII), containing a bitter caricature of Turgot.

Before relating the circumstances of Turgot's fall it might be well to summarize briefly his views on the administrative system. With the physiocrats, he believed in an enlightened absolutism and looked to the king to carry through all reforms.

As to the parliaments, he opposed all interference on their part in legislation, considering that they had no competency outside the sphere of justice. He recognized the danger of the recall of the old parliament but was unable effectively to oppose it since he had been associated with the dismissal of Maupéou and Terray and seems to have underestimated its power. He was opposed to the summoning of the states-general advocated by Malesherbes (May 6, 1775), possibly on the ground that the two privileged orders would have too much power in them His own plan is to be found in his *Mémoire sur les municipalités*, which was submitted informally to the king. In Turgot's proposed system landed proprietors alone were to form the electorate, no distinction being made between the three orders; the members of the town and country *municipalités* were to elect representatives for the district *municipalités*, which in turn would elect to the provincial *municipalités*, and the latter to a *grande municipalité*, which should have no legislative powers but should concern itself entirely with the administration of taxation With this was to be combined a whole system of education, relief of the poor, etc His large reforms amounted to a complete revolution and Louis XVI recoiled at the prospect.

Such a fundamental difference of opinion between king and minister was bound to lead to a breach sooner or later. Turgot's only choice, however, was between "tinkering" at the existing system in detail and a complete revolution, and his attack on privilege, which might have been carried through by a popular minister and a strong king, was bound to form part of any effective scheme of reform.

The immediate cause of Turgot's fall is uncertain. Some speak of a plot, of forged letters containing attacks on the queen shown to the king as Turgot's, of a series of notes on Turgot's budget prepared, it is said, by Necker and shown to the king to prove his incapacity Others attribute it to the queen, and there is no doubt that she hated Turgot for supporting Vergennes in demanding the recall of the comte de Guines, ambassador to London, whose cause she had ardently espoused Others attribute it to an intrigue of Maurepas. On the resignation of Malesherbes (April 1776), whom Turgot wished to replace by the abbé Véry, Maurepas proposed to the king as his successor a nonentity named Amelot Turgot, on hearing of it, wrote an indignant letter to the king, in which he reproached him for refusing to see him, pointed out in strong terms the dangers of a weak ministry and a weak king and complained bitterly of Maurepas's irresolution and subjection to court intrigues; this letter the king is said to have shown to Maurepas, whose dislike for Turgot it still further embittered

With all these enemies, Turgot's fall was certain; but he wished to stay in office long enough to finish his project for the reform of the royal household. This, however, he was not allowed to do On May 12, 1776, Turgot was asked to resign He retired to la Roche-Guyon, château of the duchesse d'Enville, returning shortly to Paris, where he spent the rest of his life in scientific and literary studies, being made vice-president of the Académie des Inscriptions et Belles Lettres in 1777. He died on March 18, 1781

In character Turgot was simple, honourable and upright, with a passion for justice and truth. He was an idealist, his enemies would say a doctrinaire, and certainly the terms "natural rights," "natural law," etc , frequently occur in his writings His friends speak of his charm and gaiety in intimate intercourse, but among strangers he was silent and awkward and produced the impression of being reserved and harsh Many of the reforms and ideas of the Revolution were due to him; the ideas did not as a rule originate with him, but it was he who first gave them prominence. Oncken looks upon him as a bad physiocrat and a confused thinker, while Léon Say considers that "though he failed in the 18th century he triumphed in the 19th"

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TURI, a Shi'a Mohammedan tribe which holds the Kurram Valley in the Northwest Frontier province, India, and enjoys increasing prosperity. Divided into five clans, all apparently of Hindki (*q v.*) origin, the Turis wrested the valley from the Bangash Pathāns after 1700, distributing its lands as conquered so that every original settler's family now holds fields all over it. A sturdy race, whose "fathom" is reputed to be 6½ ft., they are distraught by faction but hospitable; and a Turi escort (*badragga*) is famed for its fidelity.

They threw in their lot with the Sunnite Pathāns (1851–56) but in the second Afghan War furnished Roberts with supplies and in 1892 accepted British protection.

TURIN, a city of Piedmont, Italy, capital of the province of Turin, formerly of the kingdom of Sardinia (until 1860), and of Italy till the removal of the seat of government to Florence in 1865. Pop. (1936) 608,211 (town), 629,115 (commune), thus showing rapid growth at the expense of the Alpine valleys (*see* ITALY). The area of the city is 6·5 sq mi., and its octroi circle measures nearly 9 mi.

Built upon alluvial soil 784 ft above sea level, it stands upon the river Po. The streets and avenues, almost all of which are straight, intersect at right angles In general it has a modern aspect, but its regularity of form is in reality derived from the ancient Roman town of Augusta Taurinorum, which formed its nucleus.

The mean temperature at Turin (1871–1900) is 53° F. (winter 35°, summer 71°), with an average maximum of 90° and an average minimum of 17°. Snow falls on an average only on seven days per annum. The rainfall averages 34 in.

The cathedral of St. John the Baptist (the see has been archiepiscopal since 1515) is a cruciform, Renaissance building dating from 1492–98 by the Florentine architect, Baccio Pontelli. Meo del Caprina being the contractor. Behind the high altar of the cathedral is the chapel of the Sudario or Sindone, built (1657–94) by Guarini as a royal burial-place The "sudario" from which it takes its name is asserted to be the shroud in which Joseph of Arimathea wrapped the body of Jesus La Beata Vergine della Consolata, another of Guarini's works, has a tower which belonged to the church of St Andrew, founded by the monk Bruning in 1014

Other churches of note are San Filippo (1672–1772), the largest in Turin, the dome of which fell in just as it was approaching completion under the hands of Guarini and was restored by Juvara, and La Gran Madre di Dio, erected to commemorate the return of the court in 1814 The Palazzo Madama was erected by William VII of Montferrat at the close of the 13th century on the Roman east gate of the town, remains of the towers of which were incorporated in it. It owes its name to the widow of Charles Emmanuel II, who added the west façade and the handsome double flight of steps from Juvara's design (1718). The extensive royal palace was begun in 1646 Many of the baroque palaces have fine pillared courtyards, some of them are the work of Guarini The tower of the citadel (1566) contains the artillery museum. The Castello del Valentino is partly in the French style of the 16th century It contains the polytechnic school and geological, mineralogical and industrial museums and the university botanical garden.

The university, founded about 1400 by Lodovico di Acaja, had more than 5,000 students before World War II There is also an engineering school and an institute of commerce and economics The old university buildings erected in 1713 by the Genoese architect, Ricca, contain the library, some treasures of which were lost by fire in 1906.

The academy of sciences, founded in 1757, is in a building erected in 1678 by Guarini and contains the local antiquities of Piedmont and Egyptian treasures partly collected by Drovetti, partly excavated in the present century at Thebes, Assiout, etc.

The pictures are by Van Dyck and by north Italian masters. There is a museum of zoology and mineralogy in Palazzo Carignano (another of Guarini's buildings), and the royal palace contains the royal armoury (a fine collection begun by Charles Albert in 1833) and the royal library with its rich manuscript collection and its 20,000 drawings.

There are many modern public monuments including those to Emmanuel Philibert (1838), Charles Albert (1861), Victor Emmanuel II. (1899), the Duke of Aosta (1902), Mazzini (1915). The Mole Antonelliana, built by Alessandro Antonelli, is used for the Risorgimento Museum. It is the highest brick edifice in Europe, its summit being 510 ft above ground, the dome being raised upon a hall with three galleries, one above the other. The newer parts of the city, extending towards the south beyond the stadium (1911) are finely laid out.

Among the hospitals is that called by the name of its founder, Cottolengo, a vast institution providing for more than 7,000 persons.

The industries comprise metallurgy, machine-making, chemicals, silk and cotton weaving, tanning and leather-working, artificial silk and fibres, matches, candles, soap, furniture, perfumes, glass, damasks, velvets, woollens, ready made clothing, etc. The manufacture of motor-cars has become of great importance. Turin is the chief seat of the industry in Italy. Aeroplanes are also manufactured: and chocolate, liqueurs and vermouth are made. The application of electricity is widely developed on account of the proximity of the Alpine valleys, and the hydro-electric plants of the Mont Cenis, the Val d' Aosta, and the Toce valley all concentrate on Turin.

Milan, owing to its nearness both to the St. Gotthard and to the Simplon, is the most important railway centre of Italy. Turin is however nearest to the Mont Cenis, while the completion of the line through Cuneo over the Col di Tenda now affords direct communication with the French Riviera.

On the Hill of Superga (2,300 ft. above the sea) Victor Amadeus II. erected a basilica in memory of the liberation of Turin from the French in 1706. King Charles Albert and other Savoy princes are buried in the crypt. Not far from Turin are also the royal castles of Moncalieri, Stupinigi, Rivoli, Racconigi, Agliè, Venaria Reale. Turin was made the chief town of Piedmont by Amadeus, first duke of Savoy (*See* SAVOY, HOUSE OF) Between 1536 and 1562 Turin was occupied by the French, and in 1630 it lost 8,000 of its citizens by the plague. The French were masters once more from 1640 to 1706, and again from 1798 till 1814, when Piedmont was restored to the house of Savoy. The town was heavily bombed In World War II by the Allies.

The ancient *Augusta Taurinorum* was a city of Gallia Cisalpina, the chief town of the Taurini. The natural advantages of its site and its position with relation to the pass over the Alpis Cottia (Mont Genèvre; *see* COTTIE RESOUAT) made it important, though Hannibal, after crossing the Alps in 218 B.C., was able to take it after a three days' siege. It was partly burned down in A.D. 69, but continued to be prosperous. The Roman town formed a rectangle 2,526 ft. by 2,330 (770 × 710 metres). This measurement is questioned by F. Haverfield, *Ancient Town-Planning* (Oxford, 1913) 87, but is confirmed by an article by U. Savoia in *Town-Planning Review* xii. (1927). The walls, which were 21 *ft. high, 7 ft. thick at ground level and 3 ft. at the top*, were standing till about 1600; and the north gate, the Porta Palatina, exists. The interior of the town was divided by seven streets from east to west and eight from north to south into 72 blocks (*insulae*), and the ancient pavement and the drains below it are frequently found under the streets of the central portion of the modern town, indicating that they follow the ancient lines. Remains of a theatre have been discovered in the palace garden.

See C. Promis, *Storia dell' antica Torino* (Turin, 1869); A. d'Andrade, *Relazione dell' ufficio regionale per la conservazione dei monumenti dei Piemonte e della Liguria, 7 seq.* (Turin, 1899).

(T. A.)

Battle of 1706.—Turin was besieged in 1706 by the French under La Feuillade (*see* SPANISH SUCCESSION, WAR OF THE) who was covered by another army under the duc d'Orleans. Eugene of Savoy (*q.v.*) marching to the relief of Turin with 30,000 Austrians and Germans, eluded Orleans and in mid-August appeared before the French siege lines The united armies of Feuillade and Orleans numbered over 70,000 men, but on Sept. 7 Eugene boldly attacked them in their entrenchments between the rivers Doria and Stura. After the usual artillery duel, Eugene gave the order to advance. The Brandenburgers on the left quickly got to within a few paces of the entrenchments, but were driven back by the French fire Eugene then led the Germans on his left in a brilliant attack which stormed the entrenchments. Seeing this, Eugene's cousin, the duke of Savoy, attacked the French centre and, after three repulses, stormed it, Orleans being wounded, and his lieutenant, Marshal Marsin, killed. The French tried to rally, but the garrison of Turin took part in the discomfiture of the fugitives. Feuillade raised the siege and joined Orleans in a disorderly retreat. Each side had about 3,000 killed and wounded, but 6,000 prisoners fell into Eugene's hands and French prestige in Northern Italy was destroyed.

TURINA, JOAQUIN (1882–1949), Spanish composer, was born at Seville on Dec. 9, 1882 He studied under D'Indy, in Paris, 1905–14, where he wrote an encyclopaedia (*Enciclopedia abreviada de la música*, Madrid, 1917). His principal works are *Procesión del Rocio* for orchestra; music for the morality play, *La adúltera penitente;* a dramatic work, *Jardín de oriente* (1923), a pianoforte quintet, a string quartet, *Escena Andaluze*, for viola, pianoforte and string quartet, *Poema de una Saluqueua*, and songs He died Jan. 14, 1949, in Madrid.

TURKESTAN; *see* TURKISTAN.

TURKESTAN (Hazret, Yasi), a town in the Kazakstan S.S.R., in 43° 8′ N., 68° 18′ E., on the Orenburg-Tashkent railway 20 mi. E. of the Syr-Dana river, alt. 833 feet. Pop. about 30,000 Its main industry is cotton, and it acts as a depot for the *collection of hides and wool.* It is an ancient town and in 1397 a Persian architect was commissioned by Timur (Tamerlane) to build a mosque in honour of the Kirghiz patron Hazret Yasavi

TURKEY, a republic of the near east, with an area of 296,184 sq mi, comprising 9,256 sq mi. in Europe (Eastern Thrace) and 286,928 sq mi. in Asia (Anatolia), as well as 451 sq mi of swamps and marshes and 3,256 of lakes It is bounded on the east by the U.S.S.R (366 mi.) and Iran (Persia) (296 mi.); on the south by Iraq (234 mi.) and Syria (490 mi.) and the Mediterranean sea; on the west by Greece (126 mi) and Bulgaria (124 mi.) and on the north by the Black sea.

Turkey in Europe is separated from Anatolia by the straits—the Bosporus, the Sea of Marmara and the Dardanelles—which form the only sea passage between the Black sea and the Mediterranean. It is bounded on the northeast by the Black sea, and on the southwest by the Aegean sea The western frontier with Bulgaria and Greece was determined by the treaty of Lausanne (July 24, 1923). It runs from Ayastafanos on the Black sea along the valley of the small river Rezvaya, across the Istranca mountains and continues westward to the river Tundzha (Tunja), which it crosses about 15 mi. N. of Edirne (Adrianople) From this point it turns southwest to the river Maritsa (Meric) which it strikes about 15 mi. upstream from Edirne. There the frontier with Bulgaria ends and that with Greece begins. The border follows the Maritsa to Edirne (Adrianople), where on the right bank the suburb of Karagach (Karaagac) and a small part of the railway are included in Turkey; then the river is followed to its mouth near Enos (Enez).

The islands of Imroz (Imbros) and Bozcaada (Tenedos) off the Dardanelles belong to Turkey; otherwise the Aegean and the Mediterranean coast line is the boundary to a point just south of the mouth of the Orontes (Asi) river where the frontier with Syria begins. The line runs irregularly east and north through mountainous country, enclosing Antakya (Antioch) and its lake, to Meydaniekbez, where it turns east across the Baghdad railway, which it crosses again at Cobanbey (see *Communications*, below). It then runs about one yard south of the railway to Nusaybin (Nisibis), where it again crosses it and turns slightly north to Cizre (Jezirat ibn Omar) on the Tigris which it follows in a southerly direction to its confluence with the Khabur (Habur). The

frontier with Syria, which ends at this point, was originally defined when the French withdrew from Cilicia in the Franco-Turkish agreement of Oct. 20, 1921, and was confirmed by the treaty of Lausanne (1923). Under the terms of this treaty the Antakya-Alexandretta district known as the sanjak of Alexandretta (Iskenderun) came within the French mandate for Syria but enjoyed a special administration by virtue of its large Turkish population. In 1939, when the grant of independence to Syria (*q.v.*) appeared imminent, the district was annexed to Turkey and became the Hatay province, the boundary of which, from the mouth of the Orontes to Cobanbey, became the western section of Turkey's frontier with Syria.

The question of the frontier with Iraq, in accordance with article 3 of the treaty of Lausanne, came before the council of the League of Nations and was defined in the Ankara convention of June 5, 1926. Delimitation was completed in 1928. The frontier starts from the junction of the Khabur with the Tigris about 80 mi. N.W. of Mosul, follows the Khabur and its tributary the Hazil Su northeastward into the mountains, then turns east and traverses the difficult Kurdish highlands to the Rubar-i-Shin where it turns south across the Semdinan Su to the Rubar-i-Haji Bey and follows this river in a northeasterly direction to its source in the Persian watershed.

A frontier commission was delimiting the boundary between Turkey and Persia when World War I broke out in 1914. In order to put an end to frontier incidents which had occurred, an *accord de délimitation* was signed on Jan. 23, 1932, and a further rectification of the line in the neighbourhood of Paki and Eli was settled on May 27, 1937. From the junction with the Iraqi frontier the line runs in a general northerly direction in mountainous country to a point about 25 mi. S. of Mount Ararat (the Agri Dag), where it turns east for about 20 mi. and then north to enclose this mountain until the river Aras (Araxes) is reached. There the frontier with Iran ends and that with the U.S.S.R. begins.

The frontier with the U.S.S.R. was defined in an annex to the treaty of Moscow (March 16, 1921) and by article 4 and three annexes of the treaty of Kars (Oct. 13, 1921). From a point roughly east of Ararat the boundary line follows the Aras to its junction with the Arpa, which it then follows, skirting the Alagoz volcano, to a point about 10 mi. W. of Leninakan (Aleksandropol). There the line swings in a great bow, northwestward over the Transcaucasian mountains and then westward, enclosing Kars, Ardahan and Artvin; crossing the river Coruh (Chorokh), it reaches the Black sea less than 10 mi. S. of Batum.

Physiography.—Turkey has been described as a bridge between Europe and Asia. Though the western end of the bridge has been broken down toward the Aegean and is interrupted by the straits, the customary division into European and Asiatic Turkey is an arbitrary one derived from the strategical and political importance of the straits. European Turkey is no more than the western continuation of the northern coast land of Anatolia. The geological upheavals which determined the formation of the land surface had not ended in the 20th century, as the disastrous earthquakes of modern times testify.

Turkey in Europe, a rough triangle with its apex on the Bosporus, has a northern and southern fringe of mountains, the Istranca and Tekirdag ranges, and a central undulating plain through which run the valleys of the Maritsa and the Ergene, draining the landward slopes of both highlands. East of the Maritsa and Tundzha rivers the central lowland is the only avenue from the west to Istanbul. About 25 mi. W. of Istanbul, a transverse ridge 600 ft. high crosses the peninsula from Terkos lake to Buyuk Cekmeca. This ridge is the foundation of the defensive system known as the Chatalja (Cataca) lines.

Asiatic Turkey (Anatolia) is roughly rectangular in outline, almost three times as long from east to west (about 900 mi.) as from north to south (about 300 mi.). Its main features are: (1) a central plateau extending nearly 500 mi. eastward from the latitude of Istanbul; (2) a mountainous girdle encircling the plateau on north, west and south and (3) an almost entirely mountainous region which becomes progressively wilder and more rugged up to the frontiers of the U.S.S.R. and Iran.

The central plateau is elevated to an average height of 3,000 ft. above sea level. Most of it is semidesert or steppe with scanty pasture except where the rivers flow through it with strips of fertile land bordering them. There are numerous depressions where marshes, shallow lakes or mud flats have been formed. Some of these are brackish because of the solubility of the rocks over which the water has reached them. The largest of these basins is a salt lake, Tuz Golu, in the centre of the plateau, about 60 mi. S. of Ankara (Angora). West of Ankara much of the country is rolling upland, between 3,500 and 4,500 ft. above sea level, with a few rounded summits nearly 6,000 ft. high. To the south and east of the capital is a region of rolling uplands with the remains of extinct volcanoes and, particularly in the neighbourhood of Kayseri (Caesarea Mazaca), lava and ash from them. To the north and northeast toward Sivas the level of the plateau rises, falling again in the direction of Amasya (Amasia) and Chorum (Corum). Near Sivas the Kizil Irmak (Red river) is at about 4,500 ft., and the central plateau is enclosed by mountain ranges on the east, northwest and southwest.

The Black sea coast between the Bosporus and the Soviet frontier is about 750 mi. long and has, throughout most of its length, steep, broken country near the seaboard. The breadth of the coast land is less easy to define. There is no clear dividing line between it and the central plateau in the western part, though to the east the character changes and there is a sharp division between the high mountain ranges on the coast and the hinterland. There is a fertile plain, the delta of the Sakarya river, between the gulf of Izmit and Eregli. Between Eregli and Inebolu the mountains rise to 3,000 ft. close to the sea and peaks inland to more than 6,000 ft. The hills are well forested, and the valleys between them, running from north to south, with branches parallel to the coast, are extensively cultivated. Coal is mined between Eregli and Cide. East of Inebolu the coastal range rises steeply from the sea and then falls abruptly about 30 mi. S. of the coast. Inland of Sinop, at Bafra where the Kizil Irmak reaches the sea and also east of Samsun are areas of coastal plain. Generally speaking, the inland belt is well-wooded, and the rounded mountains form a series of plateaus with fertile depressions between them. From Ordu to the Soviet frontier the features are a coastal range about 20–30 mi. from the shore, between which and the higher volcanic ranges to the south run the Kelkit and Coruh valleys.

Western Anatolia may be defined as the region west of long. 30° E., which comprises the Aegean coastland up to the central plateau. The coast line is deeply indented and has many natural harbours. The country bordering the Sea of Marmara is relatively low with streams running north or south, for which the hills around Balikesir are the collecting ground. The valley of the Simav separates these hills from the higher country to the east in which the forest-clad Ulu Dag (the Mysian Olympus of the ancients) stands about 8,000 ft. above the fertile slopes around Bursa (Brusa), ranges average more than 5,000 ft. to the Egrigoz Dag (7,000 ft.), about 50 mi. to the south. The fertile coastal region of Bergama (the ancient Pergamum) lies between the Simav valley and the three east-west valleys of the Gediz and the Kucuk and the Buyuk Menderes (the Little and the Great Maeander). The region to the east of Izmir (Smyrna), which is watered by the last two rivers, is bounded by two semielliptical chains of mountains, the western one of which rises to an average of 4,000–5,000 ft. with peaks reaching more than 7,000 ft. Between this and the eastern range, 200 mi. inland at its furthest point, is a rich alluvial plateau. To the south are rugged highlands which end abruptly at the Mediterranean coast west of the Dalaman valley.

The southern edge of the central plateau is followed by the railway from Afyon (Afyon Karahisar), which traces a wide curve southeastward through Konya (Konia) to Kaiaman and then northeast to Kayseri. Between this line and the sea lie the Taurus mountains. From the Dalaman valley on the west to Silifke on the east a bundle of ranges, not always continuous and sometimes ill-defined, enclose the Adalia (Antalia) plain. The main Taurus, an irregular chain to the northeast, dominates the Seyhan and Ceyhan coastal plains in which lie Mersin and Adana. It is broken by the

Cakit gorge which leads to the famous Cilician Gates, the route from the central plateau to the sea The Taurus, rising to more than 12,000 ft southwest of this gorge, ends south of Kayseri, which is overlooked by the separate volcanic group, the Erciyas (*the Mount Argaeus of the ancients*). East of the Seyhan lowland is the narrow strip of lowland along the sides of the Gulf of Alexandretta, at the head of which a gap between two parallel ranges forms the ancient Amanus Gates, the Kalekoi pass between the Misis Dag on the west and the Gavur Dag (classical Amanus) on the east. Beyond the Taurus to the east is a group of seven ranges, the Anti-Taurus, all of which have a general trend to the northeast. The Kurt Dag, the Gavur and the Misis are the southernmost of the group, but none has an inclusive name The central ranges are much cut up by tributaries of the Seyhan and Ceyhan rivers. There are numerous peaks with heights between 7,000 and 8,000 ft, and the Nuruhak Dag, southwest of Malatya, is 10,100 ft.

Southeastern Turkey may be defined as the belt bounded on the south by *the frontiers with Syria and Iraq, on the east by the* frontier with Iran and on the north by the mountain ranges which form the watershed of the Euphrates and the Tigris. The Euphrates basin, on the west, is an irregular strip through which the river runs between precipitous banks. Most of the villages are on tributaries well back from the river. Between it and the Tigris valley is a barren, undulating plain, north of which rise the rugged heights of the Kurdish Taurus. The Tigris rises near the Hazar lake, flows on an erratic course southeast to Diyarbakir and then east, fed by numerous tributaries on the way. It passes there between deep gorges turning south and then east to Cizre, where it meets the frontier with Syria.

East of the Tigris to the Iranian frontier lie the Kurdish mountains, with summits rising to more than 13,000 ft On the west *the country is wild, and rivers and their tributaries cut erratically* between the crests. In the centre the ranges end in precipitous cliffs facing southwestward, further to the east the country is lower and becomes milder to the Iranian frontier. The Great Zab (Buyuk Zap Su), the tributaries of which drain the extreme southeastern corner of Turkey, passes through deep gorges in wild and difficult country and, cutting through the Cilu range, crosses the Iraqi frontier.

Eastern Turkey north of this region to the Kelkit and Coruh valleys is largely volcanic, with cones rising to 11,000 ft or more surrounded by lava fields Some ranges of nonvolcanic origin vary an otherwise monotonous landscape The Murat Su, which rises north of Lake Van, almost in the shadow of Mount Ararat, crosses the area from east to west to join the Euphrates 250 mi. away Lake Van, which lies at 5,643 ft. above sea level, is about 80 mi. long from east-northeast to west-southwest and about 35 mi. across at its widest point; it has no outlet. Mount Ararat, a volcanic cone rising to 16,916 ft, is the loftiest of the Agri Dag group on the frontier of Soviet Armenia, south of Erivan.

Climate.—The structure of Turkey—a central plateau surrounded by coastal belts of mountains—gives regional variations in climate which generally follow the divisions described above, although local differences due to latitude, altitude and topography occur. The central plateau has hot, dry summers and cold winters with rain or snow between November and May The eastern part of the plateau is colder than the western in winter, the summers are cool in the north, but hot in the south. The change in climate is rapid from the Black sea coastlands to the plateau In this region the winters are mild on the coast; the summers are hot and damp. Fog and mist are frequent throughout the year Winter temperatures fall rapidly and rainfall increases from the coast to the mountain heights inland In western Anatolia the change in altitude from coast to plateau is less abrupt and the climatic change is more gradual. The summers are hot and dry; the winters near the coast are mild and damp but become colder inland with frost and some snow Rainfall is moderate (20–30 in.) on the coast and decreases inland On the southern coastlands the temperature in winter is moderate, and this is the warmest part of Turkey. The summers are hot and, particularly in the eastern coastal lowlands, oppressive because of the high humidity. In the southeastern region the summers are extremely hot but the winters are milder than on the central plateau. Eastern Turkey has wide variations of temperature because of its mountainous character, and the northeastern district (Erzurum-Kars), where snow lies for four months of the year, has the coldest winter in Turkey. The summers are hotter in the south than in the north, but reliable records are scanty for this region. *See* Table I.

TABLE I.—*Temperatures and Rainfall*

Station	Absolute maximum and minimum recorded temperatures (degrees Fahrenheit)			Mean annual rainfall	
	Max	Month	Min	Month	Inches
Samsun	96	September	22	February	28
Istanbul	100	July	17	January	29
Edirne	107	July	−2	December	22
Izmir	111	June	12	February	25
Adalia	110	July	24	February	42
Adana	100	September	19	January	24
Konya	100	July	−8	February	11
Ankara	99	July	−13	December	14
Urfa	111	July	19	December	16
Erzurum	89	August	−17	Jan. and Feb	18
Kars	91	August	−32	Jan and Feb	20

(K. C. B)

HISTORY

The first appearance of the Ottoman Turks in history dates *from the early 13th century According to the official tradition* of the Turkish historiographers, Ertughrul, the father of the first sultan, Osman, was a member of the tribe of Kayi, the most exalted branch of the Ghuzz (Oghuz) Turks, who had been driven from their home in central Asia by the advancing Mongols He and his small band of tribesmen found their way into Anatolia, where the Seljuk sultan Ala ud-Din Kaikobad I, in gratitude for their *timely intervention* when he was hard pressed by a superior Mongol army, gave the gallant stranger a grant of lands around Soghut. Modern research (notably by Paul Wittek; see *Bibliography*) proved the greater part of this romantic story false The weight of evidence is against Ertughrul's exalted Kayi genealogy. Nor was it tribal loyalty that held his followers to him, any more than it retained men's allegiance to his descendants for nearly seven centuries

From at least the early 9th century, there are records in the Moslem east of organizations of *ghazis*, (fighters for the faith), men sworn to wage ceaseless war on the infidel, through motives of religious zeal or greed for loot or both Such were the followers of Ertughrul Ertughrul was not the only ghazi leader to establish a dynasty; the beyliks (principalities) of western Asia Minor —Menteshe, Aidin (Aydin), Karesi, Sarukhan—were all founded by ghazis. So also was the Saffarid dynasty which ruled in Persia between 860 and 1000. When a ghazi organization settled down in a conquered territory, there was always a hard core of warriors who, remaining true to their purpose, refused to become peaceful citizens These would naturally move on to any place where the fight against the infidel was still being fought. In this fact lies the reason for the extraordinary success of the line of Ertughrul, their field of operations was on the frontiers of Byzantium, where in fighting the Christian a ghazi might best fulfill his destiny. The Ottoman power was therefore perpetually strengthened by an endless stream of recruits from the more settled lands to the south and east.

In assigning to Ertughrul the lands around Soghut, the Seljuks were only recognizing a *fait accompli* Soghut remained his headquarters, and when he died in 1281, at the age of 90, it was there that he was buried

THE OTTOMAN SULTANATE

Osman I (1281–1325).—Ertughrul was succeeded by his son Osman (*b.* 1258), the first sultan of the dynasty to which he gave his name ("Ottoman" is a barbarism for "Osmanli"). In 1284 he was confirmed in his dominions by the Seljuk sultan Masud. He proceeded steadily with the work of enlarging his territories, taking Karajahisar in 1291, Bilecik and Yarhisar, and then Inegol in 1299. About 1308 the Seljuk sultanate came to an end, and the

Mongol Ilkhanids of Persia and Mesopotamia, to whom the Seljuks had been tributary, entrusted Anatolia to a Mongol prince, Timurtash, who tried with no great success to bring all the principalities under his sway. The main opposition to him came from the bey of Karaman, a powerful state which later gave the Ottomans a great deal of trouble. The fall of the Seljuks is generally regarded by Ottoman historians as marking the beginning of Ottoman independence, but it is known that Osman's successor continued to pay a yearly tribute to the Ilkhanids.

Toward the end of Osman's life, infirmity compelled him to depute his authority to his son Orkhan by 1324. By the time of his death (1325 or 1326), his dominions extended over the triangle contained by Hendek in the north, Eskisehir in the south and Lake Apolyon in the west.

Orkhan (?1324–62).—Orkhan had won the succession through his military ability, his elder brother Ala ud-Din being a man of pacific and scholarly temperament (he is generally identified, on no good authority, with the Ala ud-Din Pasha who served as vizier to the first two sultans). In 1326 the Ottoman forces captured Bursa, which had been under siege since 1315. In 1329 a Byzantine army under the personal command of the eastern Roman emperor Andronicus III was defeated at Pelecanon (Maltepe); and Nicaea (Iznik) fell shortly afterward. In 1336 Orkhan profited by a dynastic quarrel in the neighbouring beylik of Karesi to annex a portion of its territory, including Pergamum. This acquisition placed a number of experienced seamen at the disposal of the Ottomans. The next year Nicomedia (Izmit) was wrested from the Greeks, and by about 1340 the Byzantine possessions in Asia Minor had been reduced to a few coastal towns near Constantinople.

A period of consolidation followed, until 1345, when dissension among the Greeks gave the Turks a bridgehead in Europe In that year the usurper John Cantacuzenus appealed to Orkhan for aid against the rightful emperor John V Palaeologus. An Ottoman force was promptly dispatched which penetrated into the Balkans, inflicted a heavy defeat on the loyalists and returned laden with booty. John Cantacuzenus gave Orkhan his daughter in marriage; then, in 1352, as a reward for further help, he permitted the sultan to garrison the fortress of Chimpe on Gallipoli. He soon realized his mistake when the Ottomans advanced from this base to occupy the rest of the peninsula; his suggestion that Orkhan should sell Chimpe back to him and evacuate Gallipoli was not accepted After the usurper's downfall in 1355, John Palaeologus was obliged to recognize Orkhan's territorial acquisitions in Rumelia. The sultan did not neglect his eastern frontiers; in 1354 an army commanded by his son Suleiman Pasha took Ankara from the son of Ala ud-Din Ertena, an Ilkhanid governor-general who had established himself at Sivas. Orkhan died in 1362 and was succeeded by his son Murad, Suleiman Pasha having predeceased his father by three years.

Murad I (1362–89).—The reign opened brilliantly with the capture of Adrianople and Philippopolis by Lala Shahin Pasha. The efforts of the Greek emperor, in alliance with the doge of Venice, to expel the Turks from Europe came to nothing, in consequence of the Ottoman policy of settling nomads from Anatolia in the conquered territories. Although the exact date is not known, it was probably about this time that the corps of janissaries (*q.v.*) was founded, with Christian youths captured in the wars. In 1363 an allied army of Serbs, Bulgars, Walachians, Bosnians and Hungarians, headed by Louis I of Hungary, was routed on the Maritsa. Two years later Murad made Adrianople his capital and began to enrich it with palaces and mosques. By 1369 the conquest of eastern Thrace was completed The Serbian ruler of Kyustendil, an important iron-mining centre, became tributary to the Turks in 1372, and Lazar I Hrebelyanovich of Serbia was soon obliged to follow his example During the subsequent lull in hostilities the flow of Turkish settlers to the newly acquired lands continued and the foundations of Ottoman administration were firmly laid there.

The temporary peace did not interrupt the enlarging of the Ottoman territories. Murad married his son Bayezid to Devlet Khatun, daughter of the bey of Germiyan (Kermian), his southern neighbour. Her dowry consisted in the major portion of her father's lands, including the city of Kutahya From this convenient base Murad intimidated the bey of Hamid into selling him a large part of his principality, contiguous to the frontiers of Karaman Ali Bey of Karaman, probably in league with the ruler of Hamid, persuaded Stephen I Tvrtko, king of Bosnia, to attack the Turks in Rumelia and then took advantage of Murad's absence in Europe to occupy the former Hamidian provinces. Murad left Jendereli Khair ud-Din Pasha to deal with the situation in Rumelia and returned to Anatolia, with Byzantine and Serbian auxiliaries, to crush Ali Bey at Konia (1387). An Ottoman force under Timurtash Pasha invaded Bosnia but was totally defeated by a combined Bosnian and Serbian army. The princes and kings who had consented to pay tribute were encouraged to rebel by this success. Murad appealed for help to the Anatolian beys; some complied, including those of Germiyan and Hamid, but not Karaman. Murad then returned to Europe with a large force and sent Chandarlizade Ali Pasha northward; the fortresses of Shumla, Pravadi, Trnovo, Nicopolis and Silistria were taken by him. Ivan Shishman III, the rebel king of Bulgaria, was punished and his country once more subjugated. Ali Pasha then joined his master at Kosovo. There Lazar of Serbia had collected an army of 100,000 Serbs, Hungarians, Moldavians, Walachians and others. On Aug. 27, 1389, the greatest of the battles of Kosovo was fought. Lazar was captured and his army cut to pieces, but after the battle Murad was slain. Serbian tradition tells that he was assassinated by Milosh Kobilovich, a Serb who approached him on the plea of submission.

Murad was succeeded by his eldest son, Bayezid. His second son, Savji, had plotted with Andronicus, son of the emperor John Palaeologus, to dethrone their respective fathers. The attempt failed; Andronicus was ordered by his father to be blinded and Savji was put to death (1385).

Bayezid I (1389–1403).—After being proclaimed on the field of Kosovo, Bayezid ordered the execution of his remaining brother Yakub. There is some evidence that in killing his brother the new sultan was following the example set by his father on his accession. Lazar II, otherwise called Stephen, Lazar I's son and successor on the throne of Serbia, made haste to conclude peace with Bayezid; he acknowledged his suzerainty and gave him his sister in marriage. Turks and Tatars were settled between Nish and Uskub Skoplje. The sultan then returned to meet a grave threat in Anatolia. The bey of Karaman, on hearing of Murad's death, had roused the beys of Aidin, Sarukhan and Menteshe against the Ottomans. Independently of these, Yakub of Germiyan was resolved to take back the lands that had gone to make his sister's dowry. Bayezid acted with great promptness. In the winter of 1390 he overran Aidin and Menteshe and then marched east to occupy Germiyan. In his retinue was Manuel, son of the emperor John V Palaeologus. Kara Timurtash Pasha was appointed *beylerbeyi* (governor-general) of Anatolia, with his headquarters at Kutahya. In the spring of 1391 the Ottomans invaded Karaman. Hearing that the Walachians, in league with the dispossessed beys, were in revolt, Bayezid made peace with Karaman and, by a brilliant march to the Danube, put down the rebellion. Meanwhile Manuel Palaeologus, learning of his father's death, hastened to Constantinople to claim the throne as Manuel II, without obtaining leave from the sultan. Bayezid therefore blockaded the city At the end of seven months, the new emperor not only agreed to pay an increased tribute but also consented to the building of a mosque in the capital and to the appointment of a kadi to judge between Moslems residing there. The reason for the sultan's willingness to lift the blockade was that Sigismund of Hungary, later western emperor, had, with Walachian help, entered Bulgaria, capturing Nicopolis from the Turkish garrison. At the news of Bayezid's approach, Sigismund withdrew and the sultan returned to Anatolia to crush the turbulent ruler of Kastamuni (1392). At the end of 1394 Bayezid sent envoys to Egypt, requesting that the caliph should recognize him as sultan of Rum; and this was done.

In the same year Pope Boniface IX had proclaimed a crusade against the Turks. The attack came in 1396, when armies from

many European countries assembled in front of Nicopolis So elated were the allies by some minor initial successes that Sigismund even spoke of going on to the conquest of Jerusalem. The speed of Bayezid's advance was such that the crusaders at first refused to believe the reports of his proximity. Their overconfidence resulted in their annihilation. After this victory the siege of Constantinople was resumed, and about this time the fortress of Anadolu Hisari, on the Asiatic side of the Bosporus, was built. It seems that the Ottoman plan was to starve the city, rather than to take it by assault, but as the Turkish naval forces were negligible the Byzantines had no difficulty in obtaining supplies and reinforcements by sea. Bayezid overran Thessaly in 1397 and, until the spring of 1402, carried out a series of raids on the Morea, leaving colonies of Turks to hold the captured districts. In 1397 the sultan also took Konya after a siege and killed the bey of Karaman, who had attacked Ankara and captured Timurtash Pasha while Bayezid was fighting Sigismund at Nicopolis. The Ottoman territories were also extended in the northeast, to march with the empire of Trebizond.

Meanwhile Timur (Tamerlane) had started from Samarkand on his victorious career. After devastating Georgia in 1400 he marched against the Turks. Some of the dispossessed princes of Asia Minor had begged Timur to reinstate them Bayezid replied to a request to this effect from Timur in terms which made war inevitable. An attack in force was postponed by Timur's activities in Syria and Mesopotamia. But in 1402 in a great battle near Ankara the Turks were defeated and Bayezid was taken prisoner. Eight months later he died at Akshehir, probably by his own hand. This disaster checked the Ottoman advance for more than a decade. Timur reached Bursa and looted it, although Suleiman, Bayezid's eldest son, who fled after the battle, had forestalled him in carrying off the Ottoman treasury. One after another the Anatolian cities of the Ottomans were seized and plundered by the Tatars.

(G. L. L.)

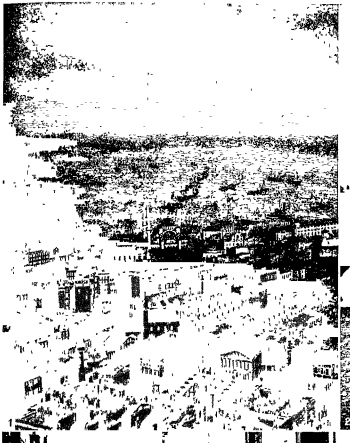
Mohammed I (1413–21).—Timur had sent letters after the fugitive sons of Bayezid promising to confer on them their father's dominions and protesting that his invasion had been due merely to the insulting tone adopted toward him by Bayezid and to the entreaties of the dispossessed princes of Asia Minor He did not cross into Europe, but moved eastward after capturing Smyrna and restoring the dispossessed beys. For some time further, disputes between the sons of Bayezid delayed the Turkish revival. However, Mohammed I (*q.v.*), the youngest, was recognized as sultan in 1413 and recovered nearly all his father's territories in his reign of eight years. Two years after his accession he compelled the prince of Karaman to yield up a number of his cities and then, turning northward, forced Mircea, voivode of Walachia, to pay tribute. The Turkish dominions in Asia Minor were extended, Amasia, Samsun and Janik being captured, and an insurrection of dervishes was quelled. In 1421 the sultan died. His services in the regeneration of the Turkish power were great. Amid the cares of state he found time for works of public utility and for the support of literature and art; he is credited with having sent the first embassy to a Christian power, after the Venetian expedition to Gallipoli in 1416. He was succeeded by his son Murad.

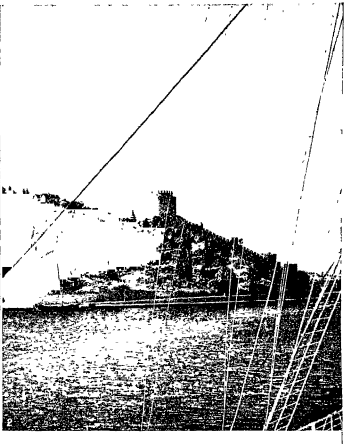
Murad II (1421–51).—Shortly after his accession the emperor Manuel, having applied in vain for the renewal of the annual subsidy, paid him by the late sultan for retaining in safe custody Mustafa, an alleged son of Bayezid (see MOHAMMED I), released the pretender. After ruling in Rumelia for more than a year he was defeated and hanged at Adrianople (1422), and Murad thereupon laid siege to Constantinople to avenge himself on the emperor. The siege was raised because the appearance of another pretender, in the person of Murad's 13-year-old brother Mustafa, under the protection of the revolted princes of Karaman and Germiyan, called the sultan to Asia. Mustafa, delivered up by treachery, was hanged (1424); but Murad remained in Asia, restoring order in the provinces, while his lieutenants continued the war against the Greeks, Albanians and Walachians. Constantinople withstood a siege in 1422, but by the treaty signed on Feb. 22, 1424, shortly before his death, the emperor Manuel II, in order to save the remnant of his empire, agreed to the payment of a heavy annual tribute and to surrender all the towns on the Black sea except Selymbria and Derkos and those on the Struma (Strymon) river Peace was also made at the same time with the despot of Serbia and the voivode of Walachia, on the basis of the payment of tribute. By 1426 the princes of Germiyan and Karaman had submitted on honourable terms, and Murad was soon free to continue his conquests in Europe. Of these conquests the most conspicuous was that of Salonika. Garrisoned by 1,500 Venetians, the city was carried by storm (March 1, 1430); the merciful precedent set by Mohammed I was not followed, the greater part of the inhabitants being massacred or sold into slavery and the principal churches converted into mosques.

By this time it was widely recognized that a further Turkish advance could be prevented only by the combined action of the northern peoples now definitely threatened. In 1442 a force of Slavs and Magyars under the voivode Janos Hunyadi (*q.v.*) drove the Turks from Nagyszeben (Sibin) In the following year they were expelled from Smederevo, which they had conquered a few years previously. Meanwhile, again confronted by a rebellion of the prince of Karaman, Murad had crossed into Asia and obtained his submission, granting him honourable terms in view of the urgency of the peril in Europe. On July 12, 1444, a ten years' peace was signed with Hungary, whereby Walachia was placed under the suzerainty of that country. Conscious of failure, Murad abdicated in favour of his young son Mohammed and retired to Manisa (Magnesia) in 1444. Pope Eugenius IV urged the king of Hungary to take advantage of this favourable opportunity, and 19 days after the truce had been concluded a large army headed by Wladyslaw I of Hungary, Hunyadi and Cardinal Cesarini crossed the Danube and reached Varna. In this emergency Murad was implored to return to the throne After some hesitation he agreed and, crossing over with his Asiatic army from Anadolu Hisari, hastened to Varna and routed the allies. Murad is said to have abdicated a second time and to have been again recalled to power because of a revolt of the janissaries. In 1446 Corinth, Patras and the north of the Morea were added to the Turkish dominions. The latter years of Murad's reign were troubled by the successful resistance offered to his arms in Albania by Skanderbeg (*q.v.*). In 1448 Hunyadi, now governor of Hungary, collected the largest army yet mustered by the Hungarians against the Turks, but was defeated on the famous field of Kosovo. In 1451 Murad died at Adrianople, being succeeded by his son Mohammed

Mohammed II the Conqueror (1451–81).—After suppressing a fresh revolt of the prince of Karaman, the new sultan gave himself up entirely to the realization of the long-cherished project of the conquest of Constantinople. After building in 1452 the Castle of Europe (Rumeli Hisari) Mohammed began the siege in 1453. Constantine XI Palaeologus, the last emperor, failed to obtain support from the west, the defenders of the city were vastly outnumbered by the Turks and on May 29, 1453, it was carried by assault. The sultan triumphantly entered the palace of the emperors, and the next Friday's prayer was celebrated in the church of St. Sophia.

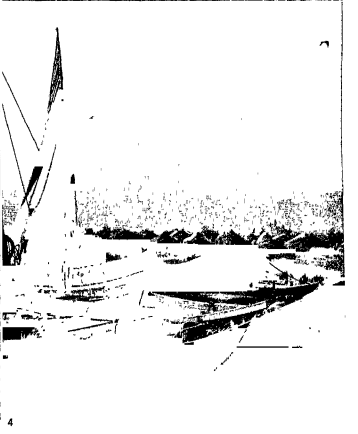
Secure in his possession of Constantinople the sultan proceeded northward and entirely subdued the southern parts of Serbia. A siege of Belgrade was unsuccessful, because of the timely succour afforded by Hunyadi (1456). Two years later internal dissensions in Serbia brought about the conquest of the whole country by the Turks, only Belgrade remaining in the hands of the Hungarians. Walachia was next reduced to the state of a tributary province. Because Venice adopted a hostile attitude after Turkey's conquests in the Morea, greater attention was devoted to the fleet; Mytilene was captured and the entrance to the straits fortified. The conquest of Bosnia, rendered necessary by the war with Venice, was next completed, in spite of the reverses inflicted on the Turks by the Hungarian king Matthias Corvinus, the son of Janos Hunyadi. The Turks continued to press the Venetians by land and sea; Albania was overrun; and Venice was forced to agree to a treaty by which she ceded to Turkey Scutari (Shkoder) and Kroia, and consented to pay an indemnity of 100,000 ducats (Jan. 25, 1478). The Crimea was next conquered and bestowed







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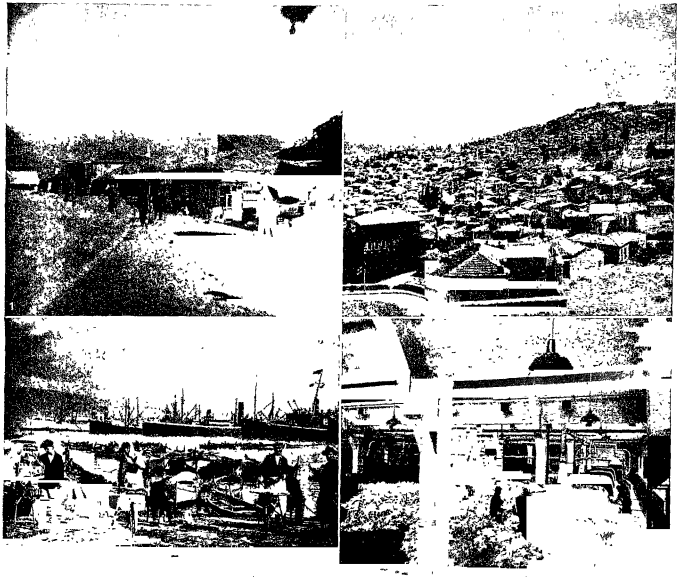
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PHOTOGRAPHS, (1, 2) EWING GALLOWAY, (3) BURTON HOLMES FROM EWING GALLOWAY, (4) PIX FROM PUBLIX

VIEWS OF ISTANBUL (CONSTANTINOPLE)

1. Comprehensive view of Istanbul and the harbour At the left is the Galata bridge, leading to Galata from Stamboul, the old section of the city (foreground)
2. Rumili Hisar, castle built by Mohammed the Conqueror in 1452 on the Bosporus, gateway to the Black sea
3. One of the numerous steep streets of Istanbul
4. Lighters and small coastal craft in the Golden Horn

TURKEY



PHOTOGRAPHS, (1, 2) ILLUSTRATION PIX FROM PUBLIC, (3) EWING GALLOWAY, (4, 5) PIX FROM PUBLIC

URBAN AND INDUSTRIAL SCENES IN TURKEY

1. A section of Ankara, near the citadel
2. Izmir (Smyrna), built on Pagus hill
3. The harbour of Izmir
4. A large cotton factory in Kayseri
5. View of the industrial section of Kayseri

as a tributary province on the Tatar khan Mengli Ghirai Mohammed now endeavoured to strike a blow at Rhodes, the stronghold of the Knights of St. John, preparatory to carrying out his long-cherished plan of conquering Italy. A powerful naval expedition was outfitted but failed, though a land attack on southern Italy at the same time was successful, Otranto being captured and held for a time by the Turks In 1481, setting out on campaign, the sultan died at Gebze. He is said to have been of a merry and even jocular disposition, to have afforded a generous patronage to learning and art and to have been master of six languages.

Mohammed II was the organizer of the fabric of Ottoman administration in the form which it retained practically unchanged until the reforms of Mahmud II and Abdul-Mejid. He raised the regular forces of the country to a total exceeding 100,000. Under him the independent princes of Asia Minor were finally subjugated Many educational and benevolent foundations were endowed by him, and it is to Mohammed II that the organization of the ulema, or legist and ecclesiastical class, is due.

Bayezid II (1481–1512).—Bayezid reached the capital before his brother Jem and ascended his father's throne. To win over the followers of his brother he paid an accession present to the janissaries. this became an established custom. Jem's attempts to seize the throne were defeated. He took refuge with the Knights of Rhodes, but they were paid to keep him in custody. He was removed to Europe and, after 13 years' captivity, died in Naples He was said to have been poisoned by Pope Alexander VI, who received 300,000 ducats from Bayezid, but from *Taj-ut-Tevarih*, the most reliable history of the period, his illness sounds like erysipelas.

Bayezid was a man of peace by nature and quite incapable of directing the warlike tendencies of the young empire. He abandoned Otranto and exempted Venice from her yearly tribute by imposing instead a 4% customs duty on Venetian goods imported. In 1492 the armies of the Turks invaded Laibach in Carniola and Cilli in Styria. In 1494 they were driven out of Styria by the emperor Maximilian. While Bayezid was fighting against his brother's claims, Moldavians attacked Turkish territory in Walachia and he was forced to lead another Turkish army into Moldavia. The khan of the Crimea, Mengli Gheraï, fought in this army, and through his influence political correspondence was opened between Russia and Turkey, and the first Russian ambassador, Mikhail Belsechev, arrived in Constantinople. Moldavia became a vassal state after two years of war. John Albert, king of Poland, invaded Moldavia in 1496; and this was followed by a counterinvasion of the Turks, but they were forced to return by the severe winter. In 1496 Hercegovina was annexed to the empire, and in 1500 the Polish wars ended with an armistice. Rome and the Italian states had encouraged the sultan to crush the Venetian republic. The Turks gained over Venice their first great naval victory at Lepanto on July 28, 1499, and concluded peace on Dec. 24, 1502; a part of Morea and a few islands passed to Turkey, Venice retaining Cephalonia. On the Asiatic side Ismail Safavi, the shah of Persia, inspired with religious zeal for the propagation of Shi'ite doctrines, raided the empire (1501). The sultan attempted a pacific solution but failed to restrain his warlike son Selim from fighting the Persians. Shah Ismail's propaganda rooted the Shi'ite doctrines so firmly in Anatolia that in spite of the sanguinary repressions during the reign of Selim I, and the republican law of 1925 abolishing the dervish orders, adherents of the Kizilbash and other Shi'ite sects remain there to this day. Bayezid had also to fight the Egyptian armies under the Mamelukes who had invaded Adana, and he drove them out.

Selim then turned upon his father and, having won the janissaries to his side with promises of conquest, forced him to abdicate. Bayezid died on his way to his retreat at Dimotika. The political influence of the janissaries on the frequent change of sultans dates from this episode.

Selim I the Grim (1512–20).—True to his promise Selim kept the janissaries in action throughout his reign. After defeating his brother's claims, he attempted to exterminate Shi'ism not only in Anatolia but in Persia which was its centre. In 1514 he annihilated Shah Ismail's forces at Chaldiran and conquered Azerbaijan and Kurdistan. His most important conquests were Syria and Egypt, which he added to the empire after defeating the Mamelukes in 1516 and 1517. According to most Turkish and western historians he obtained from the last of the Abbasid caliphs, Mutawakkil, the title of caliph. (After the fall of the caliphs of Baghdad in 1258, the descendants of the Abbasids took refuge in Cairo and enjoyed a purely titular authority under the protection of the Egyptian rulers) But the important authority of the *Taj-ut-Tevarih* implies that Selim did not base his Pan-Islamism on the prestige of the caliphate, for the *Fetih-Name* (the declaration of conquest) of Selim himself, as there quoted, has no reference to caliph or caliphate. Another contemporary historian, Hasan Tulun, a Mameluke and an admirer of Selim, in his *History of Egypt*, also implies that Selim meant to realize Pan-Islamism through force rather than through the assumption of the title of caliph. He assembled the ulema in Egypt and, referring to the fact that the Mamelukes always had their sultan consecrated by the caliph, asked whether this was necessary: the ulema declared that the sultanate depended on force rather than on consecration. The sherif of Mecca, Abu'l-Baraka, sent his son with the holy relics and the keys of holy places to Selim. But though these relics are the emblems of the caliphate it is probable that Selim wished virtually to abolish it. Not until 1774 did a sultan claim also to be caliph.

An important revolt, led by Jelal who pretended to be the mahdi, broke out at Yozgad in Anatolia, but was at once suppressed and from this date *Jelali* came to be a general term for "rebel."

Selim, who died in 1520, never fought against the Christian west. Possessed by the ideal of uniting the Moslem east, he directed his campaigns accordingly. During his reign of eight years the empire nearly doubled its extent. Although he uprooted corruption and the people enjoyed a severe but just administration, his cruelty in executing eight grand viziers is alluded to in the popular saying: "May you be vizier to Sultan Selim." He was a distinguished poet, but wrote almost exclusively in Persian. His love of culture and learning was shown by his preference for the company of the learned. Although among his subordinates he punished small offenses with death, his sheikh ul-Islam, Ali-Jemali Efendi, who was fearless and outspoken, was able to make him desist from his plan of converting the Greeks to Islam by the sword if necessary, by reminding him of the conqueror's (Selim's grandfather's) firman, which gave religious freedom to the Greeks. At one time Selim tried to make Arabic the official language, to further his Pan-Islamic policy.

Suleiman I the Magnificent (1520–66).—Suleiman (Soliman) I, known as the "Magnificent" in the west and the "Lawgiver" in Turkey, being an only son, was saved from the wars of succession which his predecessors had to fight. He began his reign with the magnanimous act of freeing all the prisoners of war and restoring the goods confiscated from the merchants who traded with Persia in Selim's time. But this record is marred by the execution of two of his sons. That of the older, Mustafa, was thought due to the influence of his wife, the famous Khurrem Sultan, known as Roxelana (the daughter of a Russian priest), in order to leave her own sons without a rival. With her began the influence of women in affairs of state. She was also believed to have influenced the execution of the able grand vizier Ibrahim Pasha in order that his power might pass to Rustem Pasha, her son-in-law.

Suleiman's conquests were mostly in the west, though he had some Asiatic campaigns. He first marched into Hungary in 1521 ostensibly because his envoy had been slighted and because he received no congratulations on his accession. But actually he was resuming the northwestward march of his house that had been blocked by Hunyadi in 1456. He captured Belgrade, which remained a base throughout the Turkish wars in Europe. In 1522 Rhodes and Cos were conquered. In 1526 the Hungarians were severely defeated at the battle of Mohacs (*see* HUNGARY: *History*), their king, Louis II, killed and the greater part of Hungary including Budapest taken. The Turks appointed John Zapolya, the voivode of Transylvania, to be king of the Magyars. The sultan then left Hungary to put down a Shi'ite rising in Tabriz.

Ferdinand, the brother of the emperor Charles V, then claimed the Hungarian throne as the brother-in-law of Louis II, invaded Buda and drove out Zapolya, who naturally appealed to Suleiman. In 1529 Suleiman with Zapolya marched into Hungary, seized Buda and defeated the Austrians, and Zapolya was reinstated Encouraged against Charles V by Francis I of France, Suleiman laid siege to Vienna, but after three weeks was obliged to abandon it. Part of the Turkish army went as far as Regensburg in Germany. In 1532 Suleiman again marched against Charles V and approached Vienna, but in 1538 a truce was signed and Hungary was divided between Zapolya and Ferdinand.

During his Persian wars Suleiman retained the friendship of Ferdinand; but in 1540 Zapolya died and Ferdinand marched on Buda. Suleiman decided to uphold the claims of Zapolya's son and of his widow Isabella. He marched into Hungary, defeated Ferdinand and placed the young king on the throne under the regency of his mother. Suleiman refused all overtures of peace and war continued both on land and sea. In 1542 an alliance between Francis I and Suleiman led to a combination of the Turkish and the French fleets against Charles V. On land, Suleiman took Esztergom, Vizegrad, Szekesfehervar and a part of Hungary that became a Turkish province consisting of 12 sanjaks. On June 15, 1547, a truce of five years was signed in Adrianople between Suleiman, Charles V and Ferdinand which recognized the Turkish conquests and bound Ferdinand to pay a yearly tribute of 30,000 ducats to Turkey for the territory left to him John Sigismund, the son of John Zapolya, was recognized as the independent prince of Transylvania and of the 16 adjacent Hungarian counties, Queen Isabella to act as regent during his minority.

The terms of the treaty were soon ignored Ferdinand being in league with Frater Gyorgy (*see* MARTINUZZI, GEORGE) to free Transylvania from the Turkish suzerainty, Suleiman sent a large army under Sokollu Mohammed Pasha into Hungary. Lippa and Temesvar were taken but a victory of the Persians in the east forced Suleiman to sign an armistice in 1553 and invite Austrian delegates to Constantinople to negotiate for peace. The negotiations failed and war continued with atrocities on both sides till 1562. On June 1, 1562, peace was concluded between Suleiman and Ferdinand, who had been crowned emperor. Ferdinand undertook to pay all his arrears of tribute to Turkey and to continue a yearly payment of 30,000 ducats, to leave Temesvar and other towns to Suleiman, to recognize the independence of John Sigismund in Transylvania and to withdraw all his Habsburg claims to interference in Hungary.

In 1564 Ferdinand died and Maximilian II succeeded him Maximilian attacked Tokay, which was in Turkish possession, and let the tribute fall into arrears. Sokollu Mohammed Pasha, the new Turkish grand vizier, desired to wipe out the disgrace of a naval defeat in Malta which had ended in the death of Adm. Torgut, and Suleiman in 1566 led an army into Hungary, although 72 years old. He died during the siege of Szigetvar, but his death was kept secret by Sokollu till the fortress fell. Thus Suleiman, after ruling 46 years in life, ruled 46 days after his death, until his son Selim ascended the throne and reached Belgrade.

On the Asiatic frontier in 1526 Shah Tahmasp of Persia had taken Tabriz from the Turks while Suleiman was fighting at Mohacs. On his return Suleiman set out for Persia with an army, conquered the Armenian plateau and joined another Turkish army commanded by Ibrahim Pasha which had already recaptured Tabriz. The Persians retreated without fighting and in 1534 Suleiman took Baghdad.

In 1536 the French ambassador, Jean de la Foret, negotiated a treaty between France and Turkey by which certain judicial and economic privileges were granted to France. This marks the beginning of the capitulations which, started when Turkey was a powerful empire, were at first regarded only as the means of procuring an easy market for Turkish goods in France. They led, however, to serious and enduring political complications and became the pretext for exploiting Turkey in her decadent days. In 1555 Suleiman concluded a treaty of peace with the Persians at Amasia after conquering Georgia, the Armenian plateau and Erzurum.

Murad II had begun the building of the Turkish navy but it was during Suleiman's reign that Turkey became a first-rate sea power At no other time did Turkey have such a large number of famous admirals. Suleiman had conceived the idea of using the renowned corsairs who raided the Spanish and Irish coasts and he had engaged Khair ud-Din Barbarossa (*see* BARBAROSSA). Barbarossa was the son of a Turkish spahi, Yakub, a Macedonian, and his mother was Greek, his native place being Mytilene. He presented to Turkey Algiers, which he had personally conquered, and he formed what was called *Garb Ojaklari* (the states of Barbary) This was a military organization which administered Algiers, Tunis and Tripoli. Barbarossa took Tunis but was driven out by the fleet of Charles V, who devastated Tunis and destroyed mosques and valuable libraries because the Turks had converted churches into mosques in Hungary. Barbarossa's greatest naval victory was in 1538 when he defeated the combined fleets of the emperor, the pope and Venice under the command of Andrea Doria, off Prevesa. He took Castelnuovo and a few islands of the archipelago and he restored Morea to the Turkish empire. Torgut (known as Dragut in the west) was another famous corsair who had ravaged the Italian and Spanish coasts and was now engaged by Suleiman. He captured Tripoli from the Knights of Malta and was appointed its governor. He died in 1565, after an unsuccessful attack on Malta. Suleiman sent an expedition by sea to India in 1537, which conquered Aden on the homeward voyage. Piale Pasha, Piri Reis, Salih Reis, Seydi Ali Reis, were other renowned admirals of this period Piri Reis and Salih Reis conquered the coasts of Yemen and Aden as far as the gulf of Basra. Piri Reis compiled a detailed sea atlas (*Bahriye*) of the Aegean and Mediterranean He also conquered Muscat but was finally executed on the grounds that he had accepted bribes from the Portuguese to lift the siege of Ormuz. Seydi Ali Reis, a distinguished mathematician, succeeded him in the command of the fleet and was also defeated by the Portuguese. He escaped to the Indian ocean with three ships on which he lived for three years; then he landed and reached Turkey by land He wrote his travels (*Mirat ul-Memalik*), a mathematical book on the astrolabe and a book called *Muhit* (Ocean) on the navigation of the Indian seas.

The Ottoman State in the 16th Century.—The Ottoman state evolved gradually from a society whose institutions were fundamentally nomadic. The power was divided between two classes. the military class representing force and the ulema representing religion. The judges belonged to the latter class, but their judgments were executed by the military. All executive power centred in the military. The sultan himself, whose autocratic person was the symbol of this power, was a soldier, as were the viziers, the leading administrators. During war the governing body accompanied the army, this being characteristic of a nomadic system. The most remarkable feature of the Ottoman state was that, down to the 18th century, the holders of almost every important post were slaves, most of them acquired by the impressment of Christian boys. The majority of the *kapikullari* (slaves of the Porte) were trained as janissaries in barrack schools. Those who showed promise of suitability for high office were sent to a school attached to the palace, where they were taught the Moslem humanities (Persian and Arabic), music and practical arts and crafts. (*See* Barnette Miller, *The Palace School of Muhammad the Conqueror* [1941].)

Suleiman's administration was one of the best of his time. The Christian population in Morea preferred the Turkish rule to that of the Venetians, and some Hungarian villages chose Turkish rule of their own accord. Financially Turkey was in a good position; it had been enriched by the addition of prosperous lands, the revenue was 183,000,000 aspres (though expenditure was 6,000,000 more) and no new tax was levied during this reign. The countries belonging to the empire were administered in two different ways. One part was ruled by the central government and consisted of 24 vilayets (provinces), 4 of which were in Europe and 20 in Asia and Africa. The second part was more or less self-governing under the suzerainty of the sultan and consisted of the kingdoms of Hungary and Transylvania, the principalities of Moldavia and Walachia, the khanate of Crimea and the sherifate of Mecca,

which was ruled by the descendants of the prophet. The *Garb Ojaklari* (the states of Barbary), consisting of the provinces of Tripoli, Algiers and Tunis, had semi-independent governors who selected their own administrative bodies and later were empowered to make independent treaties.

After the conquest of Constantinople and the transfer of the capital to the imperial city, the Turkish system was somewhat influenced by that of the Byzantine empire. The affairs of state were discussed at the imperial divan over which the sultan presided until the reign of Mohammed the Conqueror, after which the sultans thought it more in keeping with their imperial dignity to hear the proceedings from behind a grating. The permanent members of the imperial divan consisted of three or more viziers (pashas with three horsetails), the grand vizier being the chief of these and invested with supreme power by the signet of the sultan. He held the title of *serdar-i-ekrem* (generalissimo) when in command of the army, in which case one of the other viziers remained behind as *kaymekam* (lieutenant). The viziers in the divan were called *kubbe vezirleri* (viziers of the dome), because of the nature of their meeting place. Their deliberations were attended by the following dignitaries. the *kasaskers* of Rumelia and Anatolia (the two highest judges of the empire); the *kadi* (judge) of Istanbul; the *defterdar* (minister of finance); the *nishanji* (keeper of the great seal); the *yenicheri aghasi* (commander of the janissaries); the *kaptan pasha* (lord high admiral) and the *reis ul-kuttab* (chief secretary, later the foreign minister).

Each vilayet was governed by a pasha (two horsetails) called a *beylerbeyi*. These provinces were divided into *sanjaks*, each being governed by a pasha (one horsetail) called *sanjakbeyi* The *sanjaks* were divided into *kazas*, each being governed by a *kadi*.

The Turkish army during Suleiman's reign probably numbered between 200,000 and 300,000, and was one of the best disciplined and best equipped of the time. The main elements of the army were the janissaries and the spahis, the latter comprising feudal cavalry and standing cavalry divisions. Other important units were the *jebeji* (armourers), the *topju* (artillery) and the *bostanji* (originally gardeners, later police).

The land was divided into several categories: *vakuf*, *yurtluk-ojaklik*, *timar*, *zamet* and *khas*. The revenues of *vakuf*-lands provided for the upkeep of mosques, schools, hospitals and other pious purposes. *Yurtluk-ojakliks* were lands in frontier districts, the revenues of which went to the frontier guards. The other three terms denoted fiefs whose revenues amounted to 2,000–20,000 aspres, 20,000–100,000 aspres and more than 100,000 aspres respectively. Some of these fiefs provided incomes for members of the imperial house and for successive holders of the great offices of state, while others were assigned to spahis. Only the latter sort were hereditary.

Selim II (1566–74).—Selim II, after pacifying the janissaries with payments, tried to undermine the power of Sokollu, the grand vizier, but finally found himself obliged to let the country be ruled by that great statesman. The conquest of Samos was completed and the risings in Yemen suppressed by Sinan Pasha. In 1568 the peace between Austria and Turkey was renewed for eight years. With the idea of joining the rivers Don and Volga by canal so that a fleet might be sent to the Caspian sea, Sokollu attacked Astrakhan but failed in his project. Turkish historians credit him also with the intention of opening a Suez canal. Cyprus was invaded by the Turkish army under the command of Lala Mustafa Pasha, who violated the capitulations of Famagusta (1571) by executing the Venetian commander Marco Antonio Bragadino, and aroused strong feeling against the Turks. Venice, Spain and the pope united in a holy league against Turkey and their combined fleets under the command of Don John of Austria severely defeated the Turkish fleet at Lepanto (1571). A year later the advance of a new Turkish fleet commanded by Kilij Ali Pasha caused Venice to break from the league and conclude a treaty with the Turks (March 7, 1573). In 1574 Sinan Pasha and Kilij Ali Pasha recaptured Tunis and ravaged Sicily. Selim died in 1574.

Murad III (1574–95).—Murad, Selim's eldest son, opened his reign by murdering his five younger brothers. He also tried to undermine Sokollu's power and in spite of his advice opened a war with Persia which lasted 12 years. The Turks conquered Shirvan, Tiflis and Daghistan and peace was concluded when Abbas, the successor of Tahmasp, was firmly established as shah of Persia. Sokollu's efforts to build an observatory in Istanbul were opposed by fanatical opinion; and his assassination, which soon followed, is said to have been ordered by the sultan. This threw the country into disorder, for there was no man who had Sokollu's strength and authority to oppose the harem intrigues and corruption. The janissaries, refusing to accept a debased coinage that was called "Jewish money," mutinied throughout the empire. This mutiny had scarcely been suppressed when in 1593 the uncertain peace between Austria and Turkey degenerated into a regular war which is known as the "long war." This began when Hasan Pasha, the governor of Bosnia, raided the Austrian frontiers and attacked Sisak. The Austrians and the Hungarians together routed the Turks in Kulpa with great slaughter. Sinan Pasha, the grand vizier, marched on Hungary with a large army, and war continued for 14 years. Bribery, which had become widespread in the country, corrupted the army as well, and there was no office which was not susceptible to the bribe of the highest bidder. Shemsi Pasha, one of Murad's counsellors, openly boasted of having made a sultan take bribes for the first time. Veszprem and Gyor were conquered by the Turks but the Moldavian and Walachian revolts checked further victories. The sultan's Venetian wife, Safiye Sultan (Baffo), ruled for many years as his only wife, accepted bribes and interfered in state affairs, influencing the Porte's relations with Venice, although in later years she had rivals. Murad, who died in 1595, is said to have had 130 children. The capitulations with France were renewed in 1581, those with Venice in 1589 Capitulations were signed with the grand duke of Tuscany for the first time in 1578, and with Great Britain for the first time in 1580. The first British ambassador sent to Turkey was William Harborne. Elizabeth in her letter to the sultan urged as a special claim to his friendship their common mission to fight the "idolaters," an interesting example of diplomacy.

Mohammed III (1595–1603).—Safiye Sultan, who had wielded such a strong influence as wife, continued to do so as mother during this reign. The new sultan began by murdering 19 of his brothers. The war in Hungary became chronic and intrigues between Sinan Pasha and Ferhad Pasha for the position of grand vizier led to frequent changes of command in the army, with disastrous results. Sinan persuaded the sultan to command the army in person, with good results at first, for in 1596 the Turks recaptured Eger (Erlau) and in three days defeated the allied armies at Keresztes. Because the sultan was anxious to return to his easy life in the capital and because the undue severity of Chighala Sinan Pasha was causing the Anatolian troops to desert, the Turks did not gain much by their victory. Ibrahim Pasha, Safiye Sultan's favourite, became grand vizier through her influence and she sold by proxy all the high offices of state. In 1598 Gyor, Tata, Veszprem and Papa were lost by the Turks. In 1599 overtures for peace were made by all sides without result. The unique military achievement of this campaign was that of Tiryaki Hasan Pasha, who in 1600 captured Kanizsa. A year later the attempt of the archduke Ferdinand to retake it at the head of 30,000 men was defeated. Military mutinies and Jelali insurrections broke out in the interior and Shah Abbas marched on Tabriz and Erivan. The sultan died in 1603.

Ahmed I (1603–17).—Ahmed I succeeded his father at the age of 14. The war with Persia continued fitfully during his reign. The Turks recaptured Esztergom in Hungary. Transylvania passed to the suzerainty of Turkey of its own accord; Stephen Bocskay, a member of its own aristocracy was appointed king. But the continual mutinies of the janissaries and the reverses in Persia forced Turkey to sign for the first time at Zsitvatorok a treaty of peace on terms of equality with Austria. Austria was freed from future tribute to Turkey by paying 200,000 ducats down, and for the first time the emperor was referred to as *padishah* in the official Turkish documents. A treaty of peace was also concluded between Turkey and Persia in 1611, Persia giving to Turkey as indemnity 1,000,000 lb. of silk. Kuyuju ("pitman") Murad Pasha, so called because he threw the bodies of rebels into

pits, suppressed the Jelali risings in Anatolia. Friendly relations with Poland were restored

Ahmed I was of a religious disposition, and left the affairs of the state to his grand vizier. In this reign it was decided to relax the custom of killing the brothers of every new sultan. They were, instead, to be confined each in a separate pavilion enclosed in a walled garden, known as *kafes* (cage) The evil result of this humane decision was that when a sultan was succeeded by a brother and not by a son the new ruler was inevitably a man with no experience of the world or of state affairs At Ahmed's death his sons were minors and, as it was contrary to custom for a minor to succeed, his brother Mustafa became sultan (1617).

Mustafa I and Osman II (1618–22).—Sultan Mustafa being an imbecile was after three months declared incompetent to rule and Osman II, son of Ahmed, ascended the throne Sokollu's idea that friendship with Persia would be politically to the advantage of the empire was adopted by the sultan and peace was concluded with that country. Moldavia revolted and joined the Poles, and Osman marched on Hotin. The expedition was a failure and diminished the prestige of the sultan. From his contact with them he knew how utterly degenerate and useless a body the janissaries had become and decided to discipline and reform them. He pretended to go on a pilgrimage to Mecca with the intention of marching back to the capital with a loyal and well-disciplined army which he hoped to raise in Syria and Arabia. When a rumour of this reached the janissaries they revolted After marching the sultan through the streets of Istanbul and exposing him to ignominious insults they killed him.

Mustafa I (1622–23), Murad IV (1623–40), Ibrahim I (1640–48).—Mustafa I was once more dragged to the throne by the janissaries but he soon abdicated in favour of his nephew Murad IV, still a minor Till the sultan was of age the empire was in the hands of his mother, Kosem Sultan, who had to cope as well as she could with the mutinous army and the corrupt state. The army chose the grand viziers and massacred them when it wanted a change. Kosem Sultan had to open the treasury to appease these revolts, which depleted the finances still more. When Murad IV was of age he restored order by one of the bloodiest reigns of history. Marching on Baghdad and Erivan he recaptured them from the Persians, repeating the atrocities which the Persians themselves had committed. He concluded a peace with Persia which fixed the Turko-Persian frontiers On his return he murdered all his brothers with the exception of Ibrahim and continued to terrorize his officials by frequent executions. He died in 1640.

The decline in the Ottoman power continued during the reign of Murad's eccentric brother and successor, Ibrahim I. Ibrahim devoted himself to pleasure and was ruled by the women in the palace while his mother Kosem Sultan once more took the reins of power. It is not surprising that complete anarchy reigned throughout the empire, the capital included. A campaign against Crete, which belonged to the Venetians who had burned some Turkish ships, began during this reign, but continued for 25 years. For the first time the Dardanelles were closed by Venetian ships, which caused a famine and led to a revolt. Ibrahim wanted to massacre the Christians, but the ulema were able to restrain him. The change of the residence of the ambassadors from Istanbul to Pera dates from this event. Ibrahim was dethroned during a mutiny and killed.

Mohammed IV (1648–87).—Mohammed IV, the seven-year-old sultan, succeeded his father and for another eight years the affairs of state were in the hands of Kosem Sultan, his grandmother. The janissaries had supreme power, monopolizing everything, even the sale of bread. Mohammed's mother, Turhan Sultan, tried to get the power into her hands and the period of anarchy and mismanagement was prolonged by the struggle between the two women, each depending on a different military party. Turhan Sultan accused her mother-in-law of trying to poison the boy sultan and one evening she contrived that her party should invade the palace and surprise Kosem Sultan in her room. Kosem Sultan's great oratorical powers, which had enabled her to control janissary risings, failed to save her life and she was strangled with the cords of her bed curtain Turhan Sultan now put Kuprili Mohammed into power as grand vizier, the first of five from the same family of Kuprili (*q.v.*; properly Koprulu) who did much to restore the empire He restored order in the army by very drastic measures, rebuilt an efficient navy, defeated the Venetians and recaptured the island of Lemnos and other islands. The improved condition of the army led to the pacification of Transylvania which was in revolt Kuprili Mohammed Pasha died after being in office five years and his son Ahmed became grand vizier. In 1663 disturbances in Transylvania caused the Turks to attack the Austrians. At first Turkish arms were victorious; but the French, who had been alienated by the haughty demeanour of the Kuprilis, sent help to the Austrians under Raimando Montecucculi, the Austrian general, and the Turks were defeated at the battle of Szent Gotthard abbey. They lost little in the treaty of Vasvar (Aug. 10, 1664), by which a truce of 20 years was agreed upon. Transylvania was evacuated but remained tributary to Turkey. The Turks retaliated on the French by depriving those Catholics who were under French protection of some of their privileges in the holy places and granting them instead to the Orthodox Church. The Cretan campaign was still in progress and the French were helping the Venetians, but the Turks took Candia and a treaty was signed in 1669 between the Venetians and the Turks which left Crete in the possession of Turkey while the island fortresses of Suda, Spinalonga and Grabusa remained Venetian.

Events in the Ukraine led Turkey into war with Poland in 1672. The Turks captured Kamenets, Lemberg and Lublin. The Poles sued for peace and a treaty was signed in 1672 at Buczacz whereby Podolia was ceded to Turkey and the Ukraine left to the Cossacks; Poland consented to pay Turkey an annual tribute of 22,000 sequans. But John III Sobieski, who ascended the Polish throne, refused to abide by the terms of this treaty and war was renewed and continued till 1676, when the treaty of Zurawno was signed, both parties abrogating the tribute clause.

Kuprili Ahmed having died, Kara Mustafa succeeded him as grand vizier A man of great military ambitions, he led Turkey into a series of unnecessary wars. The first was against the Russians, and although the Turks were successful at the beginning, their losses were so great that they signed a treaty at Radzin (Jan. 8, 1681) ceding the disputed territory to Russia. The internal disputes in Austria caused by Protestant persecution caused Kara Mustafa in 1683 to violate the truce signed by Kuprili Ahmed and lead a vast army against Austria which laid siege to Vienna. The emperor and his court fled from the capital, but John Sobieski of Poland saved the Austrian cause by attacking the Turks in the rear and defeating them. The failure at Vienna marks clearly the beginning of Ottoman decline. It kindled the crusading spirit in Europe against Turkey and an alliance between Austria, Venice, the pope, Poland, Russia, Malta and Tuscany was formed. The Austrians made conquests in Hungary, the Venetians in Greece, the Russians in Crimea and the Poles in Podolia. Turkey tried in vain to get France to join it against this general alliance. The janissaries mutinied and Mohammed IV abdicated.

Suleiman II (1687–91), Ahmed II (1691–95), Mustafa II (1695–1703).—Mohammed's brother Suleiman II succeeded to the throne. Kuprili Mustafa was made grand vizier, and true to the tradition of his illustrious family, he restored order in the army and in the fleet, and by wise and tolerant administration won the sympathies of the non-Moslem subjects. The Austrians captured Erlau, entered Transylvania and reached Belgrade and Uskub, but Kuprili Mustafa drove them out and recaptured Belgrade. He also defeated the Russians in Crimea. Mustafa went as far as to distribute seeds for the crops of the people of the recaptured countries. In 1691 while the Turkish army was fighting in Morea Suleiman II died and was succeeded by his brother Ahmed II.

The Turks were defeated at Slankamen (Szalankemen) in Croatia in Aug. 1691 and Kuprili Mustafa was slain on the battlefield. An attack on Petrovaradin was equally a failure and the Venetians captured the island of Chios. In 1695 Ahmed died and was succeeded by his nephew, Mustafa II, Mohammed IV's son, who resumed leadership in the field of war.

Chios was recaptured and the war with Austria continued. The Turks conquered Lippa and defeated the Austrians and the Austrian field-marshal Friedrich von Veterani was killed. But the Russians took Azov and in 1697 the Austrians under Prince Eugene defeated the Turks at Zenta on the Tisa (Tisza). The war was ended, on the pressure of Venice, Holland and England, by a series of treaties with Austria, Poland and Venice concluded at Karlowitz (Jan. 1699). By the terms of these treaties Turkey retained the Banat; Austria kept Transylvania; Poland restored the places captured in Moldavia but retained Kamenets, Podolia and Ukraine; Venice retained the Morea and Dalmatia and a two years' truce was signed with Russia. In 1700 Azov was ceded to Russia by a separate treaty During this time Husein, another Kuprili, was grand vizier, but his efforts to introduce order into the country were frustrated. He was driven out of office and a fresh revolt of the janissaries forced the sultan himself to abdicate. He was succeeded by his brother Ahmed III.

Ahmed III (1703–30).—Ahmed began his reign by conceding the demands of the janissaries and accepting their chosen grand vizier. Charles XII of Sweden, having been beaten by the Russians at Poltava, took refuge in Turkey and was invited to reside at Bender. This involved Turkey in another war with Russia, which had already sent troops across the frontiers in pursuit of Charles XII (1710). Baltaji Mohammed, grand vizier in command of the Turkish army, was induced by diplomacy to grant the tsar Peter a peace less to Russia's disadvantage than his army's defeat on the Pruth merited (1711). By this peace Azov was left to Turkey, Russian fortresses on Turkish frontiers were razed, Russia consented to the return home of Charles XII and renounced all claims over the Tatars in Crimea and in Polish territory. Because the hospodars of Moldavia and Walachia had assisted Russia during the campaign they were punished, and Phanar Greek notables (*see* PHANARIOTES) governed these principalities till the Greek insurrection of 1821. Venice was next to be punished for having incited the Montenegrins to revolt, invaded Bosnia and captured Turkish ships in the Mediterranean. In 1715 Turkey declared war against Venice, quelled the Montenegrin revolt, captured Modon and Coron and with its fleet took the islands of Tinos and Cerigo, as well as the remaining Venetian fortresses in Crete. Austria intervened, urging Turkey to cede to Venice certain places in Dalmatia as compensation for its losses in Morea. This led to a declaration of war against Austria in 1716. The Turkish army was routed near Petrovaradin and pursued by the Austrian army led by Prince Eugene, which took Belgrade and overran the Banat (1717) The Turkish army then retreated to Adrianople By the mediation of England and Holland the treaty of Passarowitz was signed on July 21, 1718· Belgrade, a part of Walachia and Banat passed to Austria, and strongholds in Albania and Dalmatia to Venice. This treaty was signed by the grand vizier Ibrahim Pasha, who is accused of having betrayed Turkey by accepting it. The craze of the time in the capital was the cultivation of tulip gardens and has given to this period of Turkish history the name of the "tulip period." It created a definite literary school under Nedim, the greatest Turkish lyric poet. But popular murmurings against these costly pleasures became such that the grand vizier had to seize the occasion of the Persian defeat by the Afghans to annex several parts of Daghistan in Persia in order to appease the bellicose spirit of the janissaries. This led to a complication with Russia, but the intervention of France resulted in the treaty of Constantinople between Russia and Turkey (June 30, 1724) which allotted Baku and Derbend on the Caspian coast to Russia.

The news of the defeat of the Turkish army by the Persian army under Nadir Kuli Khan led to a rising of the mob under the leadership of Patrona Khalil, a bath waiter. The grand vizier was killed and the sultan forced to abdicate (1730) His nephew, Mahmud I, Mustafa II's son, succeeded. This was the only Turkish rising which did not originate in the army. The printing press first came into use in Turkey at this time.

Mahmud I (1730–54).—Patrona Khalil was killed and his followers dispersed after the accession of Mahmud I. The war continued with Persia, and Nadir Kuli Khan, after his successes in Iraq and Erivan, seized the Persian throne. In 1736 a Turco-Persian treaty was signed whereby all territory conquered since the reign of Murad IV was returned to Persia. Russia also returned the Persian territory it had annexed, thus laying the basis of a Russo-Persian alliance against Turkey.

The question of the Polish succession once more led Turkey into war France had put forward as its claimant to the Polish throne Stanislas Leszczynski, while Austria and Russia supported the claims of Augustus III (the elector Frederick Augustus II of Saxony) although Russia had bound itself by the treaties of 1711 and 1720 to abstain from interfering with Poland. The Russian candidate was forced upon Poland (1733), whereupon France declared war on Russia and Austria and then urged Turkey to join it. Turkey had a grievance in that Russia had refused to allow the Crimean troops to march through Daghistan during the Persian campaign, so Turkey declared war in spite of the joint efforts of England and Holland. Before waiting for a declaration of war a Russian army under Marshal B C. Münnich stormed the isthmus of Crimea, devastated the peninsula and captured Azov and Kilburun in 1736 and Ochakov the next year. The sea powers of the west mediated to restore peace and the representatives of the belligerents met in Niemirow in 1737 to arrange terms. Austria, however, put forward new claims to the principalities and the Balkan peninsula which were refused by Turkey, whereupon Austria revealed the existence of a secret alliance with Russia and threatened to fight for its new claims. Accordingly Austria's army marched on Bosnia and Walachia, capturing Nish in Serbia. But the tide of war turned against both Russia and Austria when Ochakov and Kilburun were recaptured by one Turkish army while another crossed the Danube and penetrated as far as the Banat. In 1739 Turkey consented to negotiate peace and a conference opened in the camp of the grand vizier who was marching on Belgrade. The preliminaries were signed under the mediation of the French ambassador, Louis Sauveur Renaud, marquis de Villeneuve, for whose services the Porte reaffirmed the capitulations which France had already obtained After the entrance of the grand vizier into Belgrade the definitive treaties of peace were concluded with Austria and Russia (Sept. 18, 1739). Austria gave up Belgrade and the rest of the territory south of the Save which it had gained by the treaty of Passarowitz The treaty with Russia provided that the forts of Azov should be razed and that Russia should have no warships on the Sea of Azov or on the Black sea. The Kabardias were to remain independent as a buffer state between Turkey and Russia. Turkey consented to discuss the question of recognizing the tsar's claim to the imperial title of padishah and admitted his right to send representatives to Constantinople

Two years after the treaty of Belgrade, war broke out with Persia because of Nadir Kuli Khan's attempt on Mesopotamia. It continued from 1743 to 1746 with varying fortunes, and when peace was signed Turkey retained the frontier fixed at the time of Murad IV and Persia procured a few privileges for its pilgrims to the Holy Places. Turkey refrained from taking part in the War of Austrian Succession in spite of the efforts of France, and maintained a peaceful attitude during the disorders which followed the death of Nadir Kuli Khan in Persia The sultan died in 1754 and was succeeded by his brother Osman III (1754–57). The only noteworthy events of the latter's reign were the first Wahhabi rising and the issuing of the first order for veiling women's faces.

Mustafa III (1757–73).—Koja Raghib, the grand vizier at the accession of Ahmed III's son, Mustafa III, sent an envoy to Berlin, and a treaty of friendship and commerce was signed on March 12, 1761. While he was alive Koja Raghib kept the sultan out of war. He controlled Turkey's foreign affairs while the sultan, who was of a fanatical disposition, concerned himself with the dresses and the veils of women. He projected an alliance between Turkey and France; but since France and England had differences over the Indian possessions such a treaty might have affected the English interests among the Moslems, and in consequence Sir James Porter, the British ambassador in Istanbul, used his influence against it.

Before long, events in Poland drew Turkey into war in 1768. Catherine II of Russia tried to put her favourite, Stanislas Poniatowski, on the Polish throne on the death of Augustus III.

The Poles complained to the Porte and urged Turkey to fight Russia. The sultan at first contented himself with protests, but Russia had violated the neutrality of the Kabardia, while in Serbia, Moldavia and Montenegro the Russian monks carned on seditious propaganda against Turkey. Turkey issued an ultimatum to Russia demanding that Russia withdraw its army from Poland On Russia's refusal war was declared. Turkey procured the neutrality of England, Holland and Sweden in this war, and Austria undertook to remain neutral in return for certain privileges Nevertheless Turkey had entered the war without preparations The Turks were first defeated by the Russian forces in Georgia, Crimea and Kabardia and on the Dniester; the Russian Baltic fleet under Alexis Grigorievich Orlov reached Morea, and incited the inhabitants to revolt In 1770 the Turkish fleet was burned near Cheshme (Cesme, west of Smyrna) by the Russian fleet under the direction of a Scottish admiral. The Turks were defeated in Bessarabia, and the Russians invaded the principalities and reduced the fortresses on the delta of the Danube and on the Dniester In 1771 the Crimea was conquered by the Russians. Although the Austrians had undertaken to mediate and to assist the Turks, they preferred to take a share in the partition of Poland After a fruitless conference at Focşani, the Russian representative at the conference of Bucharest (1773) issued an ultimatum demanding the free navigation of the Black sea and the Aegean sea for Russian trading vessels and warships, the cession of Kilburun and the right to protect the Orthodox subjects of the sultan. Turkey refused these terms, and the war continued, the Turks fighting hard in Silistria and Varna. Mustafa died in 1773 and was succeded by his brother, Abd ul-Hamid I.

Abd ul-Hamid I (1774–89).—Abd ul-Hamid had been kept in seclusion for 43 years and was weak in his mind. The abuses and disorders in the army and the palace were at their worst, and the situation at home gave no hope of retrieving the external misfortunes of the state. Turkey refused the mediation of Prussia, but when the Russian army reached Shumla it was forced to negotiate pence. The treaty of Kuchuk Kaynarji was signed on the anniversary of the treaty of Pruth (July 21, 1774) which had been disastrous to Russia This was the most humiliating treaty the Turks had yet signed. The treaty was the first political manifestation of the Eastern Question (q.v.). The Tatars from Poland to the Caspian sea were given their independence, the sultan merely retaining his religious leadership as caliph. Russia retained Kilburun, Kerch and Yenikale, while Akkerman, Ismail, Ochakov and Bessarabia were restored to Turkey. Moldavia and Walachia became semi-independent states under Turkey, Russia, however, having the right to intervene in the appointment and dismissal of the hospodars The imperial title of padishah was definitely conceded to the Russian tsars The Black sea and the Mediterranean were made free for commerce and navigation to both countries, and Turkey was to pay an indemnity of 15,000 purses to Russia The most important clause from the Turkish point of view was that which gave Russia the right to protect the Orthodox subjects of Turkey. Originally this treaty only accorded to Russia the right to build a church in Constantinople and the right of making representations for the protection of the officials of this church, and Turkey undertook to protect the Christians (article 7). This clause was later interpreted as an inclusive protection of the Orthodox Christians and played a disastrous part in the subsequent history of Turkey Poland, the original cause of the war, was not mentioned, having been partitioned for the first time in 1772.

Turkey took advantage of the respite to strengthen its frontier defenses and to reform the janissaries. Russia soon tried to annex Crimea, but a rupture was averted by French mediation and also by the fact that Turkey was not ready for war. Turkey signed the convention of Ainali-Kavak, March 10, 1778, whereby the Russian partisan Shahin Gherai was recognized as the khan of Crimea, and the terms of the treaty of Kaynarji reaffirmed. Five years later Russia annexed Crimea and Kuban, and Turkey was forced to sign the convention of Constantinople on Jan. 8, 1784, the stipulations as to the independence of the Tatars in the treaties of Kaynarji and Ainali-Kavak being abrogated Catherine II's triumphant entry into the Crimea and her interview with her ally the emperor Joseph II to discuss the partition of Turkey, together with the seditious Russian propaganda in Moldavia, Walachia and Morea created a war party in Constantinople which was sustained and encouraged by the British and Prussian ambassadors War was declared. The Austrians joined the Russians but were driven back from Mehadia by the Turks, who overran the Banat (1789). The Russians captured Hotin and Jassy and Ochakov, all of whose inhabitants were massacred, including the women and children, by the order of Gen. Alexander Suvórov. The news affected Abd ul-Hamid I so deeply that he died.

Reform had become so urgent and inevitable that of the two young sultans who succeeded Abd ul-Hamid I, one gave up his life for it and the other had to carry out his designs for westernization by the most sanguinary measures. The ignorance, the despotism or the weakness most of the sultans disorganized both the autonomous and the centrally governed provinces Between the treaty of Karlowitz and the treaty of Kaynarji, the absence of discipline among the *janissaries* and *their interference* in the internal policy of the state upset the administrative machinery The partially self-governed states of Barbary (Tripoli, Tunis, Algiers) had become almost independent, keeping only a nominal connection with the empire and choosing their own chiefs, called *dayi*. The Mamelukes who were allowed to stay in Egypt by Selim the Grim had become stronger and, with the help of the janissaries, were taking up a hostile attitude to the Porte. The pashas in Baghdad did the same. The recurrence of the Jelali insurrections brought forward headstrong governors who ruled the country like feudal lords In European Turkey the locally elected notables, called *ayan*, interfered in the administration This general disorganization had been partially remedied by the grand viziers belonging to the Kuprili family, but it continued worse than ever after them The system of land tenure of the time of Suleiman was violated. The *khas*, *timar* and *ziamet* were seized by the central government, apportioned to the favourites of the sultans or the viziers and sometimes even sold to the highest bidder and to people who were not able to cultivate them or to perform the military duties of the former spahi fief holders. The number of the officials increased, and their short terms of office led to continual disorder.

During the "long war" of the time of Murad III the army increased disproportionately, but its individual units were no longer trained in the barracks and their military value was next to nothing. The sultans isolated themselves in their palaces and led lives of pleasure, thus losing contact with the army. They appointed incompetent commanders and executed them if they were defeated, which paralysed the initiative of those with a genuine ability to command. As the supply of provisions and ammunition was also in disorder, many deserted from hunger and lack of munitions. Although the army decreased in numbers after the treaties of Karlowitz and Passarowitz, the leaders of the janissaries would mark any man in the street as a regular soldier, register his name and put the pay in their own pockets, while the man himself went on with his own work All attempts so far had failed to remedy these abuses To make matters worse, the frequent change of sultans, often brought about by the janissaries themselves, meant accession presents which at times depleted the treasury. Then the treasury was refilled by debasing the coinage

Science and industry which were far advanced at the time of Suleiman had taken no part in the progress of the 17th and 18th centuries but had remained hopelessly mediaeval. The official class was mostly illiterate, and the *kadis* who meted out justice were ignorant The Turks refused to learn any European languages and knew very little of what was going on in the world. When necessity arose they used Christians and Jews as interpreters and became correspondingly dependent on them Few books on philosophy, mathematics and history were printed in Ahmed III's reign. Only literature, especially poetry, flourished during this decadent age, and many of the great Turkish poets were of this time. Textile industries, being patronized by the sultans, also flourished. The manufacture of implements of war and ammunition continued, partly because of the artisans who inherited their craft and partly because of the experts who were brought from

the west for the purpose.

Selim III (1789–1807).—Selim III, the son of Mustafa III, was the only Turkish prince of the last centuries who had not been caged, which gave him an opportunity of greater knowledge and a more normal view of the world. A passionate admirer of French culture, he wanted Turkey to be equal with the western powers in every branch of progress. It was in Selim's mind that the new Turkey originated, and with him the struggle for reform and progress began seriously, at the price of so many Turkish martyrs. He hoped to bring the war to a victorious end and so acquire the necessary prestige for his reforms. When the news of the Russian victory of Kalas reached Constantinople, he called a council, enumerated the causes of defeat and disaster and proposed internal reform as the only remedy. He insisted that the people should elect their own *kethudas* (mayors) and *ayans* (notables) without the interference of the governors, that an end should be put to the unlawful tribute which the *rayas* were made to pay, that the army and the administration should be organized on a western basis.

In the meantime one Austrian army defeated the Turks in Serbia and captured Belgrade, while another in conjunction with the Russian army captured Focşani. On Aug. 4, 1791, the new Holy Roman emperor, Leopold II, who was unfavourable to the Russian alliance, made a peace with Turkey at Sistova through the mediation of England, Prussia and Holland, by which Belgrade was restored to Turkey. But Russia, after defeating the Swedes, who were Turkey's allies with Prussia, was free to carry out its policy of extension in Turkey, and the war continued. It was about this time that William Pitt in England proposed the policy of preserving the integrity of the Turkish empire. It appeared first in the form of friendly advice to Russia to make peace with Turkey, which was rejected by Catherine II. Turkey, after several reverses on the field, made peace with Russia in 1792 at Jassy, the Dniester becoming the Turkish frontier in Europe.

Selim continued his reforms, especially in the army. He formed a new corps, but in order to disarm the jealousy of the janissaries he affiliated the new corps to them. Military schools were opened, the fleet reorganized, and instructors brought from Europe. But his progress was interrupted by the war with France (1798). Bonaparte attacked Egypt, more as a move against England than against Turkey, as his aim was to open a French route to India. Turkey fought against France in alliance with England and Russia. Napoleon was beaten in Syria, the French fleet destroyed by Nelson at Aboukir, and the Ionian islands captured by the Turkish and Russian fleets. Peace was concluded with France in 1802. The reactionary governors whose interests were injured by the new reforms continued to cause disorder in every part of the empire. Pasvanoglu, the governor of Vidin, drove the peaceful *rayas* to revolt by his persecutions, and the insurgents chose Karageorge (George Petrovic) as leader and succeeded in taking Belgrade. An army was sent to punish Pasvanoglu, without result. The revolt of the Wahhabis in Nejd became another source of anxiety which continued till the time of Mahmud II. A marked renewal of trouble broke out with Russia over the principalities. Constantine Ypsilanti and Alexander Murusi, hospodars of Walachia and Moldavia, two instruments of Russia, had caused risings against the Porte which had led Turkey to dismiss them without the consent of Russia, thus violating the agreement of 1802. Russia and England protested, and the two were replaced. But, encouraged by the French ambassador, H. F. B. Sébastiani, Turkey declared war against Russia, although the British ambassador threatened to join Russia against Turkey (Nov 6, 1806). The British fleet passed the straits, anchored off Constantinople and delivered an ultimatum, ordering Turkey to dismiss the French ambassador within 24 hours and to make peace with Russia. The Porte, encouraged by Sébastiani and by popular indignation at the presence of the ships, decided to resist. The entire population of Constantinople helped to range a thousand guns along both sides of the Bosporus in one day. The British fleet retired considerably damaged.

In the meantime the reforms and the progress of the new army were leading the janissaries and the corrupt officials to make desperate efforts in opposition, and they were supported by most of the reactionary governors. In 1807 the garrisons on the Black sea rose, under Kabakjioglu, and killed their officers and all those who were known to be reformists. The rebellion became general and the abolition of the new troops was demanded. The concessions made by the sultan in the hope of preventing further bloodshed only encouraged the rebels to make greater demands, and finally they dethroned him. Sébastiani is charged by the Turkish historians with inciting the janissaries.

Mustafa IV (1807–08).—Selim's successor Mustafa IV, son of Abd ul-Hamid I, abolished all the reforms, and anarchy continued during his reign of 14 months. In 1807, during the negotiations between Tsar Alexander I and Napoleon at Tilsit for the partition of Turkey, Napoleon undertook to mediate peace between Russia and Turkey if Alexander would withdraw his troops from Walachia and Moldavia. An armistice was signed in Aug. 1807, the Turkish army retiring to Adrianople. In the winter of 1807 a committee composed of the adherents of reform in Ruschuk (Russé), persuaded Bairaktar Pasha, who had distinguished himself in the Russian war, to march on Constantinople with an army of 20,000 Kirja-Ali troops with the object of reinstating Selim and his reforms. Selim was killed by the janissaries before Bairaktar's army could enter the palace (1808). His nephew, Mahmud, Mustafa IV's brother, a youth brought up in the tradition of reform, was saved by Jevri Kalfa, a woman in the palace who threw ashes in the eyes of the murderers and enabled the future sultan to escape by the roof. Mustafa IV was dethroned and Mahmud II, the last survivor of his line, ascended the throne.

Mahmud II (1808–39).—Mahmud II appointed Bairaktar grand vizier and issued a royal proclamation ordering him to treat the people and their *rayas* with justice and to re-establish order. As the Russian question was not settled and the principal governors were all trying to instigate revolts by declaring the reforms to be antireligious and thereby exciting fanatical resistance, Mahmud II based his arguments on religious grounds and demonstrated the necessity of education and reform in the name of Islam. Bairaktar Pasha called a council in Constantinople to which he invited notables and influential men from all over the country. The council decided that the new troops, under European instructors, were to be re-established under the name of *seymen-i-jedid*; that the janissary organization was to be retained but reformed, those only nominally on the register and receiving pay without serving to be dismissed, and that the authority of the sultan was to be permanent. The new grand vizier managed to restore comparative order and began his reforms seriously, but while the Kirja-Ali troops who were loyal to him were on their Bairam leave the janissaries attacked his home at night. He pretended to parley with them asking to have his womenfolk removed to a safe place, after which he promised to give himself up. But when the women had been removed he opened fire on the rebels from his windows and fought them to the last shot, after which he blew himself up in the powder magazine under his house. The janissaries, once more masters of the situation, resumed their massacres of the new troops and forced the sultan to cancel all the reforms.

The truce signed with Russia in 1807 had had no result, and the war continued fitfully. France had encouraged the Porte to resume the Russian wars but the misfortunes of these wars aroused public opinion in Turkey against France and turned it in favour of England. On June 5, 1809, a treaty was signed in Chanak between England and Turkey, the British representative being Sir Robert Adair. A peace with Russia was also concluded on May 28, 1812, in Bucharest by the mediation of Stratford Canning, who later as Lord Stratford de Redcliffe, British ambassador, played a great part in Anglo-Turkish friendship. The treaty gave Hotin, Bender and Akkerman to Russia and confined the eastern frontiers of Turkey to the lines of the Prut river. The clause which restored Serbia to Turkish suzerainty was vague and gave rise to disputes. The Turkish army marched into Serbia and appointed one Milosh Obrenovich as the governor of his district; he, however, raised a successful revolt against Turkey and ruled Serbia in semi-independence. Karageorge, who had returned, was killed by him, and in 1817 he was designated hereditary prince of Serbia.

During the war with Persia, Russia had acquired the right from

Turkey to use temporarily the road from the Black sea to Tiflis by way of the valley of the Rion-Phasis. Russia desired to have this district ceded to it by a secret clause in the treaty of Bucharest, and the sultan had refused to ratify it. But within a few years Russia acquired the high land between the Caspian and the Black sea and the low lands along the coast between Anapa and Poti, which were nominally under the suzerainty of the sultan.

Such was the situation when a European guarantee of integrity of Turkey was proposed at the congress of Vienna, in the belief that breakup of the Turkish empire would endanger the world's peace. It was decided, with the consent of the tsar Alexander, that England, France and Austria should trace clearly the frontiers of the Turkish empire, whose integrity the powers would undertake to guarantee. The Porte, deeming the proposal to be a humiliating foreign intervention, refused. The return of Napoleon threw the question into the background and the Turkish empire thus remained outside the European concert. This Eastern Question (*q v*) which occupied the political history of the 19th century can be summed up as the result of the conflict of the following desires: Russia's and Austria's desire to reach the Mediterranean; the British desire to prevent Turkey from obstructing the route to India and the desire of the non-Moslem Turkish subjects for independence, which was often concealed under the demands for reform.

Mohammed (Mehemet) Ali Pasha, the governor of Egypt, who had become known during the war with Napoleon, had proved his strength in 1811 by destroying the Mamelukes. His successful expedition against the Wahhabis in Hejaz had made him a popular hero as the saviour of the holy places. Another Ali Pasha of Janina (*see* ALI, known as ALI PASHA), originally from Tepeleni, who kept order for a time in Greece and Albania, but who became rebellious, was slain in 1822.

The Greek Rising.—The Greeks found this an opportune moment to realize their ideal of national independence. Their hopes had begun at the time of Peter the Great and were considerably strengthened by the attitude of Catherine II (*see* GREEK INDEPENDENCE, WAR OF). Their secret revolutionary society, the Hetairia, was founded in Bucharest by the Greek poet and patriot, Constantine Rhigas; and, four years after his arrest and execution in 1798, it was revived in Odessa. The society passed into action with the help of Alexander Ypsilanti, son of hospodar Ypsilanti, a Greek who had become a general in the Russian army and used his forces to support insurgents in Moldavia in 1821. The emperor Alexander's aversion to supporting a revolutionary, even against the infidel Turks, together with the preference of the population of the Danubian principalities for the Turkish rule rather than that of the hated Phanariotes, considerably weakened the cause of the insurgents. This, the first serious rising was put down at the battle of Dragashani on June 19, 1821. The Greek rebels in Morea, however, had massacred almost to extermination the native Moslems and the sultan retaliated by executing the Greek patriarch in Constantinople on the charge of having instigated the slaughter. Russia, taking this up as an insult to the Orthodox Church, broke off relations with Turkey. The European powers used every effort to avert a Russo-Turkish conflict. Metternich hoped that with time and the moral and material assistance of European peoples the Greeks would of themselves achieve national independence. On March 25, 1823, however, George Canning induced England to recognize the Greek insurgents as a belligerent party. The Russian emperor, jealous of this new influence in favour of the Orthodox Christians of the east, called as a counterpoise a conference in St. Petersburg in April 1824. Neither the Turks nor the Greeks would abide by its decisions and the sole outcome of the conference was an offer of the joint mediation of Austria and Russia, which the Porte refused. The sultan, finding himself unable to put down the Greek revolt, asked the aid of Mohammed Ali Pasha, the governor of Egypt, promising him the general governorships of Morea, Syria and Damascus in return. The well-disciplined Egyptian fleet and army approached the Morea under the command of Ibrahim Pasha, the son of Mohammed Ali. The Greeks were defeated in June 1827, Athens once more was in the hands of the Turks, and Ibrahim Pasha was sending crowds of Greeks as captives to Egypt and replacing them by the fellahin (Egyptian peasants). An isolated Russian intervention, for which Russia was concentrating in the south, was prevented by the death of the tsar Alexander in 1825. Canning persuaded the new tsar Nicholas I to call another conference in St. Petersburg on April 4, 1826, as a result of which England was empowered to offer Turkey a settlement of the Greek question based on the establishment of Greece as a vassal and tributary state. In case of refusal the two powers, whether separately or in common, would take the earliest opportunity of enforcing a settlement. Russia, meanwhile, issued a separate ultimatum to the Porte for the satisfaction of its other grievances. The Porte, though it resented new demands being made before the others were dealt with, was unable to resist and signed the convention of Akkerman accepting the Russian demands which were the confirmation of the treaty of Bucharest; the opening of the navigation of the Black sea to Russian ships; seven years' term of office for the hospodars of Walachia and Moldavia, as well as the consent of the Russian ambassador in Constantinople before they could be dismissed and the recognition of the autonomy of Walachia and Moldavia, where no Moslem was to reside except in the fortresses.

Mahmud II, by a wholesale massacre on June 15, 1826, had crushed the janissaries, and the defense of the empire was now in the hands of the new army. Helmuth von Moltke was to be among the large number of French and Prussian instructors engaged for it. Mahmud also abolished what remained of the feudal system in the provinces. The taxes were to be gathered by the central government. The execution of individuals by the viziers without trial and the confiscation of the property of wealthy persons deceased, or of persons executed by the state, was forbidden by new regulations. Mahmud II himself discarded the turban and adopted the fez and European costume, and ordered all officials to do the same. The fez remained the official headgear of the Turks till the passing of the "hat law" by the Turkish republic in 1925.

The Greek question was still unsettled. In 1826, the Greeks formally asked for the mediation of England. Canning's objection to intervening unasked having thus been removed, he invited the co-operation of Russia in making representations to the Porte which should be based on the protocol of St. Petersburg and suggested measures of coercion in case of refusal; the tsar consented to this. The coercion was to take the form of a pacific blockade of Morea, so as to force Ibrahim Pasha to evacuate the country by cutting off his supplies. Austria and Prussia, in the conference of the five powers of the Grand Alliance in London in 1827, protested against coercion of the Porte for revolutionary purposes and withdrew. On the suggestion of France, however, the protocol was made into a treaty and, as the treaty of London, was signed by the three powers on July 6, 1827. By its public articles the powers agreed to secure the autonomy of Greece under the suzerainty of the sultan without any breach of friendly relations with Turkey. But by additional secret articles it was agreed that in the event of the Porte's not accepting the offered mediation, consuls should be established in Greece and an armistice proposed to both belligerents and enforced by the powers.

The armistice, accepted by the Greeks, was refused by Ibrahim Pasha, pending instructions from Constantinople, though he consented to keep his ships in the harbour of Navarino. In the meantime the Greeks destroyed a Turkish flotilla off Salona, and Ibrahim, taking this as a breach of the convention, set sail from Navarino northward. The Russian and French fleets joined the British fleet at Navarino and, on Oct. 20, attacked the Turkish and Egyptian fleets and destroyed them (*see* NAVARINO, BATTLE OF). Turkey broke off diplomatic relations with the three powers concerned, and the sultan issued a proclamation denouncing the cruelty and perfidy of the European powers and summoning the Moslems to a holy war. Canning had died and England had gone back to its policy of preserving Ottoman integrity, so the struggle that followed was restricted to Russia and Turkey. Russia declared war on Turkey April 26, 1828, England disapproving and France agreeing. Although Turkey was in the midst of confusion because of the destruction of the janissaries and the new army

was small and hardly formed, the resisting power of the Turks was raised to its utmost by the attitude of the powers. Russia had to fight two very hard and difficult campaigns before Gen H. von Diebitsch could dictate terms of peace at Adrianople (Sept. 14, 1829). A protocol at London on March 22 had proposed boundaries for an autonomous Greece. The treaty of Adrianople between Turkey and Russia provided that the Danubian principalities were to become practically independent; that the districts of Anapa and Poti were to be ceded to Russia; and the Greek question was to be settled according to the terms of the protocol of March 22 But in order that Russia should not enjoy the prestige of having emancipated Greece unaided, the other powers decided to give further concessions to Greece, and this was expanded into the treaty of London of May 7, 1832, by which Greece became an independent kingdom under the Bavarian prince Otto (*see* RUSSO-TURKISH WARS; GREECE: *History*).

The Egyptian Revolt.—Turkey suffered a series of serious internal revolts after the reverses had reduced her prestige. Bosnia and Albania revolted. In 1830 the French occupied Algiers Mohammed Ali Pasha, the governor of Egypt, was found to have intrigued in the revolt of Albania and in Damascus. He was recalled and replied by open revolt, sending his army under his son Ibrahim Pasha to invade Syria Mohammed Ali Pasha's hope was to seize the sultanate and to start a new dynasty—a hope which seemed feasible when, after capturing Damascus and Aleppo and defeating the Turkish army in Konya, Ibrahim invaded Kutahia. As France was supporting Egypt, Turkey endeavoured to draw England into an alliance against Egypt. Palmerston refused in spite of the efforts of Stratford Canning, and Mahmud II in desperation asked for help from Russia. The treaty of Unkiar Skelessi (Hunkiar Iskelesi) was signed July 8, 1833, and the Russian army came to the Bosporus to help the Turks against the Egyptian army which was now threatening to march on the capital. England and France, suspicious of Russia, now mediated. They forced Mohammed Ali to stop the march of the Egyptian army and made the sultan accord the hereditary governorships of Adana, Crete, Tripoli and Damascus to him This put a temporary end to the war. The treaty of Unkiar Skelessi had included clauses to which permitted: (1) Russian warships to pass through the straits and to land troops if necessary and (2) the closing of the straits to warships of all the other powers. These clauses seemed to place Turkey in the power of Russia. After securing peace under these humiliating conditions Mahmud once more began to prepare his army while Mohammed Ali increased his with recruits from the provinces which had been given him. In 1839 Mahmud sent a Turkish army against the Egyptians in Syria but was badly beaten by the forces of Ibrahim Pasha at Nezib in the north of Syria. Mahmud died in Constantinople while the battle was actually in progress (July 1, 1839).

Internal Affairs.—Mahmud II's reign opened seriously the period of westernization in Turkey. In addition to the army reforms already mentioned, medical schools were opened by experts from Europe, and the civil service was organized on a modern basis. A number of students were sent to Europe for the first time, a newspaper and the first official printing press were established. The ministry of foreign affairs and the ministry of the interior were organized as well as the ministry of public works and the supreme council of legal affairs. The naval and military schools and the school of engineering founded by Selim III were reorganized, and in 1838 a council of public instruction was formed. The basis of compulsory elementary education was laid down by a royal proclamation which forbade children who had had no elementary education to take up any craft And the pious foundations (*evkaf*) were unified and organized into a ministry.

Abd ul-Mejid I (1839–61).—Abd ul-Mejid succeeded his father at the age of 16 when Mohammed Ali Pasha of Egypt seemed on the verge of seizing Turkey and the empire seemed about to dissolve into its elements. The army, the government and the sultan were helpless and the Turkish fleet was handed over to Mohammed Ali Pasha by the treachery of Adm. Ahmed Pasha. But to prevent Russia from using the treaty of Unkiar Skelessi for its own purposes the great powers decided to intervene in the Turko-Egyptian conflict and called a conference in London. France, who had supported Mohammed Ali Pasha, took no part in the final settlement, but Russia for the purpose of breaking the entente between England and France waived its claims under the treaty of Unkiar Skelessi and joined the concert. By the *protocol de clôture*, which was signed on July 15, 1840, the governorship of Egypt became hereditary in Mohammed Ali's family without undermining the sovereign rights of Turkey, Egyptian claims to Crete, Syria and the Holy Cities were abandoned. A year later, on July 15, 1841, five powers signed the *protocol des détroits*, by which the sultan was to close the straits to warships of all the powers.

The schemes for reform which Selim III and Mahmud II had only been able partially to realize were to be more fully worked out under Abd ul-Mejid I. Mustafa Reshid, the Turkish foreign minister and ambassador to London, returned. He was the greatest statesman and westernizer of the reform period, and he personally prepared a *tanzimat* or vast plan of reforms and made the sultan sign and issue it under the name of *Gulhane-hatti-humayoumi* (royal decree of Gulhane). From this decree dates the fundamental change of Turkey from the old system based on nomadic principles to that of a modern state Like the preceding decrees, in order that it might disarm fanatical opinion, it also emphasized that all progress was in accordance with Islam It undertook to issue laws conforming with the age, to establish security of life, property and honour (no one was to be punished without trial); to remodel every branch of the administration and to accord perfect equality to all Ottoman subjects of whatever race or creed. This meant a great difference for the Christians. Though they had religious and communal freedom by the firman of the conqueror, the political complications caused by the separatist tendencies and the massacre of the Moslems in Morea by the Greeks had aroused intense hatred and made their position difficult and even dangerous. The attempt of the *tanzimat* to establish them as equal citizens helped to unite them with the ruling race and before long the Christians shared all the offices in the administration, even up to the rank of cabinet minister. Mustafa Reshid with a few convinced and westernized men around him made gigantic efforts to enforce the new principles in every department. The announcement of reforms, however, regularly ran far ahead of their performance.

Mahmud's military organization was extended by engaging more foreign instructors and opening more military schools The most important change was the recruiting law, which reduced military service, hitherto for an indefinite time, to a limited period. The Christians were exempted from military service upon payment of a special tax. A body of gendarmerie was instituted.

In addition to the only existing educational institutions, that of the ulema and the schools maintained by private donations, with studies based on the Koran, the council of education founded and multiplied both primary and secondary state schools, and tried to unify and centralize education by sending superintendents to the provinces to carry out the state system. Commercial courts were opened As the civil and penal cases were sent to the Sheria courts, a school for judges was opened and attached to the office of the sheikh ul-Islam.

Permanent ambassadors were appointed from among the best statesmen and sent to European capitals; this helped to create friendly relationships with the western powers. The promise of the reforms, which without resorting to terrorist methods appeared to be forming a centralized and efficient government, naturally aroused great sympathy for Turkey and hope for its future. The only international controversy arose when in 1848–49 Turkey, true to its traditions, refused to give up the Polish and Hungarian refugees. Turkey had England's support in this act. The difference with Persia over the frontier question was settled for the time being by the treaty of Erzurum (1848) by English and Russian mediation.

The Holy Places and the Crimean War.—The possibility of a strong and reformed Turkey made Russia uneasy. Since the time of Peter the Great and Catherine II it had considered itself the rightful heir to most of the lands of the declining Turkish state. Nicholas I, who went to London in 1844, proposed to England the

partition of Turkey, which he called a "sick man." England was to receive Crete and Egypt, Constantinople was to be a free city, and the Balkan states were to be autonomous under Russia. Suspicious of the Russian designs, England refused to solve the Eastern Question by so drastic a measure But the question came up again in 1850 through a quarrel between the Catholic and Orthodox monks about the Holy Places in Palestine.

The capitulations signed on May 28, 1740, by Mahmud I, according certain rights to the Roman Catholic (Latin) ecclesiastics in the Holy Places, had placed the French pilgrims, together with the pilgrims of the other Catholic nations, under the protection of the French flag. This stipulation of the treaty had fallen into desuetude during the French Revolution. In the meantime every advance of Russia had been marked by encroachments of the Orthodox Church on the Roman Catholic Church. The quarrels of the monks of the two churches would have passed unnoticed if Louis Napoleon had not in 1850 seized the opportunity to win over to his side the clericals in France: the French ambassador handed to the Porte a formal demand for the restitution to the Catholics of all their rights The Ottoman government proposed a mixed commission of inquiry, and France agreed with the condition that no documents later than 1740 should be admitted as evidence As this suggestion excluded the treaty of Kaynarji, the tsar demanded that nothing should be altered in the *status quo*. This was a contest between Russia and France for paramount influence in the east: England was inevitably involved and took the side of France and Turkey. The Porte arrived at a compromise in March 1852 by issuing a firman which accorded privileges to both sides, taking on itself the right of "protection." Neither France nor Russia accepted this as neither desired a settlement. Louis Napoleon, who became emperor as Napoleon III in Nov 1852 and whose new title had been recognized only equivocally by the tsar, wanted a war for dynastic reasons, and the tsar thought the moment opportune to drive out the infidel from Europe. The tsar renewed the proposals of partition made in 1844.

In 1853 Prince Alexander Sergeievich Menshikov was sent to present the Russian ultimatum to Constantinople. He demanded the recognition of the *status quo* in the matter of the Holy Places and of the tsar's right under the treaty of Kaynarji to protect the Orthodox subjects The Porte turned for advice to Lord Stratford de Redcliffe, the British ambassador, who was both popular and influential. He grasped the situation at once and persuaded Menshikov to present the two demands separately. On April 22, the question of the Holy Places was settled by the British, Russian and French ambassadors. Then when the question of the Russian protectorate over the Christians was raised, Menshikov found himself opposed by the ambassadors of the other powers. Menshikov demanded that the Porte should give a note reaffirming the Russian rights, and this the Turkish cabinet seemed inclined to accept. But that cabinet fell; Mustafa Reshid came into power and, advised by Lord Stratford de Redcliffe, refused the Russian demand. Menshikov left Constantinople on May 22. On June 22 the Russian army under Prince Mikhail Dmitrievich Gorchakov entered the Danubian principalities. It was explained, however, by a circular that this was not with the purpose of attacking Turkey but in order to obtain material guarantees for the enforcement of the existing treaties. In August a conference of the four powers assembled in Vienna, but the settlement proposed conceded everything to Russia except the protectorate, and the Porte would not agree to it. In October Turkey presented an ultimatum to Russia demanding the evacuation of the principalities, and the French and English fleets passed the Dardanelles. Lord Aberdeen, hoping to keep peace, informed Russia that as long as it abstained from crossing the Danube or attacking a Black sea port there would be no *casus belli*. But Russia bombarded Sinop on the Black sea coast and destroyed a Turkish squadron (Nov. 30), and the French and English fleets entered the Black sea and demanded that the Russian fleet should retire.

The conflict at Sinop had been more like a slaughter than a battle, and the excellent behaviour and initial successes of the Turkish land forces aroused sympathy and admiration throughout Europe. The belief in the rejuvenation of Turkey seemed justified. On March 27, 1854, Great Britain and France declared war on Russia, with the strong support of public opinion; they were later joined by Sardinia. Austria put pressure on Russia to withdraw from the Danubian principalities and occupied them itself in agreement with Turkey (*See* EASTERN QUESTION)

The main operations of the Crimean War (*q.v.*) were confined to the Crimea. The allied troops landed on Sept. 14, 1854, and the campaign lasted till Dec. 1855, when the threatened intervention of Austria forced Russia to accept terms which were ultimately embodied in the treaty of Paris (March 30, 1856). Russia abandoned its pretensions to protect the Christians in Turkey and renounced her right of exclusive interference in the Danubian principalities, to which a fragment of Bessarabia was restored, the navigation of the Danube became free under the supervision of an international commission; the Black sea was to be open to commercial ships of all countries and closed to all warships except a limited number of small warships belonging to Turkey and Russia; Turkey was admitted to the European concert and the contracting parties were to respect its independence and the integrity of its territory; the *tanzimat* was reaffirmed and enlarged by a decree of the sultan called the *Hatt-i Humayun*, which was included in the treaty under insistence from the powers.

The new era following the Paris conference opened with several outbursts against the reforms It is noteworthy that the Christians, even the clerical class, were opposed, either for fanatical reasons or at the instigation of Russia, which did not want Turkey to be strengthened. In 1859 the Danubian principalities, encouraged by France and Russia, united and, choosing Alexander John Cuza as their ruler, formed the principality of Rumania. (*See* RUMANIA.) In 1860 a disturbance in Lebanon involving the Druses and the Christians led to a French occupation, which Fuad Pasha, seconded by Ahmed Vefik Effendi, the Turkish ambassador in Paris, contrived to restrict and to terminate as soon as possible. A *réglement* was signed in Constantinople on June 9, 1861, instituting an autonomy for Lebanon under a Christian governor to be chosen by the powers with the consent of the Porte. This agreement lasted till World War I.

Toward the end of Abd ul-Mejid's reign a secret committee was formed in Constantinople to propagate the idea of a constitutional regime for Turkey.

Abd ul-Aziz (1861–76).—Abd ul-Aziz became sultan on his brother Abd ul-Mejid's death in 1861 and reaffirmed by decree the principles of the *tanzimat*. Pan-Slavism, which had its centre in the University of Moscow, began to penetrate Montenegro and Hercegovina, which rose in revolt. These revolts were put down but the Serbs also revolted, demanding the expulsion of the Moslems who lived in the fortresses. In 1862 this revolt was pacified by ceding a few more fortresses to the Serbs; and five years later, through the mediation of England and Holland, the Turkish troops were withdrawn altogether. The Cretans, aided by Greece, revolted and declared their union with Greece. Thereupon Ali Pasha, the grand vizier, went to Crete with an army and quelled the revolt; the episode led to a diplomatic rupture with Greece and in 1869 a conference of ambassadors in Paris accorded local autonomy to Crete under Christian governors. Meanwhile, Ismail Pasha, who became governor of Egypt in 1863 and was a man given to unrestrained expenditure, had obtained loans from France and England, bribed a large number of influential men in the Porte and made the sultan agree to the establishment in Egypt of a succession from father to son, which he did by issuing the firman of May 27, 1866, and June 8, 1867, the latter according to the governor of Egypt the title of khedive. Abd ul-Aziz yielded so easily because he was desirous of bringing about the same alteration in the succession in Turkey in favour of his eldest son. Also, the introduction of a regular budget system for the first time revealed the deplorable state of the treasury. New loans, internal and external, had to be raised in order to pay the interest on the old debts.

The regime of Midhat Pasha, the father of the Turkish constitution, as the governor of Nish, was so popular with all races and creeds that his methods were introduced into other Rumelian vilayets. The people elected their provincial councils, and criminal and civil courts were first opened in those provinces. On March 10,

1870, a firman instituted the Bulgarian exarchate, thus severing the Bulgarian Church from the jurisdiction of the Greek patriarch of Constantinople. In 1871, Russia, taking advantage of the weakened state of France, declared itself no longer bound by the treaty of Paris, which had restricted the number of Russia's warships on the Black sea An international conference which met in London in 1871 recognized this by abrogating the restrictions on both Russia and Turkey. The passage of the straits remained interdicted to warships.

A law promulgated on June 18, 1867, for the first time allowed foreigners to hold landed property throughout the empire except in Hejaz on condition of their being divested of their right to the protection of their own authorities concerning such property The grand vizier, Ali Pasha, also made the first amendment to the capitulations by inducing the powers to accept Turkish jurisdiction over small cases for their subjects who lived at a distance from consular towns. In 1866 a Bulgarian insurrection, instigated by Russia, broke out in Trnovo on the pretext that the reforms promised by the firman quoted in the treaty of Paris had not been carried out. Although Midhat Pasha pacified the rising, its real motive, which was nothing less than a desire for national independence, remained unaltered After the death of such able statesmen as Ali Pasha and Fuad Pasha, Abd ul-Aziz became despotic and began to exile people without trial The palace expenses increased and financial conditions became worse. The world-wide depression which began in 1873 ended the process of borrowing to cover extravagance and meet deficits Recourse was had to increased pressure for taxes, which were still payable in kind. Mahmud Nedim Pasha was obliged to declare that the government could pay only a 50% annuity on its debts; whereupon Europe considered Turkey bankrupt, and the state began to lose the prestige gained after the reforms. The agrarian conflict between the Mosiem landowners and the Christian peasantry in Hercegovina now spread to the Serbs and Bulgars. A revolt of the latter people was punished with traditional Turkish severity. The Bulgarian atrocities committed by the Turks in the summer of 1876 turned public opinion in the west against Turkey still more.

A secret revolutionary society, formed at the time of Ali Pasha and called the Young Ottomans, was spreading its ideas and influencing public opinion. The great Turkish poet and patriot Namik Kemal Bey and another poet and satirist, Zia Pasha, fled to Paris and published pamphlets inciting the people to demand a constitutional government and succeeded in smuggling them into every part of Turkey. Midhat Pasha, who shared the opinions of the Young Ottomans, succeeded in winning over other members of the cabinet for constitutional change and obtained a *fetva* for the deposition of Abd ul-Aziz, who was accordingly dethroned on May 30, 1876, with the purpose of establishing a constitutional regime. A few days after his deposition he committed suicide. His nephew Murad V, Abd ul-Mejid's son, who ascended the throne, became insane after reigning three months and was deposed. Murad's brother Abd ul-Hamid, believed to be liberal, but actually reactionary, was placed upon the throne (Aug. 31).

Abd ul-Hamid II (1876–1909).—In the autumn of 1876 Russia made preparations looking toward war with Turkey. With the hope of settling peacefully the Bosnian, Serbian and Bulgarian questions, the British government of Disraeli took the initiative in calling a conference at Constantinople After assembling on Dec. 12, the conference appeared to be making progress, proposing that the Bosnian and Bulgarian areas should be given substantial autonomy under a governor-general named by the sultan and approved by the powers. But on Dec. 23 the sultan proclaimed a constitution, mainly modelled on the French system, which had been prepared by Midhat Pasha. The defeated conference dragged on for four weeks and then disbanded. Two weeks later, on Feb. 5, 1877, the sultan dismissed and banished Midhat Pasha. Russia in exasperation declared war on Turkey on April 24. The Rumanians joined Russia and Austria declared its neutrality. Public opinion in Europe was anti-Turkish, especially in England, because of the financial repudiation and the sanguinary repression of the Bulgarian revolt, and not a single voice was raised in favour of Turkey. The Turks were defeated both in Europe and in Anatolia (*see* Russo-Turkish Wars), and the Russian army reached Adrianople where both a truce and the preliminaries of peace were signed on Jan. 31, 1878. A treaty was concluded in San Stefano on March 3, 1878. Rumania and Serbia were to become independent, while Bulgaria was to become a vast principality, its frontiers reaching both to the Mediterranean and the Black sea The provinces of Kars, Ardahan and Bayazid were to be given to Russia as a war indemnity. England objected to the treaty as violating the terms of the international treaty signed in Paris and proposed a new congress. At first only Germany, France and Italy agreed, but when Austria, which was in a position to endanger the retreat of the Russian army, came in, Russia was obliged to do likewise. Turkey contracted a defensive alliance with England on June 4, 1878 at the price of leasing to that country the island of Cyprus.

On July 13, 1878, the congress of Berlin (*q.v.*) ended the Russo-Turkish conflict. It modified the treaty of San Stefano; recognized the independence of Rumania, Serbia and Montenegro; reduced the frontiers given by the treaty of San Stefano to Bulgaria and further divided the territory into two parts, one of which became a self-governing Turkish province named Eastern Rumelia. Turkey had the sanjak of Bayazid in Anatolia restored but was to pay an indemnity of 300,000,000 roubles to Russia. The most important clause of the treaty was the formal engagement of Turkey to introduce reforms in the Rumelian provinces as well as in the eastern provinces which had Armenian minorities.

Abd ul-Hamid II, who immediately after the congress engaged a number of European experts on the pretext of reorganization and reform, before long dismissed them. Apart from the occupation of Egypt by England (1881), (*see* Egypt), the chief interest of Turkish history now lies in the steps by which Abd ul-Hamid secured his predominance The power of the Porte was slowly transferred to the palace through the machinations of Said Pasha, the first secretary of Abd ul-Hamid, who before long was an absolute monarch. Midhat Pasha, the veteran reformer, was lured back by a free pardon and appointed governor of Smyrna. Before long he was arrested, charged with the death of Abd ul-Aziz, condemned, reprieved, exiled and finally executed in prison. Since the finances had become worse after the war and the payment of debts was falling into arrears, Said Pasha, now grand vizier, founded the Ottoman Public Debt administration which gave the control of the payment of debts to European delegates. By the decree of Muharrem, Dec 1881, several categories of Turkish revenue were assigned to this administration, which exercised a weighty influence in Turkish finance until 1914.

In 1885 a rising took place in the province of Eastern Rumelia, which was united to Bulgaria Turkey appointed Prince Alexander of Battenberg (the prince of Bulgaria) governor of Eastern Rumelia, a diplomatic way of accepting the annexation. Revolts in Crete had been in progress since 1890, and Greece hoped to annex the island. The series of independent non-Moslem governments which had been founded in succession within the empire raised the hopes of all the other national minorities. The Armenians in the eastern vilayets, who enjoyed freedom of education in their schools, succeeded in permeating all the Armenian communities with the desire for national independence. Two revolutionary Armenian committees, called Hinchak and Dashnaktsutiun, who were in close touch with European centres, were formed. Abd ul-Hamid's foolish patronage of the Kurdish communities encouraged them to persecute the Armenians. This, as well as the severity with which the taxes were collected, gave the Armenians two pretexts to rise in revolt in 1894. These revolts were repressed with such sanguinary measures that England and France prepared a program of reforms for the eastern vilayets and forced Turkey to accept it. No effect was given to the Turkish promises, and in 1896, when Lord Salisbury tried to enforce reform on those vilayets, the other powers would not agree to the coercion of Turkey. The Armenian revolutionaries in despair adopted a form of revolt which would force the attention of European political circles: they seized the Ottoman bank, a European institution in Istanbul The repression was once more sanguinary.

On the ground that Greece had inspired the revolts in Crete, the

Porte declared war on April 17, 1897, and the Turkish army, after inflicting a severe defeat on the Greeks, marched on Domokos. The powers, becoming anxious, intervened and ended the war. A peace was concluded which involved a slight rectification of the frontier and the payment of an indemnity of £T4,000,000 by Greece. Crete was put under international control, *en dépôt*, and much of the capitulations which benefited Greek citizens was cancelled. In 1898 Prince George, the son of the king of Greece, was appointed governor of Crete and a national assembly called. The refusal of Austria and Germany to take part in the anti-Turkish settlement of the Cretan question emphasized a new attitude of Germany toward Turkey. As a result of its apparent pro-Turkish policy Germany obtained a concession to construct the Anatolian railway and in 1899 the Baghdad line Abd ul-Hamid's preference for Germany was partly because of the friendly attitude of the German kaiser and partly because he feared the liberal influence which France and England would have over the intellectuals in Turkey.

During the latter part of Abd ul-Hamid's reign the Macedonian question became most important. The independent Balkan states carried on anti-Turkish propaganda among their own races in the Turkish Balkans and it is through this movement that the *comitadjis* appeared in the Balkans. *Comitadjis* were armed bands of political partisans, such as have at various times worked in the Balkan peninsula. Their activities caused risings and slaughter, which were avenged by equal if not greater ferocity, thus adding to Turkish ill-repute in Europe. In 1903 after the Bulgarian insurrection in Macedonia, Turkey accepted the Mürzsteg program, which was prepared by Austria and Russia: the three vilayets of Salonika, Monastir and Uskub (Skoplje) were placed under a Turkish inspector general (Husein Hilmi Pasha) who in turn was under the supervision of Russian and Austrian civil agents. The gendarmerie was given an Italian commander, and French, English, Austrian, Russian and Italian instructors. In spite of these reforms Macedonia could not be pacified and the work of the *comitadjis* went on.

Rise of the Young Turks.—The Young Turks were the successors of the Young Ottomans, who after the closing of the first parliament had worked in secret for the restoration of the constitution by means of publications and secret societies both in Europe and in Turkey, mostly among the students in the military and medical schools. From 1882 onward Abd ul-Hamid had put the press under a strict censorship and by an elaborate network of spies had abolished freedom of speech. The obscurantist educational system was preventing the spread of modern ideas, the Christian schools alone not being affected by this system. Under these conditions Talaat Bey, a chief clerk of the Salonika post office and a student of law, and Rahmi Bey, a local notable, together with a few others, had formed the Secret Society of Union and Progress on the model of the Freemason lodges, to restore the constitution. The Turkish revolutionary societies in Europe were affiliated to the Salonika society through their leader Nazim. Then, provoked by reports that Edward VII of England and Nicholas II of Russia had planned the partition of Turkey *at their meeting in Reval in June 1908*, the officers of Macedonia such as Niazi, Enver, Mustafa Kemal and Jemal Bey joined the society, bringing to it the command of an active force in *the Macedonian army. In July 1908, Maj.* Niazi first led an armed rising in Resna and the other conspirators followed. The revolt shot through the cities of the empire, and Abd ul-Hamid was informed that he had no alternative but to restore the constitution, which he did on July 24. This bloodless revolution aroused enthusiasm even among the Serbian, Bulgarian and Greek *comitadjis* and among the Armenian revolutionaries Representatives of nearly all these came to Salonika and joined the Union and Progress, which ceased to be secret after the proclamation of the constitution. It seemed for the minute as though all the different racial elements of the empire would really unite in a constitutional Turkey. But the separatist and nationalist ideals of the different races were too deeply rooted to be swept away by momentary enthusiasms. The restoration of the constitutional regime postponed the Reval program. But both Austria, which thought Turkey an obstacle to its expansion toward the Aegean sea, and Russia, which found a strong Turkey a hindrance to its plans of expansion, felt uneasy On Sept 15, 1908, the Austrian and Russian foreign ministers A L. von Aehrenthal and A P. Izvolsky (*qq v*) met at Buchlau and agreed on a partition program by which the straits were to be in the Russian zone and Bulgaria a Russian sphere of influence, Macedonia was to be in an Austrian zone and Serbia an Austrian sphere of influence, Albania was to be in an Italian zone and Greece an Italian sphere of influence Three weeks after this meeting Austria annexed Bosnia and Hercegovina (Oct. 5. 1908), and Bulgaria declared its complete independence Turkey recognized the Bosnian annexation, for which Austria paid £2,200,000 and evacuated the sanjak of Novi Pazar. For Turkey's recognition of Bulgarian independence, Russia cancelled £5,000,000 of the Turkish indemnity of 1878, expecting to recover the greater part from Bulgaria. Before long these foreign blows were followed by the recrudescence of internal conflicts. The Albanians revolted against the new regime in Macedonia, and the Kurds attacked the Turks, the Armenians and the Nestorians in eastern Anatolia In Adana the reactionaries attacked the Armenians, and Yemen rose in revolt. Izzet Pasha was sent to pacify the Yemen which he was able eventually to do by a friendly agreement with the imam Yahya (1912). The reactionary opposition in the capital incited fanatical opinion against the new regime Finally the movement passed into a military revolt on April 13, 1909. Some officers and adherents of the new regime were massacred, and parliament was raided. Abd ul-Hamid pardoned the leaders of the revolt and formed a new cabinet. In reply an army under Mahmud Skevket, sent by the Young Turks from Salonika, marched on the capital and punished the insurgents The evident desire of Abd ul-Hamid to restore absolutism led parliament to procure his dethronement by a *fetva*. His brother Mohammed V took his place

Abd ul-Hamid had tried to revive the political influence of the caliphate in the hope of retaining the non-Turkish Moslem elements of the empire. This Pan-Islamic deal was favoured by the German emperor William II who, during his visit to Jerusalem in 1898, spoke of himself as the friend of the "caliph of three hundred million Moslems." Abd ul-Hamid constructed the Hejaz railway to further the same ideal.

Mohammed V (1909–18).—Now that the government of the Young Turks was firmly established, the Committee of Union and Progress became a political party and efforts were made to stop the interference of the army in internal politics. In spite of the great losses of territory the empire over which the Young Turkish party was to rule extended from the Adriatic to the Indian ocean and from Mt Ararat to Tunis. Thirty-three years of mismanagement under the despotic reign of Abd ul-Hamid had reduced Turkey to *such a state that in any case a new government had a* difficult task; and although the Young Turks were full of patriotic zeal and well versed in western culture, they had had no experience in governing. The army was put under intensive German instruction, the navy was put under instructors led by Adm. Sir Douglas Gambles. A French expert, Charles Laurent, was engaged for the financial department, though it was Javid Bey, the minister of finance, who first succeeded in establishing a finance department on European lines. A great change took place in public works through the concessions given to European companies, which brought foreign capital into the country. In every branch a serious and fruitful activity began.

The evacuation of Crete in 1909 by the four controlling powers led to an acute difference between Turkey and Greece In 1910 the Cretans elected deputies to the Greek parliament in Athens, but Eleftherios Venizelos refused to admit them, an act which prevented war.

The Italian and Balkan Wars.—The Italo-Turkish War (*q.v.*) began in 1911. Italy, having been assured of the neutrality of the powers, gave the Porte an ultimatum of 24 hours on Sept. 28. On its rejection the Italian navy bombarded Preveza, and Italian troops landed at Tripoli and in Cyrenaica. Without a strong navy Turkey was unable to defend Tripoli, but Enver and Fethi Beys organized a defense by the natives, who were thoroughly roused,

and the invaders were confined to the coast. Rhodes and the Dodecanese were occupied in May 1912. The outbreak of the First Balkan War forced Turkey to make peace at Ouchy on Oct. 15, 1912. Tripoli and Cyrenaica were left to Italy, but the sultan was permitted to send a representative, called *nasb-i-sultan*. The fate of the Dodecanese islands was not to be decided until the Lausanne conference of 1922–23.

In Aug 1912, a faction in the army, opposed to the Union and Progress party, had brought about a change of government, and the cabinet formed was composed mostly of the members of the old regime, including Kiamil Pasha, the well-known Hamidian grand vizier Russia offered to help Turkey in case of an attack on the Dardanelles on the condition that the Russian fleet be allowed to pass the straits. The Porte refused

To stamp out the *comitadjis*, Turkey had embarked on an attempt to disarm the people in the Balkans. Greece, Serbia, Montenegro and Bulgaria in reply reconciled their conflicting interests in the Balkans and formed an alliance against Turkey (March–Oct. 1912) Turkey was unaware of this alliance for a long time, but on Oct. 8, 1912, Montenegro declared war on Turkey; and on Oct. 14, Greece, Serbia and Bulgaria issued ultimatums demanding reforms and the demobilization of the Turkish army in the Balkans Turkey declared war on Serbia and Bulgaria on Oct. 17, and Greece declared war on Turkey the next day. The political dissensions which affected the command and the organization of the army proved disastrous to Turkey, and the army was defeated, though it made a fine and prolonged defense of Scutari (in Albania), Janina and Adrianople. Adrianople was still in the hands of the Turks when the advance of the Bulgarian army was stopped at the last defenses of Constantinople, the Chatalja lines. The Turkish cruiser "Hamidie," under the command of Rauf Bey, escaped through the lines of the Greek fleet at the straits and wandered in the Adriatic, Aegean and Mediterranean, bombarding enemy ports, hampering their transports and raising Turkish morale. At the beginning of the war the powers had declared that whatever the military results of the war might be the territorial *status quo* would be maintained in the Balkans. Turkey hoped that this declaration would apply as much in the event of Turkish defeat as of Turkish victory. The powers called a conference in London after the Turkish defeat. But since the *status quo* was clearly going to be changed in favour of the Balkan states, in spite of the declaration of the powers, and since Kiamil Pasha's government was about to cede Adrianople even before that city had fallen, the Young Turks determined to seize power again. They raided the Sublime Porte and forced Kiamil to resign. A Young Turkish cabinet was formed under Mahmud Shevket. Although at first the new cabinet refused the terms of peace of the London conference, the intervention of Russia and Austria and the fall of Adrianople enforced their acceptance by treaty at London on May 30, 1913. This brought the Turkish frontiers in Europe to the line Midia-Enos.

A month later the Second Balkan War broke out, with Greece and Serbia fighting Bulgaria over the division of territory. The Rumanians, with the purpose of annexing the Dobruja, also marched on Bulgaria. This moment was seized as opportune by the Turkish army to march on Adrianople, which was recaptured. A treaty of peace was signed with Bulgaria in Constantinople on Sept. 29, by which Adrianople passed to Turkey. On Nov. 13 peace was concluded with Greece, by which it was given Crete and the rest of the Aegean islands except Tenedos and Imbros and the Dodecanese islands, the latter of which were still under Italian occupation. On March 14, 1914, peace was signed with Serbia. The net result of the series of treaties contracted with the Balkan states was the loss to Turkey of all its possessions to the west of the Maritsa river. (*See* BALKAN WARS.)

Young Turkish Policy.—Mahmud Shevket Pasha then attempted a settlement of differences with England and France. Hakki Pasha, ex-grand vizier, was sent to London to come to an understanding over the Persian gulf controversy and to negotiate for the modification of the financial capitulations Javid Bey, ex-minister of finance, was sent to France to settle the railway questions, to modify the financial capitulations and to raise a loan. But during these negotiations the opposition (the Liberal Union) murdered Mahmud Shevket, and the Young Turks passed repressive measures A new cabinet was formed under Said Halim Pasha. A military mission was brought from Germany under Gen. Otto Liman von Sanders, who was also appointed commander of the army corps in Constantinople. The navy was under the Englishman, Adm. A. H. Limpus. A detailed program of reform for the eastern vilayets was prepared. As the powers refused to provide experts, inspectors were engaged from Sweden; the ministry of the interior, however, employed British inspectors.

The policy of the Young Turks had begun by being a policy of "Ottomanism," which aimed at uniting all the racial and religious elements of the empire The risings in Macedonia had proved that the nationalism of each element, encouraged by outside powers, could not be assimilated by such a weak state as Turkey. Turkey through the Balkan War lost its Albanian, Bulgarian, Serbian and most of its Greek subjects, and the Arabs, incited by France, also manifested separatist tendencies, although to give the right to use Arabic officially in the courts in Arabia was the only decentralizing measure the Young Turks had taken. The failure of Ottomanism was followed by the revival of Abd ul-Hamid's Pan-Islamist policy, a decision encouraged by the sympathy which the Indian and the Egyptian Moslems had shown during the disasters of the Italian and Balkan wars. It was this Pan-Islamism which later led the Young Turks to proclaim jihad (holy war) in the hope of influencing the Moslem combatants in the Allied armies during World War I. This revival was led by Enver Pasha; it was opposed, in the name of pure nationalism by a larger group led by Ziya Gokalp, the poet and philosopher, who was helping the cultural-nationalist institutions called the "Turk Yurts" and the "Turk Ojaks" (opened 1912). The influence of Turkish refugees from Russia caused the nationalism of the Union and Progress party to take a Pan-Turanianist form

The disagreement between England and Germany over the Baghdad railway and that between France and Germany over their respective railway spheres were settled by two agreements signed in Feb. 1914 between France and Germany and in June between England and Germany.

World War I.—In 1913 Enver Pasha, formerly Enver Bey, became minister of war. His policy was to give the high commands in the army to younger men. The military organization continued to be under the German mission. There were secret negotiations between Germany and Turkey known only to the grand vizier Prince Said Halim Pasha, Talaat Bey and Enver Pasha. A secret alliance was signed on August 2, 1914, when war was breaking out between Germany and Austria on one side and England, France and Russia on the other. Turkey declared its neutrality but mobilized at the same time. There were war and antiwar factions in the party. The antiwar faction tried to come to an understanding with the Allies, declaring that Turkey would remain neutral if the financial capitulations were modified and a loan granted. Javid Bey, the minister of finance, was at the head of the antiwar faction. The Allies made no promises, but they demanded the dismissal of the German commanders and the expulsion of the crews of two German cruisers which had taken refuge in the Dardanelles. The British government commandeered the two Turkish dreadnoughts which were then being constructed in England with the money raised by popular subscription, an act which, though legal, caused surprise and resentment And when Germany offered the warships "Breslau" and "Goeben" to the Turkish navy the antiwar faction was weakened. The war faction argued that Turkey had lost by its political isolation since the Crimean War, that it should join Germany who was fighting against the hereditary enemy of Turkey, tsarist Russia, and that should Turkey become victorious, it might become free from the capitulations and even regain some of its lost territories. On Sept. 8, 1914, Turkey declared the capitulations abolished, which raised protests from all the powers, including its ally Germany. When the two German warships, which had become units of the Turkish navy though still under German command, attacked Russian ships and ports in the Black sea, Russia declared war, and England and France did the same. Turkey thus found itself at war with the

Allies on the Egyptian, Mesopotamian and Caucasian frontiers as well as at the Dardanelles (*see* DARDANELLES CAMPAIGN; MESOPOTAMIA, OPERATIONS IN; PALESTINE, OPERATIONS IN). The Dardanelles were successfully defended by Turkey, but the Russians took Trebizond, Erzurum and Erzanjan and marched toward Sivas; while Turkey failed in its attack on the Suez canal and the British took Mesopotamia including Baghdad. During the Turko-Russian battles on the Caucasian front, the Armenians created disturbances behind the Turkish lines and threatened to cut the lines of communications. The Turkish government began early in 1915 a general deportation in which atrocities were committed on a large scale. When Gen Antranik, the Russo-Armenian general, entered eastern Anatolia, the Armenian soldiers under his command (so-called "Christian Army of Revenge") replied by similar atrocities, though on a far smaller scale. As Turkey had mobilized to its utmost limit it became almost impossible to sustain the army, the civil population suffered privation hitherto unknown; martial law was proclaimed everywhere. The Communist Revolution led Turkey and its Allies to conclude a peace treaty with Bolshevik Russia at Brest-Litovsk, March 3, 1918, by which all its lost territory was restored to it (even those districts which it had ceded to Russia in 1877). But the Arab nationalists, supported by England, drove out the Turks from Hejaz, except from Medina The British army occupied Syria. On Oct. 30, 1918, an armistice was signed at Mudros, on the British warship "Agamemnon," between Adm. S A. G Calthorpe and Rauf Bey, the Turkish minister of marine. Although the armistice aimed at ending World War I, it did not end yet for Turkey who had to fight for four years more actually against Greece though virtually against the Allies themselves

During the war secularization in education and other departments had taken place. The university had been extended and its principal chairs were occupied by German professors. The Sheria courts were taken from the sheikh ul-Islam and given to the ministry of justice. A family law issued in 1916 reformed marriage and divorce regulations. Women, who already had equal education with men, now filled public posts, and the university opened its doors to them.

Mohammed VI (1918–22).—Mohammed V had died in July 1918 and had been succeeded by his brother Vahid ed-Din, who took the name of Mohammed VI. In the early months of the reign the Turks welcomed the armistice as being the end to the great suffering of long years. But they soon forgot this suffering in the humiliation and persecution to which they became exposed The Allied fleets and armies occupied the straits, Istanbul and even places outside the armistice line, and the terms of the armistice were stretched to the point of violation. Under these conditions the Turks had a bitter foretaste of the peace that they would receive at the hands of the Allies. Both in Istanbul and in the provinces, officers and intellectuals met in secret and began to discuss how to secure a tolerable peace, and as the nationalists appeared in the forefront of the general reaction against the Allies this agitation received the general name of the "nationalist movement." Meanwhile the Allies could not come to an agreement among themselves over the Turkish peace. Finally, on May 15, 1919, the Greek army was landed in Smyrna under the protection of the British, French and U.S. fleets, and the Greeks inaugurated their occupation by massacres committed in full view of the Allied fleets. (Italy, having retired from the peace conference for the moment, did not take part. By the interalhed agreement of St. Jean de Maurienne in 1917, Smyrna and Adalia had been apportioned to Italy, and Italy had landed troops in Adalia in April 1918.) The Greek landing in Smyrna aroused general indignation in Turkey which ended in the national determination to resist to the last, even if this meant total disintegration. Mass meetings in Istanbul were the first manifestation of this feeling.

The National Pact.—Meanwhile Turkey was in a state of anarchy. The responsible leaders of the Union and Progress party had escaped to Germany, and the party was dissolved. Mohammed VI, a personal enemy of the Young Turks, forced Izzet Pasha's cabinet, which to some extent was able to keep order, to resign, and the Liberal Union came into power. Certain nationalist leaders wanted to save the country from disintegration by cooperating with the sultan and using his prestige as sultan-caliph. Among these was Mustafa Kemal Pasha. But Mohammed VI preferred to sacrifice the existence of his nation to his personal security, and this he did by bringing Damad Ferid Pasha into power and, through him, giving the reins of the government to the high commissioners of the Allies. In western Anatolia organizations for a national defense against the Greek invasion were rapidly arising. In eastern Anatolia, especially in Trebizond and Erzurum, associations, under the guidance of Kiazim Kara-Bekir Pasha, were preparing to oppose any attempt of the Allies to create an Armenia out of the territories which, even before the deportations and atrocities, they claimed to have been predominantly Turkish. The sultan with the Allies' assent, in order to control these organizations and disperse them if necessary, sent Mustafa Kemal Pasha to eastern Anatolia as the military inspector general Kemal reached Samsun four days after the Greek landing at Smyrna But as he was already in correspondence with these organizations, he met Rauf Bey, Ali Fuad Pasha and Col. Refet at Amasia on his way to Erzurum and signed the Amasia protocol on June 19, 1919; Kiazim Kara-Bekir Pasha also signed by telegram This protocol is the first document that formally declared the national determination to resist both the Allies and the sultan, as the instrument of the Allies. A national congress assembled in Erzurum, on July 23, 1919, and Mustafa Kemal Pasha, having resigned from the army, presided. Another congress assembled in Sivas on Sept 4, 1919, to which the national associations of western Anatolia sent representatives. This congress reaffirmed the decisions of the Erzurum congress, added plans for the defense of Eastern Thrace and chose a representative body to control the movement in Anatolia. No president was chosen, but Mustafa Kemal Pasha's leadership was generally recognized. This manifestation of the national will forced the sultan to dismiss Damad Ferid Pasha. A new cabinet with nationalist tendencies came into power. In Jan. 1920 a new parliament assembled in Istanbul, containing a nationalist majority. The parliament issued the national pact as accepted by the two congresses

This national pact formulated the demands which the nationalists made during the whole struggle, and which they obtained eventually at Lausanne. It proposed self-determination for the Arab provinces south of the armistice line; it agreed to the opening of the straits to commerce and it proposed to grant to non-Turkish minorities the same rights as they had secured in Europe under various postwar treaties. The pact also demanded, either explicitly or implicitly, that Turkey should retain all territories inhabited by non-Arab Ottoman Moslem majorities, which meant not only Anatolia but eastern Thrace and the Mosul vilayet; that Istanbul should be given military security; that the capitulations should be abolished and that there should be a reasonable settlement of the public debts.

The Allies were watching with some anxiety the nationalist activities, which consisted mostly of smuggling in arms and ammunition and organizing the defense. Mustafa Kemal Pasha stayed in Anatolia to conduct these activities. The Allies, in conjunction with the sultan and the Liberal Union party, decided to strike at the nationalist movement through the persons of the leading deputies and intelligentsia in Constantinople. On March 16, 1920, the Allied forces in the capital seized a large number of nationalists, including Rauf Bey, the leader of the nationalist party in parliament, and Kara Vasif Bey, the head of the nationalist organization in Constantinople, arresting them in the parliament house itself. Parliament was then closed by the orders of the sultan. Some deputies and a few of the intelligentsia escaped to Ankara, which had become the nationalist centre.

The Ankara Government.—Mustafa Kemal Pasha had issued a proclamation inviting Anatolia to elect its deputies for a new assembly, which was opened in Ankara on April 23, 1920. Mustafa Kemal Pasha was elected president both of the assembly and of the government. Thus came into existence a new Turkish government over all territories not under foreign occupation. A new temporary constitution, known as the Law of Fundamental Organization, proclaimed the sovereignty to belong to the nation without restriction, and the great national assembly to be the sole

and lawful representative of the nation, exercising sovereignty in its name. But Mustafa Kemal Pasha tried to make use of those who were still loyal to the sultan by declaring in his speeches that the sultan-caliph was a prisoner in the hands of the Allies and that he would be restored after the realization of the national ideal The government of Istanbul, controlled by the Allies, condemned the leading nationalists to death by extraordinary courts and issued a *fetva* denouncing them as outlaws. The Anatolian government retaliated similarly. The sultan's government sent forces under the name of the caliphate army and roused counterrevolutionary outbreaks around Ankara, which, however, were put down by the nationalists When the Allies found themselves embarrassed by the nationalist success, they accepted the offer of Venizelos that the Greek army should advance beyond the area allotted to it in order to deal with the nationalists. In the months of June and July 1920 the Greek army occupied eastern Thrace and marched on to Bursa and Ushak. On Aug. 10, 1920, the Allies concluded the treaty of Sèvres with the sultan's government in Istanbul which aimed at destroying the independence of Turkey. In Europe, eastern Thrace nearly as far as the Chatalja lines, including Gallipoli, was assigned to Greece; and provisionally Greece was also given Smyrna and a zone around it A tripartite agreement between England, France and Italy laid out French and Italian spheres of influence in parts of those Anatolian territories which under the peace treaty were nominally left to Turkey. The outlines of the Armenia which was to be formed in eastern Anatolia were left to Pres. Woodrow Wilson to define. The treaty strengthened the nationalist cause by arousing unanimous indignation. The British forces in Eskushehir withdrew under the pressure of Ali Fuad Pasha's forces In Cilicia and Aintab the nationalist forces were struggling successfully against the French army.

The continual raids by the Armenians of the Armenian republic on the Turkish frontier villages, as well as the necessity for a direct route to Russia, led Turkey to attack the Armenian republic. The Turkish army captured Kars and Alexandropol, and a victorious peace was concluded with Armenia at Alexandropol on Jan. 3, 1921. A Turkish delegation sent by the Ankara government signed a treaty of friendship with Russia by which Russia became the first country to recognize that government. The Menshevik government of Georgia was overthrown, and Turkey with the consent of Georgia occupied Ardahan, Artvin and Batum. When the Caucasian republics were federated to Russia, a treaty signed in Kars Oct. 16, 1921, between Russia, the government of Ankara, and the three Caucasian republics, left Kars, Ardahan and Artvin to Turkey and restored Batum to Russia.

The defeat of Venizelos in the general elections in Greece and the return of King Constantine alienated the Allies, especially France The Greek army in Anatolia started a new offensive, but was twice checked by the Turkish army at Inonu (January–April 1921). The Allies called a conference in London to which representatives of both the government of the sultan and the government of Ankara were invited (January–February 1921). At this conference it became clear that the Allies realized the necessity of amending the treaty of Sèvres: the Ankara delegates initialled agreements with the French and Italian governments which were not accepted by Ankara. These agreements nevertheless were the first signs of the difference of opinion between the Allies on the Turkish question The Allied high commissioners at Istanbul as a result of this dissension announced the neutrality of their governments on May 18, 1921, and designated neutral zones forbidden to the belligerents on each shore of the Bosporus and the Dardanelles On July 10, 1921, the Greek army once more passed to the offensive and drove the Turkish army east of the Sakariya. At the suggestion of a commission of inquiry sent by the great national assembly to the front, Mustafa Kemal Pasha was now appointed generalissimo. He fought during 20 days the decisive battle of the Sakariya, after which the Greeks retired westward As a reward he was made marshal and was given the title of *ghazi* by the great national assembly.

Henri Franklin-Bouillon was delegated by France to negotiate an agreement which was signed in Ankara on Oct. 20, 1921. It recognized the Ankara government and traced the Turko-Syrian frontier, as later reaffirmed in the Lausanne treaty. On March 24, 1922, the Allies intervened in common to propose a truce between Turkey and Greece, but the Turks declared that they could only negotiate after the evacuation of Anatolia. However, the Ankara government sent to Europe first Yusuf Kemal Pasha, the commissary of foreign affairs, and then Fethi Bey, the commissary of the interior, to seek a peaceful solution. Fethi Bey arrived in London with especially conciliatory proposals, but during his three weeks' stay was not received by any cabinet minister. The Ankara government concluded that the question could be settled only by force of arms. The Greeks, to raise their morale, demanded permission to occupy Istanbul, which the Allies refused. On July 30, 1922, Aristeides Stergiadis, the Greek high commissioner in Smyrna, proclaimed the autonomy of the Anatolian territory under Greek occupation, apparently with the intention of continuing the Anatolian war in the guise of a local Greek national movement, in case the Greek army should be compelled by diplomatic pressure to evacuate Anatolia. The Allies proclaimed their neutrality for the second time on August 10, 1922, by the decision of the supreme council of war

The Turkish offensive began on Aug. 26 and the Greek army was completely routed. On its way from Ushak to Smyrna, it burned to the ground the most prosperous towns in the west of Turkey, and atrocities were committed on a large scale. Nearly a million people were made homeless. The Turkish army entered Smyrna on Sept. 9, and masses of the native Christians left the town in great disorder. The central part of the town was burned on Sept. 13.

The annihilation of the Greek army produced a dangerous situation. At first England and France agreed to act in concert in case of necessity by opposing any Turkish violation of the neutral zones. On Sept. 16, David Lloyd George further announced that the British dominions, Yugoslavia and Rumania had been asked to promise military support for maintaining the freedom of the straits. This announcement incited the Turks to action, both by its threatening tone and because it contained no reference to the nationalists' territorial demands in Eastern Thrace. In consequence the Turkish army advanced toward the neutral zone. France and Italy withdrew their troops, and Franklin-Bouillon was sent to Smyrna from Paris to mediate with Mustafa Kemal Pasha and so arrest the march of the Turkish army. The British troops remained alone. On Sept. 23, Lord Curzon came to an agreement with M. Poincaré which accepted the British view regarding the temporary question of the neutral zones and the French view regarding the definitive peace terms. On the same day, in accordance with this agreement, the principal Allied powers invited the Ankara government to a peace conference on two bases: that Turkish sovereignty should be restored in Thrace up to the river Maritsa, and that during the interim period, pending the negotiations and entry into force of the peace treaty, the inviolability of the neutral zones should be maintained. Meanwhile the Turkish cavalry had advanced almost up to the British wire at Chanak, and only the tact and firmness of Gen. Charles Harington, as well as his desire to prevent war, averted a disaster. The nationalists accepted the Allied invitation and suggested a preliminary conference on Sept 29. On Oct. 13 a military convention was signed at Mudania between the Ankara delegates, the Allied generals in Istanbul and Greek representatives.

The Allies had also invited the sultan's government to the peace conference. Tewfik Pasha, the last grand visier of the Ottoman empire, wrote to the great national assembly proposing joint action, and this made it necessary for the assembly to face the dilemma of having two governments in one country. In consequence the caliphate was separated from the sultanate, the sultanate was abolished, and the sovereignty of the nation without any restriction, already inserted in the new constitution, was reaffirmed on Oct. 1, 1922. It was decided, however, to keep the caliphate in the house of Osman. The governmental departments in Istanbul then passed to the Ankara government, which formality was accomplished by Refet Pasha, that government's high commissioner for Thrace Thus the house of Osman, which had reigned for seven centuries, came to an end through the treason of its last

sultan, Mohammed VI, and for the first time in its history Istanbul was no longer the capital of the state to which it belonged On Nov. 17, 1922, Mohammed VI took refuge in the British warship "Malaya" and escaped to Malta. The commissary of Sheria deposed the refugee caliph by a *fetva* and elected Prince Abd ul-Mejid, the son of Abd ul-Aziz, as caliph. The new caliph recognized the sovereignty of the great national assembly and gave up his claims to the sultanate by a written document. This was the last time the Turks used the *fetva*

The Treaty of Lausanne.—The Lausanne conference met on Nov. 20. 1922, and after a recess from Feb. 4 to April 23, 1923, signed a peace treaty on July 24. By it the Turks procured the demands they had put forward in the national pact, except that concerning Mosul. The capitulations were abolished. To realize racial unity in new Turkey the Orthodox Greeks in Anatolia were to be exchanged for the Moslem Turks in Greek Macedonia; the Greeks of Istanbul and the rest of the Christian minorities were to have the same rights as were secured to other minorities in Europe under the postwar treaties. The tracing of the frontier with Iraq was to be discussed between England and Turkey at a future date and if necessary to be submitted to the League of Nations. Turkey also concluded treaties with the U.S. and Poland which restored diplomatic relations with these countries.

(A. A. A.; G. L. L.)

THE REPUBLIC

The Ottoman empire, which had tried to end the war in 1918 by the armistice of Mudros, was no more. The Turks, principal element of the defunct empire, had created a new independent Turkish state. The new Turkey had abolished the capitulations and contracted treaties with all the other states. Released from external troubles, it was free to begin a new era of progress and reconstruction. The new constitution was not complete, and the position of the president of the national assembly, who was the head of the state at the same time, was vague. Taking advantage of this, during a difficulty in forming a new council of commissaries, Mustafa Kemal Pasha proposed a constitutional amendment by which Turkey would become a republic (Oct. 29, 1923) This amendment was accepted, and Mustafa Kemal Pasha was elected the first president of the Turkish republic. Ismet Pasha, his right hand man, formed a cabinet.

Mustafa Kemal's Presidency.—Mustafa Kemal Pasha accepted the clause in the new constitution which declared the state religion to be Islam. But there was a growing conviction that radical reform would be possible only after freeing the state from religion. Turkey after adopting the republican form of government was determined to complete the partial secularization of the preceding regime and to prevent all interference by religious influence, which was regarded as having been the principal obstacle to modernization The clause in the constitution declaring Islam the state religion and the position of the *jainéant* caliph were accordingly the first objects of attack. On March 3, 1924, the great national assembly passed three laws at one sitting: (1) expelling the Ottoman dynasty; (2) abolishing the caliphate, the commissariat of *sheria* (the recognized office for the religious affairs) and *evkaf* (pious foundations) and (3) attaching all the educational and scientific institutions, including the *medresses* (religious colleges), to the commissariat of public instruction. By these laws the Turkish republic put an end to Pan-Islamism in Turkey and also paralyzed the Khilafat movement in British India. The most important step in secularization was the clause of one of the three laws which withdrew the civil transaction section of the *sheria*, which so far had dominated the Turkish code through the *mejelle* (Turko-Islamic code). The dispatch of all concerns and cases which related to dogma and religion passed to an office called the presidency of religious affairs. Thus for the first time Turkey tried to separate religion from the state. Of the two classes, the ulema and the military, which had dominated the Turkish state, the ulema were no more. The military, from the time of the *tanzimat*, had nominally ceased to interfere in internal politics. But in spite of the deposition of Abd ul-Aziz (1876), the re-establishment of the constitution (1908) and the nationalist movement (1918) were all brought about through the army. And although during the last and most important changes of regime, including state secularization, military influence was not obvious, the force behind the throne in the Turkish state was still the army A month before the passing of these laws Mustafa Kemal Pasha assembled the commanders of the army in Smyrna and discussed these questions with them, thus diplomatically shifting the responsibility to the shoulders of the army in case of any public opposition. A new constitution which was extremely democratic in form was adopted on April 20, 1924. To win over the peasantry, who constituted the majority and who did not regard these radical measures favourably, the tithes, which lay heavily on the agricultural classes, were abolished and military service was reduced to 18 months. The deficit in the revenue resulting from abolition of the tithes was met by a heavier taxation of the urban population.

Although constitutionally the natural sovereignty was in the hands of the national assembly, Mustafa Kemal Pasha, through his personal prestige won in the field and through his hold over the army, showed decided tendencies toward a personal dictatorship. This created an opposition under Rauf Bey and Kiazim Kara-Bekir Pasha, which attempted to keep the republic on a democratic and liberal basis and was called the Republican Progressive party (Nov. 1924) Ismet Pasha's cabinet fell and Fethi Bey, a liberal and moderate statesman, formed a new cabinet. The Kurdish provinces revolted because they resented the extreme centralization and the harsh measures of the government in carrying out new reforms and because of the separatist tendencies of some of the leading chiefs. Mustafa Kemal Pasha seized this as a pretext to strike at the opposition. Pretending that the liberal clause in the Progressive program which advanced liberty of conscience had encouraged this rising, he forced the Fethi Bey cabinet to resign, on the ground that it had refused to carry out drastic measures in the peaceful parts of Turkey. Ismet Pasha formed a cabinet for the second time. The law of maintenance of order was passed.

With the passing of this law, the tribunals of independence, which had functioned during the nationalist struggle against the antinationalists, were revived. The opposition party was suppressed. The freedom of speech which the new constitution had accorded to the Turkish nation was evaded through the very vague terms of the law. Mustafa Kemal was able to establish his dictatorship, despite a very democratic assembly, by the absence of any clause in the constitution which would place the president of the republic above parties. Therefore he, as the active president of his own party, could wield unbounded power. The Kemalist party (People's party), like Abd ul-Hamid and the Committee of Union and Progress, believed that the Turkish nation was not yet ready for a liberal regime. Although the Kurdish insurrection was put down by tribunals and military operations, the disturbances continued in Van, Bitlis and Diarbekr and led the republic to begin a partial deportation of the Kurds. The religious orders were abolished and the *tekkes* (monasteries) were closed as having influenced the Kurdish rising. A decree ordered the army to adopt a kepi and the civil servants to wear hats A law passed in Nov. 1925 abolished the fez and obliged everybody to wear hats (women were not included). This law provoked several counterrevolutionary risings in the eastern provinces, which the tribunals suppressed by death sentences and imprisonments. On Feb. 17, 1926, the assembly adopted a new civil code which was almost a translation of the Swiss. By the adoption of this code Turkish legislation was wholly freed from Islamic influence. The laws concerning marriage, divorce and inheritance, which had been totally different from those of the west, were altered, and polygamy was legally prohibited. This radical secularization led the non-Moslem minorities to renounce of their own accord the minority rights which they had procured at the Lausanne conference The secular republic had now only two points of contact left with religion: the clause in the constitution which stated that the religion of the state was Islam, and the law which attached the presidency of religious affairs to the prime minister's office. The former of these was broken on April 9, 1928, by an amendment to the constitution.

On the pretext of a conspiracy against Mustafa Kemal Pasha's life, "discovered" in the summer of 1926, all the members of the

suppressed opposition party, both in and out of the assembly, as well as the leading members of the Union and Progress party, were arrested by the tribunal of independence. At the trial political opponents were assumed to be conspirators by the mere fact of their being in the opposition. Kiazim Kara-Bekir Pasha, Ali Fuad Pasha and Refet Pasha were acquitted by the pressure of the army. Several members of the assembly, whose parliamentary immunity was violated and who had been in the forefront of the nationalist movement, were executed. Javid, the foremost Turkish financier, Shukri, Nazim and Janpoulant, all ex-ministers of the Unionist regime and some of them deputies, were also executed The ex-prime minister Rauf, who was in Europe at the time, was condemned to ten years' imprisonment.

A decree of 1928 discarded the Arabic alphabet for the writing of Turkish and imposed the Roman instead. This change was in accordance with the policy of modernizing the language itself and freeing it from its dependence on Arabic and Persian.

The year 1930 saw two advances in Turkey's political life: women received the vote for municipal elections; and on Aug. 13 the former prime minister, Fethi Bey, formed an opposition group, the Liberal Republican party. In the municipal elections of the same year his party polled about 25% of all votes, women were for the first time elected, and the Greek, Armenian and Jewish minorities presented their candidates. But by the end of the year the opposition party was dissolved.

Turkey did not escape the economic depression of the early 1930s. But that adversity did not arrest—although it curtailed—the economic reconstruction of the country. This was fostered by the formation of a number of state banks, to each of which was delegated the establishment and control of state industrial and mining enterprises and public utilities. A long-term credit of $8,000,000 was negotiated with the Soviet government for the acquisition of Russian cotton-spinning machinery. Many occupations, until then mostly exercised by foreigners, were reserved for Turks—partly to promote their education in trade and commerce. In 1932 a five-year industrial plan was promulgated and an important program of economic and educational reforms was launched. The metric system was adopted; and English replaced French, Arabic or Persian as the principal foreign language to be taught in the schools.

On Dec. 6, 1934, the great national assembly changed the constitution so that all Turkish men and women were henceforth entitled to vote in legislative elections as soon as they had reached the age of 23 and to become elected at the age of 31. At the same time it was also decided that the president was to be elected from among the deputies, his term of office being identical with the life of the assembly. During 1935 women were for the first time elected to the great national assembly. The international women's congress met at Istanbul in April of the same year. Sunday was introduced (in place of Friday) as the weekly rest day. The old Turkish titles—such as pasha—were abolished; and family names were introduced, as in the west. Mustafa Kemal received the surname of Atatürk; the premier Ismet, that of Inönü. On Feb. 5, 1937, the assembly accepted the six principles of the Republican People's party—republicanism, nationalism, democracy, evolutionism, separation of state and religion and state supervision of the principal industries, public utility services and means of communication.

In Oct. 1937 Ismet Inönü, who had been prime minister for almost 15 years, resigned and was replaced by the former minister of economic affairs Celal (Jelal) Bayar. After the death of Kemal Atatürk on Nov. 10, 1938, at the age of 58, Inönü was elected president of the republic.

Foreign Affairs.—On May 19, 1924, a conference assembled in Istanbul to trace the Turko-Iraqi frontier, which had been left over by the Lausanne conference. No result was achieved and in accordance with the decision of the Lausanne conference, England and Turkey submitted the question to the League of Nations. On Dec. 16, 1925, the League decided to give most of the vilayet of Mosul to Iraq. To this the Turks would not at first consent. A treaty of mutual neutrality was concluded on Dec. 17 for three years with the U.S.S.R. Turko-Soviet relations, which had become distant since the Lausanne conference, once more became very close. The *Turk* [illegible] was not mitigated [illegible] stating that Turkish [illegible] Germany. [illegible] no Pan-Turanian [illegible] overnme[illegible] British, Turkish and [illegible] signed a treaty on June [illegible] Iraq with a slight rectification [illegible] for a period of 25 years from [illegible] the Iraqi government was [illegible] received from the expiration [illegible] 1926, a treaty of neutrality [illegible] treaty of perpetual peace and [illegible] istan on May 27, 1928, and a [illegible] tion with Italy on May 30, [illegible]

In 1930, after an exchange of [illegible] and arbitration were signed [illegible] co-operation between Greece and [illegible] also maintained with the Soviet [illegible] and Balkan conference met in [illegible] delegates from Albania, Bulgaria, [illegible] Turkey attending. In July 1932 [illegible] and at about the same time [illegible] Britain and France. A further step [illegible] on Feb. 9, 1934, when under Turkish leadership a Balkan entente —which included Rumania, Yugoslavia, Greece and Turkey (but not Bulgaria) was established. In Nov. 1935 the existing treaties with the Soviet Union were prolonged for a further ten years. The treaties with Iran, Iraq and Afghanistan were consolidated by the signing, at Saadabad on July 9, 1937, of an Asiatic pact of nonaggression with those states.

The rapprochement with Great Britain became more marked in 1936. Turkey promised to co-operate with Great Britain in case of a conflict with Italy in the Mediterranean; and a conference at Montreux removed (with British support) the limitations imposed upon Turkey by the treaty of Lausanne in respect of the militarization of the straits. The visit of King Edward VIII to Istanbul still further strengthened Anglo-Turkish relations.

By an agreement with France of July 3, 1938, the district of Alexandretta was established as an autonomous part of Syria, but conforming in most respects to the order prevailing in Turkey. It received the name Hatay, after the ancient Hittites, regarded by the modern Turks as their ancestors. In less than a year Hatay was ceded wholly to Turkey, at the signing of the declaration of mutual assistance with France.

World War II.—As president, Ismet Inönü followed, on the whole, the constructive and cautious policy of his predecessor. But his cabinet was soon faced with the imminence of war in Europe. In view of this crisis Turkey signed declarations of mutual assistance with Great Britain (May 12, 1939) and France (June 24), aiming at the maintenance of peace in the eastern Mediterranean.

Turkey's position seemed secure because of its friendship with the western democracies on the one hand and with the Soviet Union on the other. Turkey might indeed have become the connecting link between these two camps, both of which were then opposed to German aggression. But the pact of friendship between the Soviet Union and Germany of Aug. 1939 profoundly altered Turkey's position. Turkey tried to maintain its friendship unchanged, and the Turkish foreign minister visited Moscow in the autumn, but without result. On Oct. 19, therefore, Turkey concluded a treaty with Great Britain and France, and a series of staff talks between the general staffs of the western democracies and Turkey began. Turkey was unable however, to transform the Balkan entente into a military alliance.

Italy's entrance into the European war in May 1940 extended the area of the conflict into the eastern Mediterranean and thus created for Turkey a *casus foederis*. But the downfall of France and the complete uncertainty of the future of Great Britain made Turkey hold back. Although Turkey made every effort to increase the strength of its army it was largely a bayonet army, inadequately equipped with modern aircraft and armour. President Inönü, therefore, adopted a policy of neutrality. Nevertheless, although Turkey did not enter the war as an active ally of Great Britain, it continually stressed its solemn intention of remaining

faithful to the alliance.

It was expected that Turkey would enter the war actively if the security of the straits or of the near eastern oil fields were threatened, or if Bulgaria and the Greek region of Salonika—which Turkey regarded as her security zone—were invaded Accordingly, in Jan 1941, Anglo-Turkish staff talks were held in Turkey and the British foreign secretary Anthony Eden visited the country But fear of German military superiority kept the Turks inactive when the time for action came Thus, when the German army occupied Bulgaria at the beginning of March, Turkey did not move, nor did it come to the help of Greece and Yugoslavia when they were attacked by Germany. The German conquest of Greece and the occupation of the Greek islands in the Aegean sea in the spring of 1941 isolated Turkey strategically and made its participation in the conflict impossible for the time being. By the end of 1941 the war had come near to Turkey on all sides. Bulgaria was in it on the side of the axis. Greece was completely occupied by Bulgarian, Italian and German forces Greek and Italian islands held by the axis were being equipped for fighting. Syria, Iraq and Iran were thoroughly controlled by Great Britain, Free France and the U.S.S.R. The Balkan entente and the Asiatic pact had gone, and the Anglo-Franco-Turkish treaty for mutual aid was uneasily asleep Turkey sat alone—a small neutral buffer state in the midst of mighty antagonists.

In general Turkey had nothing to lose and everything to gain by a policy of neutrality. It held no colonial territory and desired no extension of boundaries. Its economic surpluses were eagerly sought by both sides Participation in the war would have meant heavy expense and renewed depletion of its manpower. During almost five years of World War II, therefore, Turkey maintained a firm and scrupulous neutrality. No concealment, however, was made of a determined intention to resist with all resources any invasion of its territory The danger of invasions by axis forces was certainly great: in fact, Hitler's choice in June 1941 to attack the U.S.S.R. rather than to overwhelm the middle east probably saved Turkey from terrible disaster. A German drive might have rolled with comparative ease across Turkey to Egypt and the Persian gulf, to join forces with Japan in southern Asia. This danger was averted, but it was not removed so long as Germany was active in North Africa and advancing toward the Caucasus and Iran. But the resounding defeats of El Alamein and Stalingrad remove the "pincers" threat, and after Jan. 1943 Turkish fear of Germany diminished rapidly.

Under the circumstances Turkey's neutrality was convenient to both sides. The Germans, while fighting in the U.S.S.R., could feel secure against a thrust from the southeast. The Allies on the other hand possessed a neutral barrier on the north while they strengthened themselves in Egypt and improved the roads across Iran for transporting supplies to the Soviet Union. In particular, Turkey protected the Anglo-Iranian oil fields, which were of vital consequence to the whole eastern war.

In the midst of its tribulations the Turkish government had thought best to sign a two-year nonaggression pact with Germany on June 18, 1941, only four days before the German attack on the U.S.S.R. This was followed on Oct. 9, after much haggling, by a commercial treaty. products to the value of £T100,000,000 on each side were to be exchanged during 1943 and 1944; Germany was to deliver to Turkey war material to the value of £T18,000,000, and in exchange Turkey agreed to provide Germany with 90,000 tons of chrome ore per year. Great Britain and the United States offered counter proposals: on Dec 3, lend-lease advantages were promised to the Turks, and in March 1942 a first large shipment arrived During the course of the war the Anglo-Saxon countries continued to provide Turkey with war material, naval vessels, locomotives, railway cars, wool, cotton yarn, mining machinery and foodstuff (military preparedness had caused shortages of foodstuffs by removing men from the farms). The supplies entered Turkey mainly at Mersine and Alexandretta, ports which were improved by wharves and jetties. While the western nations steadily increased their support of Turkey, Germany was less and less able to fulfill its promises and was reported to have received only 25,000 tons of chrome ore during 1943, paying four times the prewar price for it.

Relations with the Soviet Union were disturbed after an attempt in Feb. 1942 to assassinate the German ambassador Franz von Papen. Among 50 persons arrested five were Russians Two of the latter—employees of the Soviet consulate in Istanbul—were convicted on June 17

In July Shukru Saracoglu, who had long served successfully as Turkish foreign minister, became premier. In Feb 1943 a new great national assembly was elected. Meeting in March, it re-elected Ismet Inönu as president for four years The president conferred at the end of January with the British prime minister Winston Churchill at Cairo. He returned there in December to meet Churchill and Pres. Franklin D. Roosevelt. Both conferences appeared to be very cordial, but no visible changes of Turkish policy ensued

The heavy war expenditure strained Turkish finances seriously. To meet the deficit a law of Nov 11, 1942, created a form of capital levy tax called the *varlik vergisi*, the penalty for nonpayment was forced labour in the eastern provinces. The tax was fairly levied upon Moslem Turks and foreigners but it was unjustly and ruthlessly applied in the case of Jews, Greeks and Armenians of Turkish nationalty—against whom considerable feeling had been aroused because of their alleged war profiteering. Within six months more than £T300,000,000 had been collected.

The year 1944 brought increasing successes to the Allies and discomfiture to the axis; and Turkish policy responded cautiously to the change. In January the Japanese Domei correspondent was expelled. In May a Pan-Turanian and fascist plot was uncovered in Istanbul; many arrests were made and martial law was proclaimed. In March, however, relations with Great Britain became strained because Turkey was still shipping chrome ore and other products to Germany and manifested no intention of joining in the war. Great Britain, therefore suspended shipments to Turkey of munitions and foodstuffs. In justification of its inaction Turkey claimed that it had not received the quantity of war material which had been promised

Not until Aug. 2, 1944, did Turkey yield to pressure from the United Nations to fulfil its treaty obligations, and then it only broke off relations with Germany. Promptly thereafter German representatives left Turkish soil and commercial exchanges came to an end. Turkey, however, still refused to declare war and join in the final grand assault in Germany It did not, indeed, make the formal declaration until Feb. 23, 1945 after the Allies had announced that only those states which had done so would be invited to take part in the United Nations conference at San Francisco.

Internal Affairs after World War II.—The collapse of the Nazi regime and the close association of Turkey with Great Britain and the U.S. were bound to weaken Turkey's attachment to the one-party system established by Kemal Atatürk. It came to an end in Jan. 1946 when the Democratic party—an opposition party founded by Celal Bayar, one of Turkey's most eminent statesmen—officially came into existence. The new party received the blessing of the president, the government and the press. The first election under the two-party system was held in July 1946, and resulted in a sweeping victory for the government. The opposition leaders charged the government agents with irregularities. The result, however, would probably have been much the same if the votes had been properly counted.

The great national assembly took westernization of its parliamentary system in its stride The Democratic party followed the maxim that it was the duty of the opposition to oppose. It constantly criticized the government, and its effectiveness was out of proportion to its numbers. It continued to gain strength in the country, but it refused to contest any of the by-elections of 1948 and 1949 on the grounds that the amendments to which the government had consented in the electoral law had not gone far enough. Early in 1950, however, a new electoral law was passed by the assembly which provided all the safeguards demanded by the opposition (secret ballot, public counting, judicial supervision, etc.); and on May 14, a general election was held. It resulted in an overwhelming defeat for the Republican People's

party, which had been in power continuously since 1923. The Democratic party won 416 seats against 69 for the Republican People's party and one Nationalist The president of the assembly and all the ministers, except the prime minister, lost their seats. Celal Bayar was elected president of the republic. He invited Adnan Menderes to form a cabinet. A distinguished historian and university professor, Fuat Koprulu, became minister of foreign affairs.

The Democratic party drew its leaders mainly from the middle class: they were merchants and industrialists, with a few professors and journalists. Its domestic policy might be described as liberalism plus the nationalization of railways, power, coal, steel and other large-scale activities, but greater scope was promised for private enterprise. In foreign affairs it undertook to carry on the policy of its predecessors.

Communism did not appear to be a serious problem in Turkey after World War II. Its doctrines would not ordinarily appeal to a prosperous Moslem peasantry, and the fact that it was sponsored by Russia, the historic enemy of Turkey, handicapped Communist agents and propaganda Nevertheless, the government decided to prohibit Communist organizations. In 1946 out of 55 suspects arrested, 44 were convicted of being members of an illegal organization, and several professors were dismissed from Ankara university for Communist sympathies. Attempts to start a Communist movement were however revealed in 1951, when a further considerable number of arrests were made.

The most serious problem which confronted successive governments during and after the war was the cost of living. In 1947 the Istanbul Chamber of Commerce stated that "the minimum monthly expenditure for a family of five persons was £T348, or £T550 less tax. Yet thousands of families were eking out a miserable existence on £T100–£T150 per month. For them there was no alternative but to accept bribes or starve."

One of the most important measures adopted by the great national assembly was the land reform bill of 1945. It aimed at converting Turkey into a country of smallholders by distributing state and ecclesiastical lands, reclaimed and uncultivated lands and privately owned lands more than 4½ sq.km. in area among landless peasants and immigrants. The dispossessed owners were to receive 4% state bonds for their property, and the agricultural bank was to grant loans to the peasants, free of interest and repayable over 25 years, to assist them in stocking and equipping their farms The bill also had provisions against the splitting of holdings through inheritance.

After protracted discussions, the great national assembly decided in 1948 to introduce the teaching of Islam—but only in the two highest classes of the primary schools and outside the regular school hours.

Foreign Relations.—Until the establishment of the republic, Russia and Turkey had engaged in a continual succession of wars for nearly 300 years. Russia, therefore, came to be regarded by the Turks as the inveterate enemy, the inevitable aggressor, whose aim, down the centuries, remained the same: to possess Istanbul and the straits. In 1925, however, cordial relations were established by Lenin and Mustafa Kemal, which endured until the signature of the Soviet-German pact of 1939. Although its treaty with the U.S.S.R. still remained in force, Turkey suspected (not without reason, as was subsequently proved) that the U.S.S.R. was bargaining with Germany at Turkey's expense. The suspicions were allayed neither by the German invasion of the Soviet Union in 1941 nor by the reaffirmation, on Aug. 10, 1941, by Great Britain and the U.S.S.R. of their fidelity to the Montreux convention.

The estrangement was no less pronounced on the Soviet side since Turkey continued to maintain its attitude of nonbelligerency, keeping the straits closed to Soviet and Allied warships. At the same time the activities of the Turkish Pan-Turanian party, which held irredentist views concerning Russian Turkistan, where there were as many Turks as in Turkey itself, had caused annoyance in Moscow. Thus the ancient hostility was revived, and with it the ambition—dormant since the Russian Revolution—of gaining control over the straits Early in 1945 Moscow launched a war of nerves against Turkey, which was not mitigated by Turkey's belated declaration of war against Germany. The subsequent denunciation, therefore, by the Soviet government in March 1945 of the Turko-Soviet treaty of friendship (due to expire on Dec. 17, 1945) did not come altogether as a surprise in Ankara. This was followed by a Soviet demand: (1) for a revision of the Montreux convention of 1936 which would permit the U.S.S.R. to share in the defense of the straits and (2) for the return of the old Turkish provinces of Kars and Ardahan, which had been annexed by Russia in 1878 and ceded back to Turkey by Lenin.

These demands were clarified by exchanges of notes in which the Soviet government proposed: (1) that the straits should always be open for the passage of merchant vessels of all countries, (2) that they should always be open for the passage of warships of the Black sea powers only; (3) that the passage of warships of non-Black sea powers should not be admitted, except in special cases; (4) that the regime of the straits should be the joint responsibility of the Black sea powers with Turkey and (5) that the defense of the straits should be carried out jointly by Turkey and the U.S.S.R. Turkey intimated in its replies that it might agree to the first three proposals, but pointed out that the regime of the straits was governed by the Montreux convention, which could not be revised except by its signatories. It refused to consider the suggestion that the U.S.S.R. be allowed to share in the defense of the straits, pointing out that this would mean granting bases on Turkish territory to a foreign power, which would be an infringement of Turkish sovereignty and a menace to its independence. Great Britain supported Turkey, as in the past, on this issue, and British support was strengthened by that of the United States, which thenceforth took the lead in the support of Turkey.

The visit in the summer of 1946 of the battleship "Missouri" to Istanbul aroused enthusiasm in Turkey and was followed by visits of successive squadrons of U.S. warships. These fleet movements were unmistakable hints to the U.S.S.R. that the United States would not tolerate any offensive move against Turkey, a cosignatory with the U.S.S.R. of the charter of the United Nations. On March 12, 1947, Pres. Harry S. Truman, in a special message to congress, recommended the employment of U.S. funds and military and civil equipment to assure the independence and economic stability of Turkey. Thereafter the question of the straits and the Soviet demand for Turkish territory were dropped by Moscow. The war of nerves, however, continued, forcing the Turks to keep their army mobilized, a precaution which Moscow denounced as warmongering.

From 1947 the United States pursued, without interruption, a policy of full support for Turkey's military, naval and economic strength. War material of every kind poured into Turkey, taxing to the utmost the latter's ability to handle it. Important naval and military missions arrived from the United States, and U.S. experts were soon studying and preparing plans for the development of Turkey's agriculture, irrigation, coal, oil, banking, transport system, education, electrification and foreign trade. By 1950 work had begun on a number of schemes, and equipment of every kind for Turkey's economic development had begun to arrive. In addition hundreds of U.S. technicians were engaged and hundreds of Turks went to the U.S. to receive military or technical instruction. In the spring of 1948 military aid alone was stated to have reached the value of $1,000,000,000.

Meanwhile Turkey's relations with Great Britain remained cordial; Turkish leaders stated on many occasions that the British alliance was the cornerstone of its foreign policy. Moreover, early in 1949 the French foreign minister assured the Turkish government that France regarded the Anglo-Franco-Turkish treaty of alliance of 1939 as still in force. The statement was received with great satisfaction in Turkey. It was felt that with the support of the United States, Great Britain and France, Turkey was reasonably secure against possible Soviet aggression.

On Aug. 9, 1949, Turkey and Greece were invited by the committee of ministers to join the Council of Europe. Turkey was alloted eight seats in the consultative assembly.

The collapse of the Balkan entente and the ineffectiveness of the Saadabad pact with Iran, Iraq and Afghanistan, as well as the in-

terest manifested by the Soviet Union in Arab affairs, directed the attention of Turkey's leaders to the importance of closer relations with the Arab states. Relations with Egypt were already cordial and new treaties of commerce and friendship were signed with Iraq in 1946 and with Jordan in 1947. At mid-century the question of Hatay impeded the establishment of friendly relations with Syria and Lebanon.

Since the end of the World War II trade with Italy had steadily increased; and March 24, 1950, Turkey signed a treaty of friendship and conciliation with the Italian republic. Commercial relations with Germany were also rapidly restored.

Turkey early announced its decision to send a brigade to support the army of the United Nations in the Korean war. Turkish troops landed at Pusan in Oct. 1950 and distinguished themselves in the fighting against the Chinese at Kunuri in November.

In Sept. 1951 the council of the North Atlantic Treaty organization, meeting in Ottawa, invited Turkey and Greece to join it. The agreement of all other members of the organization was obtained and the Turkish parliament ratified the treaty on Feb. 18, 1952. (A. A. A.; A. H. L.; A. C. Es.)

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Population.—The origins of the modern inhabitants of Turkey remain somewhat obscure, but in spite of many invasions it appears that the physical types found in the country have changed very little in the last 4,000 years. The earliest invaders probably came from the Eurasian steppes around the Black and Caspian seas. The Hittite empire was established in Mesopotamia and in Anatolia by 1800 B.C., and the Turks of today take great pride in their Hittite ancestry. The Hittite empire on its fall gave place to Phrygian invaders and to refugees from Greece, who overran western Anatolia. They in turn were followed by the Persians, by the Macedonians under Alexander, by Celtic tribes from the middle Danube (Galatians), by the Romans, by the Arabs (Saracens) and, finally, by the Seljuk Turks. The Seljuks themselves were of mixed descent and probably brought with them Mongol elements.

The history of the country is reflected in the variety of types found in modern Turkey, though generally the people are muscular and well-built, round-headed, with high cheekbones, brown eyes, square jaws and large somewhat aquiline noses. The majority has Mediterranean colouring, but there is a fairer strain. It was estimated that the present people of Anatolia owe about 75% of their ancestry to the original inhabitants and 25% to the Seljuk Turks

The Kurds, somewhat scattered but living mainly in the eastern and southeastern provinces, are differentiated from the rest of the people by their height (average 5 ft. 7 in.) and very long heads and by the high proportion of them with fair hair and blue eyes.

The *growth of the population* of the republic as shown by census figures is given in Table II, the density in Table III.

TABLE II.—*Population*

Year	1927	1935	1945	1950
European Turkey	1,040,669	1,267,753	1,466,612	1,626,229
Anatolia	12,007,607	14,890,365	17,903,562	19,308,441
Total	13,648,270	16,158,018	18,790,174*	20,934,670

*9,446,580 male, 9,343,594 female.

TABLE III.—*Density (per square mile) of Population*

Year	1927	1935	1940	1945	1950
European Turkey	124	137	168	165	170
Anatolia	44	52	57	59	67
All Turkey	46	54	59	62	70

The greater part of the population lives near the coast, where agricultural activity is most intense and where the trading centres are There the density varies from 75 to 100 per square mile. In the central plateau and in the mountains of eastern Turkey, the *density* is from 1 to 25 per square mile. On the edge of the plateau, in western Turkey and in the southern coastlands the density varies from 25 to 75 per square mile.

The urban population in 1945 amounted to 4,687,102, of which 37% lived in the ten principal towns. These were (1950 pop. in parentheses). Istanbul, 860,558 inhabitants (1,000,022); Ankara, 226,712 (286,781), Smyrna, 198,396 (230,508); Adana, 100,780 (117,799); Bursa, 85,919 (100,007); Eskisehir, 80,030 (88,459); Gaziantep, 62,873 (72,743); Konya, 58,457 (64,599); Kayseri, 57,864 (65,489) and Erzurum, 50,875 (54,360).

The distribution of the population by occupational groups in 1945 is shown in Table IV.

TABLE IV.—*Employed Persons, 1945*
(In thousands)

Occupation	Men	Women	Total	Percentage
Farming, forestry and fishing	3,800	1,093	5,723	50 5
Industry, handicrafts and mining	592	82	674	3 6
Commerce, transport and communications	408	14	419	2 8
Public administration and professional services	662	32	694	3 7
Domestic and personal services	13	13	26	0.2
Others, including families, itinerant tradesmen, pedlars, etc	3,073	7,278	11,251	59.2
Grand Totals	9,447	9,344	18,791	100 0

GOVERNMENT AND ADMINISTRATION

Before the Kemalist revolution, a "Turk" was generally taken to mean a Moslem subject of the sultan. In 1924 the meaning was established in article 88 of the organic law as follows:

The people of Turkey, regardless of religion and race, are Turks as regards citizenship

The organic law, adopted on April 20, 1924, was a concise document showing the influence of U.S., French and British examples. It contained six chapters: (1) fundamental provisions; (2) legislative powers; (3) executive powers; (4) judicial powers; (5) general rights of Turkish citizens and (6) miscellaneous, containing articles relating to the administration and to the conditions for amendment of the constitution itself. Article 2 later underwent important amendments; in 1928 the provision that Islam was the religion of the state was deleted, and in 1937 the six principles of the People's Republican party (at that time the only political party)—republicanism, nationalism, state socialism (*étatisme*), sovereignty of the people, secularism and revolution—were inserted. These were regarded as fundamental principles and were accepted by all parties, though interpretation of them varied. "Nationalism" was not aggressive but looked inward with an educative

and humanitarian aim; "state socialism" was designed to build up economy and industry on a Turkish foundation and to encourage social and cultural progress; "revolution," an expression of reaction to the slow and ineffective reforms of Ottoman times, signified the will to reform methodically the life and institutions of the country. Other important modifications to the organic law were the extension of the suffrage to women (1934); the alteration in the system of voting in parliamentary elections from indirect to direct (1946), and the introduction of the secret ballot (1948). Other important provisions were: that sovereignty belongs without restriction to the nation; that the grand national assembly is the sole and real representative of the nation, on whose behalf it exercises the right of sovereignty; that the legislative authority and executive powers are concentrated and manifested in the grand national assembly and that the grand national assembly exercises its executive authority through the person of the president of the republic, elected by it, and through a council of ministers chosen by the president. Under chapter 5 it was laid down that "Every Turk is born free and lives free. Liberty consists of any action which is not detrimental to others . . All Turks are equal before the laws . . . Personal immunity, freedom of conscience, of thought, of speech and press, the right to travel, to make contracts, to work, to own and dispose of property, to meet and to associate, form part of the rights and liberties of Turkish citizens."

The assembly's term is four years, and it meets annually on November 1 without a summons; it must remain in session for at least six months every year, and the annual budget must be presented at the beginning of the session. The functions of the assembly include: the making, amending, interpreting and abrogation of laws; concluding treaties; declaring war; examining and ratifying laws drafted by the commission on the budget; coining money and accepting all contracts and concessions involving financial responsibility.

The president of the republic is elected by the members of the assembly from their own number for the four years of their own office He is eligible for re-election. He may preside over the assembly on ceremonial occasions and, if he deems it necessary, over the cabinet. But he may take no part in debates or cast a vote. He is bound to publish laws passed by the assembly within a period of ten days; however, he may return for reconsideration with an explanation of his reasons laws of which he does not approve, except organic and budget laws. The president is the supreme commander of the army, personifying the assembly in which the office is vested. He selects the prime minister from the members of the assembly; other ministers are chosen by the prime minister and presented to the assembly after the president's approval.

Members of the council of ministers are responsible individually and collectively to the assembly for the policy and conduct of the department of state. The prime minister decides the number of ministers (usually 15) in charge of the following departments: justice, national defense, interior, foreign affairs, finance, education, public works, economy, health and social assistance, customs and monopolies, agriculture, communications, commerce, labour and state enterprises. In addition there is a minister of state who is deputy prime minister.

The council of state is both an advisory body and a judicial authority in administrative matters. It is attached to the office of the prime minister, and its members are chosen from prominent citizens with administrative and judicial experience. It may advise on draft laws submitted to it by the government.

The country is divided into 63 provinces (*ils*, formerly *vilayets*). Provinces are divided into districts (*ilces*, formerly *kazas*) and districts into communes (*bucaks*, formerly *nahiyes*). The highest administrative official in each is the *vali*, the *kaymakam* and the *bucak muduru*. The *vali*, who is appointed by the president of the republic on the recommendation of the minister of the interior, is the chief administrative officer of the province, representing all the departments (except those of war and justice) and co-ordinating their work in his province. He corresponds directly with each ministry and has a staff of advisers, who also form an administrative council under his chairmanship. The organization of the district (*ilce*) under the *kaymakam* and of the commune (*bucak*) under the *bucak muduru* follows the same pattern. The commune comprises a number of villages each of which has a headman (*muhtar*) and a council of elders, numbering from 5 to 12, according to the size of the village. A provincial council, elected for four years, debates questions of local administration, and its resolutions have legal effect; the *vali*, who is president of the council, may however refer proposals of which he does not approve to the council of state. In every headquarters town of a province or district and in all other towns of 2,000 inhabitants or more there is a municipality (*belediye*). At the head of the municipality is the mayor (*belediye reisi*), who is assisted by an elected municipal council and a committee composed partly of officials and partly of persons chosen by the council for a year's term of office.

Justice, Police and Gendarmerie.—Under articles 8–54 of the organic law, the courts of justice were made entirely independent of the assembly and the government. The highest court is the court of cassation in Ankara, which has civil, penal, commercial and bankruptcy chambers, each divided into special sections. Each court chamber has its president; the chambers together form the quorum of the court of cassation which has its own president and forms the highest court of appeal. Lower courts are: (1) peace courts, (2) courts of first instance, (3) central criminal courts and (4) commercial courts

The most sweeping of the changes made by the revolution was the abolition of the religious courts and the Moslem Shari code and the adoption, in 1926, of the Swiss civil code, the Italian penal code and a commercial code based on several European models.

The minister of the interior is responsible for the maintenance of order and the internal security of the country. He exercises his powers through the director-general of security and the general commanding the gendarmerie and, in case of necessity, by calling on the armed forces, although a decision of the council of ministers is necessary before the army can be employed. The police are divided into three groups: administrative (prevention of crime, maintenance of law and order, etc.), in which they are under the orders of the civil authorities; judicial, in which they are under the public prosecutor and political (*i.e.*, for matters concerning the internal security of the state). In the capital the police are organized under a director-general. In the provinces the police subdivisions are attached to the *valis*, *kaymakams* or *mudurs*. A law of 1930 established the gendarmerie as a military force, administratively under the minister of the interior, which reinforces the police mainly in rural districts and is subject to the same local authorities, administrative or judicial. The gendarmerie is formed from men serving with the colours and is primarily a military formation, its training and instruction being supervised by the general staff.

Education.—Primary education is, in theory, compulsory for both sexes between the ages of 7 and 12. Among the problems of primary education at mid-20th century was the lack of teachers. Although great expansion had taken place, there was probably still a considerable number of children in the provinces receiving little or no education. The secondary schools provide a three-year course which may be followed by a three-year or four-year course at a *lycée*. Parallel with the secondary schools are the boys' technical schools, with three-year, five-year or six-year courses, where engineering, building and other trades were taught; girls' institutes giving training in home management, cooking, hygiene, etc.; and commercial schools in which general as well as commercial subjects are studied. Technical and commercial instruction may be continued in a small number of *lycées* specializing in these subjects. Evening trade schools are also provided for men and women who have not had more than a primary education; the number of these at mid-century was still small. The Istanbul technical university, reorganized in 1941, is designed to give instruction, both practical and theoretical, in engineering subjects. The course lasts four years. With it is associated a technical department, with a two-year course in civil or mechanical engineering. A technical university for Ankara was being planned by 1951. Other universities include that at Istanbul, with faculties of law,

medicine, science, letters and economics, and one at Ankara, with faculties of languages, history and geography, science and medicine and schools of law and archaeology.

An interesting and successful experiment was the establishment of village institutes (*koy enstitülari*), at which boys and girls who have had primary education are given general and vocational training designed to fit them as teachers in village schools or as farmers able to apply modern agricultural methods to their work. The rural atmosphere is maintained in these institutes and the training is severely practical. A boy returning as a village schoolmaster is expected to be able not only to teach but to build and maintain a schoolhouse of a standard pattern, if necessary.

Education is free in all government schools; but board and lodging, where this is necessary, are not always provided, though many scholarships that cover all expenses at school or university are awarded. A number of Turkish private schools exist, as well as the schools for the minorities (Greek, Armenian or Jewish) and the foreign schools, (of which the American Robert college in Istanbul is the best known). The Turkish government's insistence on the secularization of education throughout the country raised serious difficulties for the foreign schools, and some were forced to close. In 1947 the ban on religious instruction was relaxed, and Moslem schools were permitted to open, in addition to but not in replacement of the secular state schools.

The spread of education was enormously assisted after the Arabic alphabet was superseded by the modified Latin alphabet, introduced in 1928 by a nation-wide campaign in which Kemal Ataturk himself took a prominent part. At the same time efforts were made to reform the Turkish language by the substitution of pure Turkish words for Arabic or Persian words in general use. This led to some confusion and the effort was allowed to slacken.

Adult education was still much needed at mid-century. Apart from stationary and mobile schools for the illiterate, vocational and professional training schemes with day or evening classes had been developed. To help in filling the need for adult education "people's houses" (*halkevleri*) were established all over the country; activities include language and literature, fine arts, drama and history. Libraries and museums were also established.

Sports are encouraged in all schools and in the village institutes. Football, basketball, wrestling and field sports are all popular.

Table V shows the increases in the number of schools and students between 1935 and 1949, illustrating particularly the great importance attached to technical training.

Labour and Welfare.—The ministry of labour was established in 1945 to regulate relations between employers and workers, to secure a better standard of efficiency of the labour force and generally to supervise the laws relating to labour and social insurance. The first of these was passed in 1936 and was followed by the supplementary laws of 1946, 1947, 1950 and 1951 The basic law of 1936, which applied only to establishments employing ten or more persons, regulated conditions of employment (health and safety arrangements, hours of work, etc) and forbade strikes or lockouts. Of the 300,000 persons covered by this law in 1949 about 74,000 were members of the 83 trade unions. The functions of the unions and employers' associations were defined by law. Any trade union representing the majority of workers in an industry could, on the written demand of one-fifth of the total number of workers, initiate collective bargaining with an employer. Any employer wishing to make mass dismissals had to give a month's notice to the ministry of labour.

Insurance measures were introduced in 1946 and supplemented after- [illegible]

[illegible]

TABLE V.—*Education*

Year	Number of schools	Number of students	Primary schools	Secondary schools	*Lycées*	Vocational schools	Higher schools and faculties
1935-36	6,614	770,600	6,275	191	66	44	18
1940-41	11,040	1,109,300	10,596	238	82	69	20
1945-46	14,615	1,522,400	14,010	252	83	196	31
1948-49	16,858	1,632,300	16,119	321	88	257	32

beds); religious foundations, 1 (250); provincial authorities, 54 (3,239); municipalities, 16 (1,589); various ministries, 6 (860), foreign organizations, 10 (683); minority communities, 5 (749); charitable associations, 3 (326); private, 20 (503); and state-controlled factories, 23 (809).

Campaigns against malaria, trachoma and syphilis were vigorously conducted with considerable success. Great efforts were made to reduce the very high infant-mortality rate (120-350 per 1,000 live births in 1918), but the shortage of nurses and midwives made this difficult.

Each province (*il*) has a director of health services, with doctors in the districts (*ilces*) and communes (*bucaks*) who not only supervise sanitary conditions but, in the *bucaks*, are the local medical practitioners, giving free advice and treatment Each large town has its own municipal health organization The state-controlled factories, moreover, have their own hospitals and staff

Finance.—Continuous adverse trade balances caused the value of the Turkish pound (£T or TL) to depreciate between 1923 and 1930, when the £ sterling reaching the value of £T11.00 Action by the Turkish government brought the rate to £T10.30, at which it remained until Great Britain went off the gold standard in Sept. 1931. From that date the Turkish pound was kept pegged to the French franc at 12.06 fr per £T1. In 1936 the franc was devalued, and the Central bank, which had started operations in 1931, maintained the old gold parity and exchange rates so that the pound sterling equalled £T5 20. This, however, was only a theoretical rate, as exports enjoyed a premium and imports suffered a surcharge. This situation was regulated in 1946, when the Turkish currency was devalued When sterling was devalued in 1949, the old rate with the dollar was retained (*See* Table VI.)

TABLE VI —*Exchange Rates of the Turkish Pound*

	1930	1931	1936	1938	1945	1946	1947	1949 (Sept)	1952
£ sterling	11 00	10.30	5 20	6.16	6 21	7.24	11 33	7 90	7 84
Dollar				1 26	1 31	1 81	2.81	2.80	2 82

Reduction in imports and competitive buying by the belligerents during World War II resulted in a considerable rise in Turkey's gold reserves and foreign-exchange assets between 1939 and 1945. But when manufactured goods became more easily available and exports were artificially restricted, these balances were rapidly dissipated. The Marshall plan aid came to Turkey's rescue (1948), and further substantial assistance was given under the European Recovery plan, as well as both financial and technical help from the U S. under the auspices of the Economic Co-operation administration.

The state budget and those of the para-statal bodies (state railways, steamship lines, etc), and of the state-owned mining and industrial enterprises may be said to interlock in so much as some are subsidized or subsidize others. The final accounts of state finances showed deficits in all except two years between 1936 and 1950-51; with the exception of the Monopolies administration (tobacco and alcoholic liquors), deficits were also shown by the state-owned undertakings. The monopolies' profits could be regarded as the equivalent of excise duties in other countries. The financing of deficits was difficult since there was no organized capital market and the public became unwilling to subscribe to internal loans. In 1951, when 37% of the revenue was derived from direct taxes and 56.7% from indirect taxes, the government promised to do its best to improve the state of affairs. The reformed income tax laws that came into force in 1950 had, moreover, failed to provide the expected amount of revenue because, it was believed, of evasion and false returns. (*See* Table VII)

Table VIII shows the more important departments' expenditures

[illegible]

TABLE VII—[illegible]

	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

TABLE VIII.—*Main Expenditures*

	1948		1949		1950–51	
	Millions of £T	Percentage of total	Millions of £T	Percentage of total	Millions of £T	Percentage of total
Ministry of national defense	376·9	26·8	460·5	36·7	458·2	32·2
Dept of public security	32·3	2·3	33·8	2·6	34·5	2·4
Gendarmerie	36·8	2·6	42·9	3·4	40·5	2·8
Ministry of finance	150·1	10·7	141·2	11·2	214·3	15·0
Public debt	211·0	15·1	168·4	13·4	203·5	14·3
Ministry of education	106·5	7·6	165·7	13·2	176·4	12·4
Ministry of public works	97·4	6·9	118·2	9·5	98·6	6·9

was transferred to the territories then detached from the Ottoman empire. Turkey remained responsible for a sum of £T84,590,000. Agreements with the bondholders were revised in Turkey's favour in 1928, 1933 and 1936, and the Turkish government assumed the liabilities and took over the management of the debt in 1940. Table IX includes this liability but not the debt of the state industrial organization, which amounted to £T334,200,000 in 1948 and £T266,700,000 in 1949.

TABLE IX.—*Turkey's Internal and Foreign Debts*

	Millions of £T			Percentage of total	
	Internal	Foreign	Total	Funded	Floating
May 31, 1939	395·5	223·7	619·2	53·5	46·5
1940	508·3	333·6	841·9	53·3	46·7
1941	730·1	358·3	1,078·5	44·6	55·4
1942	955·6	357·9	1,313·5	38·8	61·2
1943	1,099·6	360·7	1,392·3	40·4	59·6
1944	1,115·0	377·1	1,492·1	42·0	57·4
1945	1,126·4	362·1	1,488·5	44·2	55·8
Dec 31, 1945	1,103·2	343·2	1,446·4	46·8	53·2
1946	1,144·5	741·1	1,885·5	59·9	40·1
Oct 20, 1947	1,606·8	200·0	1,811·9	79·4	20·6
Dec. 31, 1948	1,252·8	851·3	2,195·1	74·4	25·6
1949	1,270·4	709·9	2,882·3	68·9	31·1

Source. Turkish ministry of finance, *Overseas Economic Survey* (1951).

Communications.—*Railways.*—Before the constitution of the republic, Turkey was badly served by railways, nearly all of which were owned by foreign companies; their total length was 2,536 mi. The republican government put in hand a program of extensions which added 1,238 mi. in its first ten years. By the end of 1949 517 mi. of line had been transferred to the state by conventions and 1,000 mi. of 2,000 mi had been bought from foreign companies and 2,250 mi. had been constructed by the government since 1923, bringing the total length of lines to 4,767 mi. During World War II the rate of construction had been slowed down because of rising costs and difficulties in the supply of materials. In 1947 a 15-yr. plan was worked out under which it was intended to add a further 1,435 mi. to the system between 1950 and 1965. The directorate-general of the Turkish state railways and ports (*Devlet Demir Yollari ve limanlari*) operated at mid-century under the general control of the ministry of communications. It was self-supporting as far as current operations were concerned. Its revenue more than covered its current expenditure, but it was burdened with heavy internal and external debt, roughly half of which represented the payment for foreign concessions nationalized.

Roads.—In 1923 the roads, surfaced and unsurfaced, amounted to only 8,073 mi. During the next 15 years an average of £T7,300,000 a year was spent on building and reconstruction. By 1935 the total length had almost been doubled, and in 1939 a comprehensive program was announced under which 19,872 mi. of modern roads were to be built in ten years at a cost of £T120,000,000. World War II put a stop to this work, and development was slow until, in 1948, an agreement was signed between the American Mission for Aid to Turkey and the ministry of public works, in which a nine-year program for the construction, reconstruction and improvement of a national highway system of 13,437 mi. of all-weather roads was announced. By the end of 1949 661 mi of new construction had been completed; the total of macadamized road at the same time was 9,578 mi. The following highways were included in this program: Edirne-Istanbul-Ankara-Adana-Antioch-Yayladagi (878 mi.); Edirne-Saray-Istanbul-Izmit (Kocaeli)-Duzce-Eregli-Safranbolu-Kastamonu (Kastamuni)-Kabili-Samsun-Hopa-Kars (1,293 mi.); Canakkale (Chanak)-Bursa-Eskisehir-Ankara-Yozgat-Sivas-Erzincan-Karakose (1,362 mi.); and Izmir (Smyrna)-Aydin-Mugla-Antalya-Icel-Adana-Gaziantep-Urfa (Edessa)-Diarbekr-Bitlis-Van-Hakkari (1,528 mi.).

Ports and Shipping.—The railway administration was made responsible for the maintenance and exploitation of the terminal ports of Haydarpasa (Istanbul), Derince, Iskenderun (Alexandretta), Mersin, Samsun, Alsancak (Smyrna), part of the quays at Sirkeci (Istanbul) and the quays at Bandirma and Edremit. Istanbul, which handles 70% of Turkey's foreign trade, suffered from congestion at mid-century and improvements to it were among the projects submitted to the International Bank of Reconstruction and Development.

The Turkish merchant navy in 1950 included 40 passenger ships, 3 tankers and 14 cargo ships owned by the state shipping administration and 60 cargo ships in private ownership; total gross tonnage was 322,682. There were also state-owned ferryboats and auxiliary craft. In 1951 the state shipping lines were converted into a semicommercial corporation called the Maritime bank in which the government retained 53% of the shares.

Civil Aviation.—The state airlines operated 19 airfields at mid-century, with the main traffic centres at Ankara, Istanbul, Smyrna, Afyon and Elazig. Civil air agreements were concluded by Turkey with the United States, Sweden, France, Italy, Denmark, Czechoslovakia, Greece, Netherlands, Great Britain, Brazil and Iran. In addition to internal services, the state airlines established a service on the route Istanbul-Ankara-Nicosia-Beirut.

Posts, Telegraphs and Telephones.—The republican administration claimed that the number of post and telegraph offices in Turkey increased from 688 to 1,679 by 1948. Work on the expansion of telephone and telegraph interurban services was begun in 1947, and a wide-scale training program to fit the staff to cope with new technical problems was initiated. In 1934 broadcasting was taken over by the government from a semiofficial body; its supervision being vested in the director-general of the press, publication and tourism Three transmitters were in operation in 1951. Radio Turkey (Ankara), 120 kw., 182 kc. per second; Radio Ankara, 20 kw., 9,465 kc. per second; and Radio Istanbul 150 kw , 704 kc. per second. Programs in Urdu, Serbian, Arabic, Persian, German, Bulgarian, Greek, Rumanian, Polish, French and English were being broadcast from Ankara. Receivers registered in Turkey numbered 263,165 in 1949, compared with 38,498 in 1938. The cost of broadcasting was met entirely from a grant out of the budget allocation for the directorate-general of the press.

ECONOMICS

Agriculture and Forests.—Agriculture is Turkey's most important industry, providing a livelihood for 75–80% of the population, largely on small farms. For some years the republic spent relatively small sums on the scientific development of agriculture in comparison with its expenditure on industrial projects, but after World War II great efforts were made to improve technique, promote irrigation, conserve the soil, breed better cattle and extend transport facilities.

The principal crops are cereals, cotton, tobacco, fruit, (fresh and dried), nuts, oilseeds, olives, pulses and vegetables. Tables X, XI, XII and XIII give approximate data on the first four of these crops.

Besides grapes and figs (*see* Table XIII), other fruits, *i e* , citrus fruit, apples, pears, quinces, peaches, apricots, melons and strawberries, grow in abundance, but no export trade had been developed by mid-century and statistics of production were not made available

Olives are grown in western Anatolia and in the south. Turkey ranked fifth among the olive-growing countries at mid-century but did not export any significant quantity either of fruit or oil.

Hazelnuts, walnuts, pistachios and almonds are grown but only the hazelnut is exported in any quantity. It is grown on the Black sea coast near Samsun and the crop averages about 30,000 tons of shelled nuts a year. About 2,000 tons of pistachios are exported annually.

The principal crops of oilseeds are sunflower, cotton, sesame, linseed and poppy. Estimated production in 1949 was about 360,000 tons, of which nearly one-half was cottonseed (*see* Table XI).

Vetches of various kinds were coming into increased use for fodder at mid-century. Haricot and broad beans, lentils and chickpeas are plentiful, and potatoes are widely grown Onions, garlic, leeks, eggplants, artichokes, tomatoes, cabbage, lettuce, cucumbers, carrots and turnips are extensively grown for local consumption

TABLE X.—*Principal Cereals: Areas Sown and Yield** (In thousands)

	1934–38		1947		1948		1949	
	Hectares	Tons	Hectares	Tons	Hectares	Tons	Hectares	Tons
Wheat	3,628	3,708	4,177	3,246	4,590	4,853	3,955	2,557
Barley	1,855	2,071	1,805	1,512	1,808	2,163	1,714	1,247
Maize	448	587	535	511	543	701	584	736
Rye	380	368	416	348	468	517	418	274
Oats	259	247	270	196	285	289	288	235
Rice	30	60	24	55	24	61	27	58

*Cereals are grown principally in the central plateau, except maize, grown on the Black sea coast, and rice, in the Adana-Iskenderun district and in southeastern Thrace.

TABLE XI.—*Cotton: Area Sown and Yield**

Year	1934–38	1946	1947	1948	1949
Thousand hectares	268	247	206	297	358
Thousand tons. cotton	60	59	51	58	105
cottonseed.	107	111	94	111	176

*The cultivation of cotton is concentrated in the Aegean and Adana regions.

TABLE XII.—*Tobacco: Area Sown and Yield**

Year	1934–38	1946	1947	1948	1949
Thousand hectares	79	123	132	106	124
Thousand tons	61	98	102	74	98

*Most of the tobacco is grown in the Aegean district but important areas are also on the Marmara coast and on the Black sea coast near Samsun.

TABLE XIII —*Dried Fruit: Tonnage and Value Exported**

Year	Sultanas		Figs	
	Tons	Value in £T	Tons	Value in £T
1936–39	61,000	10,000,000	33,000	4,000,000
1945	30,880	19,000,000	14,148	6,000,000
1946	60,323	36,000,000	26,776	28,000,000
1947	31,018	27,000,000	23,094	15,000,000
1948	29,021	26,000,000	26,224	14,000,000
1949	63,586	46,000,000	17,377	11,000,000

*No reliable figures of total production were available in the early 1950s. The white seedless grape, *sultanya*, grows in the valleys in western Anatolia. The best figs are grown in the Aydin district of western Anatolia and near Izmir (Smyrna).

Tea growing was started in 1931 in the Rize district on the Black sea coast. There were 1,500 ac. under cultivation in 1949 and it was planned to expand this to 11,000 ac. The factory at Rize, a government monopoly, produced 160 tons of tea in 1949.

The forests of Turkey, according to official statistics published in 1944, occupied 35,400 sq.mi. *i.e.*, about one-eighth of the total area of the country (the alternative figure given of 40,500 sq mi was probably exaggerated). Forests, however, had been diminishing for many years as a result of neglect, indiscriminate cutting and destruction by goats. At mid-century a scheme of reafforestation was being carried out by which it was intended to increase the forest area to about 60,000 sq.mi. The principal species are pine and fir (western Anatolia and the Black sea coast), beech (Marmara region, western Anatolia and Black sea coast) cedar (southern coastlands) and oak, valonea oak grows only in western Anatolia. There are fringes of oak scrub on the Black sea, Marmara and Mediterranean coasts.

Livestock and Fisheries.—Except for a few state farms the care and feeding of livestock remained poor at mid-century, and a large proportion of the grazing land (artificial pasture being almost non-existent) was bad. Sheep and goats are the most common stock since they can exist on poor grazing. The sheep are mostly of the Karaman, fat-tailed variety, there are large numbers of ordinary goats, and the Angora goat, which thrives on dry, elevated plateaus, is bred extensively. Cattle are still largely used as draught animals, the Turkish gray cattle being especially suitable for this. Crossbreeding with Swiss cattle was being tried after World War II. The horses are mainly of Turkish origin, but breeding from Hungarian stock was introduced on a small scale; the five government stud farms breed mostly English thoroughbred and Arab race horses. There are large numbers of fowls.

No official census was taken before 1948 (*see* Table XIV).

TABLE XIV —*Livestock*

	Estimate 1945	Census 1948	Census 1949
Sheep	23,400,000	25,800,000	23,000,000*
Goats	12,200,000	14,600,000	13,400,000*
Goats, Angora	4,000,000	3,200,000	3,200,000*
Horses	970,000	1,100,000	1,120,000
Donkeys	1,600,000	1,700,000	1,600,000
Cattle	9,800,000	10,300,000	10,300,000
Hens	17,800,000	19,000,000	20,300,000

*Heavy losses were suffered in the winter of 1948–49.

Annual production of wool probably amounted to 20,000–25,000 tons at mid-century; of mohair (from the Angora goat), about 6,000 tons. The average milk yield per animal was low; except near the large towns and at the sugar factories, there was no organized dairy industry. There was a large production of yogurt and various kinds of cheese and small production of inferior butter.

The main fishing industry is in the Sea of Marmara and the Bosporus, but fishing is carried on in various forms all around the coasts. Bonito, tunny, swordfish, mackerel, herring and sardines constitute the principal catch. The only inland fishing centre is Lake Van though trout, pike, carp, eels and coarse fish are common in inland waters. About one-third of the catch of fish is consumed in the country, the remainder being exported salted, canned, dried or fresh

Mining.—Turkey's principal minerals are coal, lignite, iron, chrome, copper, manganese, lead, zinc and emery, but only coal, lignite, iron and chrome are extensively produced.

The only bituminous coalfield is around Zonguldak on the Black sea coast, about 150 mi. E. of Istanbul. Although output increased from about 700,000 metric tons in 1934 to more than 4,000,000 metric tons in 1949 it did not keep pace with the internal demand, and there was no export trade in coal. Deposits of lignite are widespread; it is most abundant in western Turkey. The principal mines worked are at Soma, Degirmisaz and Tunchlek. Other extensive coalfields, both bituminous and lignite, are known to exist but lack of transport facilities and power prevented their exploitation. Some progress was made possible by Marshall plan aid after World War II.

Industry.—The policy of *etatisme*, or state exploitation, did not necessarily involve 100% control of any particular industry. The Sumer bank was created in 1933 to take over existing industries and to found and administer new ones In 1950 it controlled 60% of the cotton textile industry; 50–55% of the woollen textile industry, 100% of the artificial fibre industry; 100% of the iron and steel industry; 100% of the paper and cellulose industry; 20–25% of the cement and firebricks industry; about 10% of the leather and shoemaking industry; and 10–20% of the gluemaking industry. The Eti bank was founded In 1935 to exploit and develop mineral resources and electrical power facilities. It acquired control of by far the largest part of the exploitation of minerals. The manufacture of tobacco and cigarettes, alcohol and alcoholic drinks, matches and salt was made a state monopoly under the General Directorate of Monopolies. The beet sugar industry was two-thirds government owned at mid-century, and was under the Sugar Monopoly organization

Textiles.—The principal cotton products of the Sumer bank and other factories are cabot, white sheetings, prints, low-grade shirtings and cambrics The "cottage industry" also produces an appreciable quantity of rough cotton fabrics woven on hand looms. The production at the Sumer bank mills in 1949 was about 93,000,000 m. In 1948 private mills produced about 64,000,000 m.

In addition to five woollen mills owned by the Sumer bank, there were nearly 40 privately-owned woollen mills, some of them very small. In 1949 the former produced 4,900,000 m. of piece goods and 4,100 tons of yarn, the latter, in 1948, produced 6,500,000 m. of cloth

The old-established silk industry at Bursa remained entirely in private hands Production in 1948 was 200 tons of yarn and 1,500,000 m. of silk fabric There was a small silk weaving industry in Istanbul. A factory for synthetic fibres, owned by the Sumer bank, produces about 360 tons of yarn every year

Iron and Steel.—The iron and steel works at Karabuk are operated on behalf of the Sumer bank The iron ore is brought by rail from Divrik (600 m away) and coal from Zonguldak, but the quantity by the 1950s was still insufficient for the works to reach the production for which it was designed (*see* Table XV).

TABLE XV.—*Iron and Steel Products, Karabuk*
(In metric tons)

Year	Pig iron	Steel	Rails, plates, etc.	Cast iron pipes
1946	79,162	79,694	64,083	4,576
1947	96,504	93,983	72,073	7,308
1948	100,050	98,053	65,985	8,225
1949	112,742	101,972	68,167	10,900

A sulphuric acid plant, installed at Karabuk by a German firm during World War II, produced about 11,000 tons of acid in 1949. The raw material is imported

Paper.—The paper industry, all controlled by the Sumer bank, consisted at mid-century of two mills at Izmit with outputs of 14,000 and 16,500 tons a year By 1951 it had been decided that one of these was to be enlarged (to give an extra capacity of 4,000 tons) and that a third with an annual capacity of 8,000 tons was to be erected. All classes of paper were being made.

Cement.—Six factories with a nominal capacity of more than 400,000 tons produced 377,000 tons in 1949.

Sugar.—The Sugar Monopoly organization owned four factories at mid-century, one at Alpullu in Thrace, the others in Anatolia at Eskisehir, Usak and Turhal In 1949 they employed a staff of 375 with 887 permanent and 4,814 seasonal workers. (*See* Table XVI.)

TABLE XVI —*Sugar Production*
(In thousand metric tons)

Year	1939	1944	1945	1946	1947	1948	1949
Beet treated	628	561	552	615	589	708	818
Sugar	95	90	90	97	97	118	135
Molasses	28	22	26	26	24	29	32

Tobacco.—A state monopoly produces about 18,000 metric tons of tobacco annually (more than 80% cigarettes)

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(K. C. B.)

TURKEY. Domesticated breeds of turkeys were developed from indigenous wild stocks of North America. The Ocellated turkey, an indigenous species of the Yucatan peninsula of Mexico and the adjoining territory, apparently was not domesticated and differs considerably from the species from which domesticated breeds descended. The Ocellated turkey is smaller than the wild North American species, has no breast tuft or "beard," has two extensible fleshy appendages called "leaders" on the head instead of one and brighter coloured plumage with eyed (ocel-

lated) main tail feathers. There are five subspecies of the North American wild turkey, the two most important being the Mexican subspecies indigenous to central Mexico and the subspecies indigenous to the northeastern and middlewestern parts of the United States as far west as Oklahoma and Iowa and as far north as southern Ontario in Canada.

Evidence clearly indicates that the turkey had been partially domesticated by the Indians prior to the discovery of North America in 1492. Domesticated birds of the Mexican subspecies were imported into Spain from America about 1519. From Spain domesticated stocks became distributed throughout the rest of Europe and were introduced into England between 1524 and 1541. A white variety known as the White Austrian and a Belgian parti-coloured variety known as Ronquieres were developed in Europe. In 1865 the original Mexican stock was known in England as the Cambridge Bronze, and English breeders developed a black variety known as Norfolk Blacks and a buff variety known as Fawns. Some of the domesticated English and European stocks were taken to North America by the early colonists and served as foundation strains along with wild stocks of the northeastern subspecies in the development of the six long-established varieties in North America—Bronze, Narragansett, White Holland, Bourbon Red, Black and Slate—as well as two newly established varieties, Nittany and Royal Palm.

Turkeys are raised in most countries of the world but mostly as farm flocks of limited size. In the United States, however, turkey raising on a commercial scale is a very important enterprise in some sections of the country. Flocks of several thousand birds are not uncommon.

The Bronze is the largest sized variety and is the most popular one among commercial turkey raisers in Canada and the United States. Bourbon Reds, White Hollands and Narragansetts are also kept to a considerable extent. Up to about 1930, turkey breeders attached much importance to breeding large sized turkeys; it was not uncommon for young Bronze toms to weigh as much as 25 lb. and old Bronze toms 40 lb. After 1930, however, efforts were made to reduce the size somewhat and to improve the type of market turkey especially with respect to the amount of fleshing over the breast. So-called "broad-breasted" strains were developed with a pronounced degree of fleshing over the breast. Breeding stock selected for shorter shanks also resulted in improving the type of market turkeys produced. The United States government developed a small-sized strain of white turkeys with a view toward meeting the demands of many housewives for dressed turkeys weighing about 12 to 14 lb.

For best results in growth and fleshing, turkeys are fed much the same kind of diets as growing chickens, except that turkey diets should contain relatively more protein and fibre and more of certain vitamins. A fattening diet containing a high proportion of yellow corn is fed for about one month before the birds are marketed. Well-bred stock of the Bronze variety at 24, 26, 28 and 30 weeks of age should be expected to attain average weights for both sexes of 15, 16, 17 and 18 lb. or more, respectively. Comparable weights for White Hollands, Bourbon Reds and Blacks should be at least 13, 14, 15 and 16 lb. and for the small-type variety the weights should be about 13, 14, 15 and 16 lb., respectively. Birds of the small type variety are usually ready to market about four weeks before birds of the largest sized Bronze variety. Bronze turkeys consume about 55 to 60 lb. of feed per bird up to 24 weeks and about 75 to 80 lb. per bird up to 28 weeks. The smaller sized varieties consume less feed and the small-type variety still less. On the basis of efficiency in utilization of feed or pounds of feed consumed per pound of gain in growth, the broad-breasted strains are apparently superior.

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TURKEY BRIDGE, BATTLE OF, an engagement of the American Civil War which took place near Richmond, Va., on June 30, 1862. The battle of Turkey bridge was a part of the action known variously as the battle of Frazier's farm, Glendale or White Oak swamp, which was, in turn, one of the series of combats known as the Seven Days' battle (*q.v.*). The battle of Frazier's farm was, like that of the other battles during the seven day campaign, an attempt by the Confederate army to prevent the safe retreat of the Union forces under Gen. McClellan from the neighbourhood of Richmond. At Turkey bridge, located about 15 mi. S.E. of Richmond, Confederate forces under Gens. Theophilus Holmes and John B. Magruder endeavoured to turn the enemy's rear but a Union contingent under Gen. George Sykes was successful in frustrating the attempt.

TURKEY ISLAND, the name of a small island in the Detroit river, Michigan, below the city of Detroit, and formerly the name of a larger neighbouring island, now known as Fighting island. The two islands were so called by the French, who named them Isle aux Dindes (turkeys) and Petite Isle Dindes, because of the large number of birds abounding on the islands.

At the time of the Indian chief Pontiac's siege of Detroit (1763–64), the two islands had great strategic importance because the Indians were able to use them to ambush ships carrying supplies up the Detroit river to the beleaguered garrison. On June 23, 1763, an attack by Indians, who had entrenched themselves on the smaller of the two islands, was repulsed by a ship whose captain had concealed the larger part of its crew below the decks, hoping thereby to encourage the Indians to attack the vessel openly. His ruse succeeded when the Indians, under cover of night, canoed close enough to the ship so that when its guns opened fire, many of the attackers were killed or wounded. The ship was then shortly able to carry its cargo of reinforcements and supplies to the fort. The larger island was used by the Indians as a base for attacking the schooner "Gladwin" on Sept. 4, 1763, when 350 Indians boarded the ship with a crew of 12 men. Only the courage of the first mate, who gave the order to blow up the ship, saved the crew and its important cargo, for one of the Indians, understanding the command, warned his companions to abandon the ship, which then sailed safely on to Detroit.

TURKHEIM, BATTLE OF. At the end of 1674 the imperial army under Bournonville had crossed the Rhine at Strasbourg and invaded Alsace in order to check the aggressions of Louis XIV (*see* DUTCH WARS and TURENNE, HENRI DE LA TOUR D'AUVERGNE). After an indecisive battle at Enzheim, Turenne, the French commander, withdrew northwards as if for the defense of Lorraine; thereupon the imperialists spread themselves into winter quarters over S. Alsace.

This was exactly what Turenne wanted. He re-entered Alsace from the south at Belfort, taking the imperialists by surprise. A rapid thrust at Strasbourg might have been decisive, but the long march had exhausted Turenne's men; and when at last he did move northwards, the allies had had time to concentrate their army, 50,000 strong, in a formidable position between Colmar and Turkheim. Turenne, with only 35,000 men, decided to manoeuvre his enemy out of position. Giving half his force to the Comte de Lorge, he ordered him to demonstrate particularly against the town of Colmar, on their left. As he had hoped, the imperialists at once began to move troops from their right and centre for the defense of Colmar, whereupon Turenne, who had moved the rest of his army close up to the enemy's right, sent Foucault forward with 12 battalions and some cavalry and guns to cross the stream near its junction with the Fecht. On Jan. 5, 1675, Foucault attacked and brilliantly forced the imperial right back upon their centre. As Turenne had anticipated, the imperialists, fearful that their flank was turned, fell back upon Strasbourg. The losses were unimportant; but the battle was decisive, Alsace being cleared of its invaders.

TURKI, strictly speaking an Arabic or Persian adjective formed from Turk, used by European writers in two rather different senses. (1) It is applied to tribes or languages which are Turkish as opposed to Aryan, Semitic, etc. (2) It is used as the special designation of the tribes and languages of Kashgaria and eastern Turkistan. (*See* TURKS.)

TURKI LANGUAGE. The dialects of the Turkish language may be roughly divided into four main groups, namely (1) the oriental dialects of the Altai, (2) the western dialects including Kirghiz, Bashir and the Tatar of the Volga, (3) the dialects of central Asia with which this article will deal and (4) the

southern dialects, including Turkoman, Azerbaijani, Anatolian, Crimean and modern Ottoman Turkish (Osmanli). These dialects differ in a remarkably small degree from one another. There are, however, two Turkish dialects, namely, the Yakut and the Chuvash, which, owing to their isolation, have undergone considerable modification The Central Asian dialects which are spoken from the eastern frontiers of Persia as far as Hami on the edge of the Gobi desert include Taranchi, the Turki of Hami, Aqsu, Kashgar, Yarkand, Sart, the dialect of Kokand, and the Uzbeg of Bokhara and Khiva. The literary language of Chinese Turkestan is known as Eastern Turki or Jaghatai from the name of one of the sons of Jenghiz Khan who founded a Khanate in this region at the beginning of the 13th century. The first monuments to be discovered of the ancient Turkish language were those contained in the Orkhon inscriptions dating from the 8th century which were written in a Runic character. They were known to exist in 1730, but were only deciphered in 1893 by the Danish scholar Vilhelm Thomsen. Since then a vast manuscript literature in a similar language, both in Runic and in other alphabets notably the Uighur (derived through Sogdian from the Aramaic) has been rescued from under the sands of Central Asia. (Documents have also been found in Estrangelo [two forms], Brahmi, and even Tibetan.) When the Uighur alphabet was introduced is not exactly known, but it must, at a later stage, have overlapped with the Runic alphabet which was certainly employed in the 6th century of our era. Although with the submission and consequent conversion of Chinese Turkestan to Islam a vast number of Arabic words were introduced into the Turki language, the number of these was far smaller than was the case with Osmanli Turkish, and consequently old roots have been preserved in Turki which have almost entirely disappeared from the westerly dialects. The Uighur alphabet was still in use in the 14th century and mss have been found dating from the 15th century, but owing to the influence of the Arabian culture, it was finally discarded in favour of the Arabic alphabet. The Turki language spoken to-day from Yarkand to Hami is practically identical with the Turki of the 10th century. Down to the 14th century very few literary works were produced in Turki, but in the 15th, 16th and 17th centuries there appeared a large number of distinguished writers in that language among whom may be mentioned the great poet and patron of poets Mir Ali Shir Navai, the Sultan Babur and the historian Abul-Gazi Bahadur Khan. The characteristics of the Turkish languages have been described elsewhere. (*See* TURKISH LANGUAGE AND LITERATURE.) Turki is rich in verbal affixes which modify the root meanings. Shaw cites an example which illustrates the manner in which these affixes may be multiplied in a single word—in *Birlishturalmaidurman. Birmaq* is "to give"; *almaq* is "to take"; *biralmaq* is "to be able to give"; *biril* is "to be given"; *birilish* is "to be given to one another"; *birilishtur* is "to cause to be given to one another"; *mai* is the negative; *dur* is the present tense; *man* indicates 1st person singular. The whole thus means "I am unable to cause (them) to be given to each other."

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TURKISH LANGUAGE AND LITERATURE. Turkish, now generally understood as referring to the Osmanli or Ottoman Turkish speech of Europe and Asia Minor, is correctly the name of a family of tongues. The Turks were known to China in the 6th century A.D., and the Turkish inscriptions from the Orkhon river district in northern Asia bear dates from before the middle of the 8th century. The best known divisions of the Turks are the Uigurs, the Seljuks, and the Osmanlis. The last-named took Constantinople in 1453 and set up the Ottoman empire. (*See* TURKEY.)

The root of the name is *türk*, meaning "power" (or, as some authorities have it "to arrive at maturity"). The name is found in many languages from China to the Caucasus, but was not used by the Osmanli Turks until the beginning of this century. The Turkish languages are spoken over 140 degrees of longitude, from Macedonia to Siberia, and are characterized by a remarkable homogeneity. These languages are everywhere easily identifiable and leave ineffaceable marks on surrounding tongues (*e.g.*, in Mongolia and Siberia). The Asiatic Turks were at different periods decidedly forceful and their languages made attacks on other speech systems, analogous to those physical assaults made by the Turks on surrounding peoples.

A prominent feature of the Turkish languages is the vocalic harmony (prevailing throughout the family) upon the eight vowels, *ä, i, ö, ü; a, i, o, u.* The Turkish tongues are sweet-sounding and a comprehensive scheme of vowel-attractions governs the euphonic interests of the family. Nouns are declined and compounds can be built up by adding suffix to suffix: from *chal-(mak)*, "play a musical instrument" *chal-gi*, "a musical instrument"; *chal-gi-ji* "a musician," and with *-lär* (a sign of the plur.), *chal-gi-ji-lär*, "musicians." This building up from a stem is seen to perfection in the verb. The declension of nouns now comprises genitive, dative, accusative, locative, and ablative, although in earlier times there were other cases The plural (marked by the suffixes *-lär, -tär, -där,* and *-när*) is not invariably used: bir tavuk satmak, "to sell $\left\{\begin{matrix}\text{a}\\\text{one}\end{matrix}\right\}$ hen," *tavuk satmak*, "to sell hens." The copula is frequently omitted, in which event the order of words reveals the sense: *oglan öksüz* (lit. "boy orphan"), the boy is an orphan, and *öksüz oglan*, "a boy orphan."

The usual copula in the Turkish languages is the aorist of *durmak*, "to stand up." "The boy is an orphan" with the copula expressed would be *oglan öksüz tur-ur.* The construction of the sentence is accomplished by use of pronouns both before and after the predicate in accordance with the following table. (In the post-predicate position the pronoun is merely an enclitic.)

Verb and Pronoun Prefixes and Suffixes

Number and person.	Independent personal pronouns.	Copula suffix	Imperative suffix.	Possessive suffix.
Singular				
1st. pers.	*ban, man, mn*	*-ban, -van -man, -min, etc.*	*-ay, -ayin* *-eyin*, etc.	*-m*
2nd pers	*san, sin*	*-sin*	*-kil*	*-ng*
3rd pers.	*ol, ul*	*-durur, -dir*	*-sin, zin*	*-(s)i, -i*
Plural				
1st pers.	*biz, bis*	*-biz, bis*	*alim*	*-biz*
2nd pers.	*siz, sizler*	*-siz, -sizler*	*-iniz, -igiz*	*-ngiz*
3rd pers.	*olar, ular*	*durur, dirlar*	*-sin, -sinlar*	*-lari*

Suffixes to the general verb are of two kinds, (*a*) those forming nouns of action (*tran*), or in Osmanli *-dik* and (*b*) predicative suffixes which form other tenses or moods of the verb. These are added to the base, *e.g.*, from *atmak* (to throw), base *at-*+suffix *-in* or *-iniz* gives the imperative *atin, atiniz*, "throw!" Frequently, however, the base alone is used as an imperative and, except in its written form, the Turkish language in whatever dialect it is found is far from stable.

The Turkish numeral system is decimal. It is nearly, but not quite, uniform throughout the languages; it is possible that the parent idiom had not developed a complete system before the break-up of the primal family. In certain cases the colloquial has borrowed one or two number-names from surrounding peoples. The Osmanli Turkish numerals are:

1, *bir*, 2 *iki*, 3 *uch*, 4 *dört*, 5 *besh*, 6 *alti*, 7 *yedi*, 8 *sekiz*, 9 *doquz*, 10 *on*. Eleven is *on bir*, and so regularly to 20, which is *yirmi*; 30 *otuz*; 40 *kerk*; 50 *elli*; 60 *almish*; 70 *yetmish*, and so regularly to 100 (*yuz*). One thousand is *bin*.

The general outlines of the language have remained unchanged throughout the centuries, but in details there are wide differences between the languages of the different localities. The modern Ottoman (Osmanli) Turkish differs very widely from the Turkish tongues of northern Asia. It is much more harmonious to the

ear and much simpler in grammatical structure. It is a difficult task to trace the development of written Turkish from the *kök-türk* or pseudorunic script of the Orkhon regions through the Uigur script of Mongolia and Turkestan to the modern use in Turkey and central Asia of the Arabic script adapted to Turkish needs. For Turkish has used several different scripts, writing in Syriac characters (*Estrangelo*) and a modified form of this script called Manichaean, in Brahmi, in Tibetan, in Armenian, Greek and Hebrew The most modern development is the decision of the decree of the Turkish government in 1928 that the Roman alphabet should be universally substituted for the Arabic script.

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LITERATURE

During the rule of the Ottoman Sultans the Turks gave little sign of literary inventiveness and the two great schools, the old and the new, into which we may divide their literature were closely modelled, the one after the classics of Persia and the other after those of modern Europe, and more especially of France. The last 30 years have seen a steady development of the new school which, from being at first imitative or adaptive, has now struck out a line of its own Turkish literature has not however yet had time to manifest its reaction to recent drastic political and religious changes. Its most modern writers all belong to the period preceding the rise of Mustafa Kemal Pasha, and even the most advanced thinkers among Turkey's men of letters have never ventured under former régimes even to hint at such reforms as have been carried out by the order of one man. The old school may be conveniently divided into three periods, which may be termed respectively the pre-classical, the classical and the post-classical. Of these the first extends from the early days of the empire to the accession of Suleimān I., 1301–1520 (700–926); the second from that event to the accession of Maḥmūd I, 1520–1730 (926–1143); and the third from that date to the accession of 'Abd-ul-'Aziz, 1730–1861 (1143–1277).

The Pre-classical Period.—The works of the old school in all its periods are entirely Persian in tone, sentiment and form. Some two centuries before the arrival of the Turks in Asia Minor the Seljūḳs, then a mere horde of nomads, had overrun Persia, where they settled and adopted the civilization of the people they had subdued. Thus Persian became the language of their court and Government, and when by-and-by they pushed their conquests into Asia Minor, and founded there the Seljūḳ empire of Rūm, they carried with them their Persian culture, and diffused it among the peoples newly brought under their sway. It was among the descendants of those Persianized Seljūḳs that so-called Ottoman Turks rose to power in the middle of the 13th century (*see* TURKS). The Ottomans naturally absorbed the culture of the Seljūḳs, and an extraordinary love of precedent, apparent in all Islamic literature, was sufficient to keep their writers loyal to their early guide for centuries till at length the allegiance, though not the fashion of it, changed and, about the middle of the last century, Paris replaced Shīrāz as the shrine towards which the Ottoman scholar turned. The poetry of the old school is greatly superior to the prose.

Ottoman literature may be said to open with a few mystic lines, the work of Sultān Veled, son of Maulānā Jelāl-ud-Dīn, the author of the great Persian poem the *Mathnawī*. Sultān Veled flourished during the reign of 'Osmān I, though he did not reside in the territory under the rule of that prince. Another mystic poet of this early time was 'Āshik Pasha, who left a long poem in rhyming couplets, which is called, inappropriately enough, his *Divān*. The nocturnal expedition across the Hellespont by which Suleimān, the son of Orkhan, won Gallipoli and therewith a foothold in Europe for his race, was shared in and celebrated in verse by a Turkish noble or chieftain named Ghāzī Fāzil Sheikhī of Kermiyān, a contemporary of Moḥammed I. and Murād II., wrote a lengthy and still esteemed mesnevī on the ancient Persian romance of Khusrev and Shīrīn; and about the same time Yazijī-oghlu gave to the world a long versified history of the Prophet, the *Muḥammediya*. The writers mentioned above are the most important previous to the capture of Constantinople; but there is little literature of real merit prior to that event. The most notable prose work of this period is an old collection of stories, the *History of the Forty Vezirs*, said to have been compiled by a certain Sheikh-zāda and dedicated to Murād II. A few years after Constantinople had passed into the hands of the Ottomans, some ghazels, the work of the contemporary Tatar prince, Mīr 'Alī Shīr, who under the *nom de plume* of Nevā'ī wrote much that shows true talent and poetic feeling, found their way to the Ottoman capital, where they were seen and copied by Ahmed Pasha, one of the viziers of Moḥammed II. The poems of this statesman, though possessing little merit of their own, being for the most part translations from Nevā'ī, form one of the landmarks in the history of Ottoman literature. They set the fashion of ghazel-writing; and their appearance was the signal for a more regular cultivation of poetry and a greater attention to literary style and to refinement of language. In Sinān Pasha (d. 1420), another minister of Moḥammed the Conqueror, Ottoman prose found its first exponent of ability; he left a religious treatise entitled *Tasarru'āt* (Supplications), which, notwithstanding a too lavish employment of the resources of Persian rhetoric, is as remarkable for its clear and lucid style as for the beauty of many of the thoughts it contains Twenty-one out of the 34 sovereigns who have occupied the throne of 'Osmān have left verses, and among these Selīm I. stands as the most gifted and most original poet. The most prominent man of letters under this sovereign was the legist Kemāl Pasha-zāda, who left a romantic poem on the loves of Yūsuf and Zuleykhā, and a work entitled *Nigāristān*, which is modelled both in style and matter on the *Gulistān* of Sa'di. His contemporary, Mesīhī, whose beautiful verses on spring are perhaps better known in Europe than any other Turkish poem, deserves a passing mention.

Classical Period.—With the accession of Selīm's son, Suleimān I., the classical period begins. Fuzūlī (d. 1563), showed far more originality than any of his predecessors; for, although his work is Persian in form and in general character, he struck out a new line for himself Bāḳī (d. 1599) of Constantinople, though far from rivalling his contemporary Fuzūlī, wrote much good poetry. The Ottomans have been particularly successful with elegies; one by Bāḳī on Suleiman I. has never been surpassed. Rūhī, Lāmiī, Nev'ī, the janissary Yahya Beg, the mufti Ebu-Su'ūd and Selīm II. all won deserved distinction as poets. During the reign of Aḥmed I arose the second of the great poets of the old Ottoman school, Nef'ī of Erzerūm, who owes his pre-eminence to the brilliance of his ḳasīdas Nābī (d. 1712), who flourished under Ibrāhīm and Moḥammed IV. was a prolific author who imparted into Ottoman literature, a didactic style of ghazel-writing which was then being introduced in Persia by the poet Ṣā'ib; indeed, it is not always easy to know that his lines are intended to be Turkish. A number of poets took Nābī for their model. The glory of the classical period ending with Nedīm, dates roughly from the accession of Aḥmed I. 1603 (1012), to the deposition of Aḥmed III., 1730 (1143).

We will now glance at the prose writers of this period. Under the name of *Humāyūn Nāma* (Imperial Book) 'Alī Chelebi made a highly esteemed translation of the well-known Persian classic *Anvār-i Suheylī*, dedicating it to Suleiman I. Sa'd-ud-Dīn (d. 1599), the preceptor of Murād III., wrote a valuable history of the empire from the earliest times to the death of Selīm I. This work, the *Tāj-ut-Tevārīkh* (Crown of Chronicles), is reckoned, on account of its ornate yet clear style, one of the masterpieces of the old school, and forms the first of an unbroken series of annals

which are written, especially the later among them, with great minuteness and detail Of Sa'd-ud-Dīn's successors in the office of imperial historiographer the most remarkable for literary power is Na'īmā. His work, which extends from 1591 (1000) to 1659 (1070), contrasts strongly with that of the earlier historian, being written with great directness and lucidity, combined with much vigour and picturesqueness. Evliyā, who died during the reign of Moḥammed IV, is noted for the record which he has left of his travels in different countries. About this time Ṭash-kopri-zāda began and 'Aṭā-ullāh continued a celebrated biography of the legists and sheikhs who had flourished under the Ottoman monarchs. Ḥājī Khalīfa, frequently termed Kātib Chelebi, was one of the most famous men of letters whom Turkey has produced He died in 1658 (1068), having written a great number of learned works on history, biography, chronology, geography and other subjects. The Persianizing tendency of this school reached its highest point in the productions of Veysī, who left a *Life* of the Prophet, and of Nergisī, a miscellaneous writer of prose and verse. The first printing-press in Turkey was established by an Hungarian who had assumed the name of Ibrāhīm, and in 1728 (1141) appeared the first book printed in that country; it was Vankulī's Turkish translation of Jevheri's Arabic dictionary.

Post-classical Period.—Coming now to the post-classical period, we find among poets worthy of mention Beligh, Nevres, Ḥishmet and Sunbuli-zāda Vehbī, each of whom wrote in a style peculiar to himself. Three poets of note—Pertev, Neshet and Sheikh Ghālib—flourished under Selīm III The last-named is the fourth great poet of the old school. *Hum u 'Ashk* (Beauty and Love), as his great poem is called, is an allegorical romance full of tenderness and imaginative power. Ghālib's style is as original as that of Fuzūlī, Nef'ī or Nedīm.

When we reach the reign of Maḥmūd II., the great transition period of Ottoman history, during which the civilization of the West began to struggle in earnest with that of the East, we find the change which was coming over all things Turkish affecting literature, along with the rest, and preparing the way for the appearance of the new school The chief poets of the transition are Fāzil Beg, Wāṣif, 'Izzet Molla, Pertev Pasha, 'Ākif Pasha, and the poetesses Fitnet and Leylā. In the works of all of these, although we occasionally discern a hint of the new style, the old Persian manner is still supreme

More intimate relations with western Europe and a pretty general study of the French language and literature, together with the steady progress of the reforming tendency fairly started under Maḥmūd II., resulted in the birth of the new or modern school, whose objects are truth and simplicity. The transformation of Turkish literature and the creation of the Young Turk party were alike due to three great men, Shināsī, Kemāl and Ziyā. Shināsī's small volume of translations from various French poets appeared in 1859. In the following year he founded the first non-official journal in Turkey, in which he published in simple language articles dealing with the scientific and social questions from a modern European point of view. The first work of fiction ever translated into Turkish was Fénélon's *Télémaque* which appeared in 1862, the translator being Yusuf Kemāl Pasha. It was Ahmad Midhat who conceived the idea of writing stories depicting Turkish life and manners. The first collection of national tales appeared in 1870 In 1869 Ahmad Vefiq Pasha published translations of three of Molière's comedies, adapting the scenes and the names to suit local conditions. In 1871 appeared the first original Turkish drama, a form chosen by Abd-ul-Ḥaqq Ḥāmid for his best poetry.

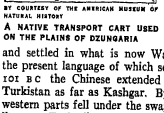
The Revolution of 1908.—The turning point in Turkish national conscience came with the Revolution of 1908, which marks the beginning of a new era. With the rise of democracy there naturally was felt the need of a closer collaboration between the cultivated classes and the people who had for centuries been kept at a distance from one another for the reason that men of letters only wrote for a small circle of intellectuals in a language and on subjects which were unteIligible to the lower classes. The battle cry of the new school was *Khalqa doghru*, "towards the people," and societies were formed like the Türk Derneyi at Constantinople and the Yeni Lisanjilar at Salonica, whose object was to introduce a new literary language adapted to the understanding of the people and a literature free from foreign influences. Among the foremost workers in this new field were 'Alī Jānib, Omar Saïfeddīn, and Ziyā Gök Alp (1875–1925), the real founder of the new Turkish nationalist movement, and last but not least Mehmed Emīn, a religious poet who came of lowly stock and as spokesman for the people has enjoyed very special popularity. The new movement found its first expression in newspapers, and all the new writers began as journalists or novelists or as poets contributing to newspapers. Among those who have attained the highest rank may be mentioned the following writers: Tewfiq Fikret (d. 1915), Jenāb Shehāb ad-Dīn (b. 1877), Nigar Khanum, a distinguished poetess (1871–1918), Mehmed 'Ākif (1870–1937), Khalīd Ziyā, Aḥmad Hikmet (b. 1879), Mehmed Ka'uf (b. 1875). Ya'qub Qadri (b. 1889), Khalidé Edib Hanum (b. 1883) and Husein Jahid (b 1875) Literary criticism is notably represented by Köpruli Zadé Mohammed Fūad Bey, one of the professors of Constantinople university, an ardent scholar who is engaged in compiling a new history of the Ottoman literature. (E. D R.)

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TURKISTAN, a name conventionally employed to designate the regions of Central Asia which lie between Siberia on the N. and Tibet, India and Afghanistan on the S., the western limit being the Caspian Sea and the eastern Mongolia and the Desert of Gobi. Etymologically the term is intended to indicate the regions inhabited by Turkish races. The regions called Turkistan not only contain races which do not belong to the Turk family, but exclude races which do, *e.g.*, the Turks of the Ottoman Empire. What was formerly called Eastern Turkistan is now mainly the southern portion of the Chinese province of Sinkiang (*q.v.*, see also TARIM, etc.), while the former West Turkistan is included in the Uzbek, Turkmen, Kazakstan, Kirghiz (*qq.v.*) and Tadzhik Socialist Soviet Republics (*see* TAJIK REPUBLIC).

HISTORY

Our knowledge of the history of Turkistan is very fragmentary until about the beginning of the Christian era. It may be that at a very early period East Turkistan was inhabited by an Aryan population When the Huns (Hiung-nu) occupied west and east Mongolia in 177–165 B.C. they drove before them the Yue-chi (*q.v.*), who divided into two hordes, one of which invaded the valley of the Indus, while the other met the Sacae in East Turkistan and drove them over the Tian-shan into the valley of the Ili. Thus, by the beginning of our era, the Tarim region had a mixed population of Aryans and Ural-Altaians, some being settled agriculturists and others nomads. There were also several independent cities, of which Khotan was the most important. One portion of the Aryans emigrated and settled in what is now Wakhhan (on the Pamir plateau), the present language of which seems very old. Between 120 and 101 B.C the Chinese extended their rule westwards over East Turkistan as far as Kashgar. By the end of the 5th century the western parts fell under the sway of the "White Huns" (Ephthalites, or Tochari), while the eastern parts were under Tangut (Thygun) dominion. An active trade was carried on by means of caravans, corn and silk especially being mentioned at a very early date.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

A NATIVE TRANSPORT CART USED ON THE PLAINS OF DZUNGARIA

The civilization and political organization of the country were

dominated by the Chinese, but were also influenced to some extent by Graeco-Bactrian civilization, which had probably secured a footing in the country as early as the 3rd century B.C. From the 2nd century to the first half of the 7th our knowledge is slight, and is derived chiefly from the *Journeys* of the Chinese pilgrims, Fa-hien in 399–415, Song-yun and Hwei-seng in 518–521, and Hsüan-Tsang in 629–645. By this time Buddhism had reached its culminating point: in Khotan there were 100 monasteries and 5,000 monks, and the Indian sacred literature was widely diffused In the 7th century the Tibetan king, Srong-btsan, with the help of the western Turks, subjugated the western part of the Tarim basin In 712–713 the Mohammedans, after excursions into West Turkistan, invaded East Turkistan. In 790 the Tibetans were masters of East Turkistan, but later (9th century) the territory fell under the rule of an Uighur people In the 11th century Mongol hordes overran East and West Turkistan and in the 14th, Tughlak Timur accepted Islam and shifted his capital from Aksu to Kashgar His son reigned at Samarkand, but in 1380 Timur devastated Dzungaria (*q.v.*) and East Turkistan.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

A SEKKOLIS MERCHANT OF SOUTHERN CHINESE TURKISTAN WEARING HIS NATIVE DRESS

Chinese Turkistan.—In the 14th and 15th centuries Bukhara and Samarkand became centres of Muslim scholarship and sent great numbers of their learned doctors to Kashgaria. Rubruquis, who visited East Turkistan in 1254, Marco Polo between 1271 and 1275; and Hoïs in 1680 all bore witness to great religious tolerance; but this entirely disappeared with the invasion of the Bukharian mullahs or Mohammedan priests. In the 17th century a powerful Kalmuck confederation arose in Dzungaria, and extended its sway over the Ili and Issyk-kul basins, having its capital on the Ili To this power or to the Kirghiz the "Whites" and "Blacks" alternately appealed in their struggles, in which Yarkand supported the latter and Kashgar the former. The Chinese entered Dzungaria in 1758, the Kalmucks fled, and Dzungaria became a Chinese province, with a military colonization of Sibos, Solons, Dahurs, Chinese criminals and Muslim Dzungars. The Chinese next re-conquered East Turkistan, marking their progress by massacres and transporting 12,500 partisans of independence to the Ili (Kulja) valley. Hereupon the dissentient khojas fled to Khokand in West Turkistan and there gathered armies of malcontents and fanatic followers of Islam. Several times they succeeded in overthrowing the Chinese rule —in 1825, in 1830 and in 1847—but their successes were never permanent. In 1867 another insurrection broke out; but a few months later the Chinese again took Kashgar. In the course of the Dzungarian outbreak of 1864 the Chinese were again expelled, and Yakub Beg became master of Kashgar in 1872. His rebellion was defeated in 1877 and a Chinese province under the name Sinkiang established in 1881. In 1932 occurred another Mohammedan rebellion, which was suppressed in 1937 by Governor Sheng Shih-tsai. Russia withdrew its control in 1943.

Old Russian Turkistan.—Soviet Central Asia comprises some part of Turkistan. Since Russia conquered Turkistan about 1865, Tashkent and Samarkand were occupied and further territory was absorbed and the whole united into Russian Turkistan. Until 1917 Russian Central Asia consisted of several territories, including the governor-generalship of Turkistan. After the revolution the Soviet Government established its power in these districts, and the khanates of Khiva and Bukhara were destroyed (1920). In the same year was set up a Peoples' Soviet Republic and the former governor-generalship of Turkistan became an Autonomous Socialist Soviet Republic within the R S F S R in 1921. In 1925 a redistribution took place and the new States of Uzbekistan, Turkmenistan and Tajikistan, together with several autonomous regions, were set up. The remaining Turkistan areas were linked with the Autonomous Kirghiz Socialist Soviet Republic

Afghan Turkistan.—Afghan Turkistan, now called the Mazar Province, the northern province of Afghanistan, is bounded on the east by Badakhshan, north by the Oxus river, north-west by Russia, and south by the Hindu Khush, the Koh-i-Baba, and the northern watershed of the Hari Rud basin, which separates it from the Herat Province. Its northern frontier was decided by the Russo-Afghan Agreement of 1873, and delineated by the Russo-Afghan Boundary Commission of 1885, which gave rise to the Panjdeh incident. With a length of some 500 m. and an average breadth, north to south, of 114 m., it comprises about 57,000 sq m., or two-ninths of the kingdom of Afghanistan. Except in the river valleys it is a poor territory, rough and mountainous towards the south, but subsiding into undulating wastes and pasture lands towards the Turkman desert, and the Oxus riverain, which is highly cultivated. The population, which is mostly settled in and around its towns and villages, is estimated at 800,000. The principal town is Mazar-i-Sharif.

The bulk of the people are of Persian and Uzbeg stock, interspersed by Mongol Hazaras and Hindus, with Turkoman tribes in the Oxus plains. Ancient Balkh or Bactriana was a province of the Achaemenian empire. About 250 B.C., Diodotus (Theodotus), governor of Bactria under the Seleucidae, declared his independence and commenced the history of the Graeco-Bactrian dynasties, which succumbed to Parthian and nomadic movements about 126 B C. Traces of the Buddhist era which succeeded remain in the rock-cut topes of Haibak. Devastated by Jenghiz Khan, it belonged to the Delhi empire for about a century, and then fell into Uzbeg hands. In the 18th century its khanates—Kunduz, Tashkurgan, Balkh with Akcha, and the four western khanates, or "Chahar Vilayet" of Saripul, Shibarghan, Andkhui and Maimana—formed part of the dominion of Ahmed Khan Durani, and so remained under his son Timur, but relapsed on Timur's death to the independent rule of various Uzbeg chiefs, dominated by Bukhara. Between 1850 and 1859 Amir Dost Muhammad re-established Afghan influence, but sovereignty over the Chahar Vilayet was disputed by Bukhara until settled in favour of Afghanistan by the Anglo-Russian Agreement of 1859.

Under the strong rule of Abdur Rahman these territories were more closely welded to Kabul, some relaxation of authority under Amir Habibullah having been made good by King Amanullah, who in 1927, together with his queen, visited Maimana, Mazar-i-Sharif, Tashkurgan and Kataghan, and by royal decree gave the district the name of the Mazar Province. In 1926, a dispute between Russia and Afghanistan regarding Urta Tagai, an island in the Oxus, was settled in favour of Afghanistan. A motor road and telegraph line linking the Mazar Province to Kabul were under construction in 1928. There are aerodromes, on the main Kabul-Tashkent air route, at Mazar-i-Sharif and Haibak. Half of Mazar-i-Sharif was destroyed by fire in June 1927. The Province is administered by a governor directly responsible to the Central Government. Schemes for the extension of cotton cultivation are under consideration. Mazar-i-Sharif is an important centre of the trade in astrakhan and furs.

TURKMEN REPUBLIC, a constituent member of the U.S.S.R., created in 1924. Area 187,142 sq.mi. Pop. (1939) 1,253,985 (urban 416,376; rural 837,609). Boundaries: west, the Caspian sea; south, Iran and Afghanistan; east, the Uzbek S.S.R.; north, Kazakstan, with the Kara-Kalpak A.S.S.R. The oasis of Khiva, incorporated in the Uzbek S.S.R., forms an island of separate territory in the northeast.

The changes in the course of the Jaxartes (Syr-darya) and the Oxus (Amu-darya), and the supposed periodical disappearance of Lake Aral, are problems in geography and it is here that we must look for a clue to the physical changes which transformed the Euro-Asiatic Mediterranean—the Aral-Caspian and Pontic basin—into a series of separate seas, and desiccated them,

powerfully influencing the distribution of flora and fauna, and centuries ago compelling the inhabitants of Western and Central Asia to enter upon their great migrations.

A mountain chain, comparable in length to the Alps, separates the deserts of the Transcaspian from the highlands of Khorasan. It begins in the Krasnovodsk peninsula of the Caspian, under the names of Kuryanyn-kary and Great Balkans, whose masses of granite and other crystalline rock reach an altitude of some 5,350 ft Farther south-east they are continued in the Little Balkans (2,000 ft.) and the Kopepet-dagh or Kopet-dagh. The latter rises steep and rugged above the flat deserts over a stretch of 600 mi. In structure it is homologous with the Caucasus chain; it appears as an outer wall of the Khorasan plateau, and is separated from it by a broad valley, which, like the Rion and Kura valley of Transcaucasia, is drained by two rivers flowing in opposite directions—the Atrek, which flows north-west into the Caspian, and the Keshef-rud, which flows to the south-east and is a tributary of the Murghab. On the other side of this valley the Alla-dagh (Aladagh) and the Binalund border-ranges (9,000 to 11,000 ft.) fringe the edge of the Khorasan plateau. Descending towards the steppe with steep stony slopes, the mountain barrier of the Kopet-dagh rises to heights of 6,000–9,000 ft. to the east of Kyzyl-arvat, while the passes which lead from the Turkmen deserts to the valleys of Khorasan are seldom as low as 3,500, and usually rise to 5,000, 6,000 and even 8,500 ft

While the Alla-dagh and Binalund border-ranges are chiefly composed of crystalline rocks and metamorphic slates, overlain by Devonian deposits, a series of more recent formations—Upper and Lower Cretaceous and Miocene—crops out in the outer wall of the Kopet-dagh. The mountains of Asia which stretch toward the north-west continued to be uplifted at a geologically recent epoch Quaternary deposits have an extensive development on its slopes, and its foothills are bordered by a girdle of loess.

The loess terrace, called Atok ("mountain base"), 10 to 20 mi. in width, is very fertile, but it will produce nothing without irrigation, and the streams flowing from the Kopet-dagh are few and scanty. The winds which impinge upon the northern slope of the mountains have been deprived of all their moisture in crossing the Kara-kum—the Black Sands of the Turkmen desert; and even such rain as falls on the Kopet-dagh (10½ in at Kyzyl-arvat) too often reaches the soil in the shape of light showers which do not penetrate it. Where the mountain streams run closer to one another, as at Geok-tepe, Ashkhabad, Lutfabad and Kaaka, the villages are more populous, and the houses are surrounded by gardens, nourished by irrigation

North of this narrow strip of irrigated land begins the desert—the Kara-kum—which extends from the mountains of Khorasan to Lake Aral and the plateau of Ust-Urt, and from the Caspian to the Amu-darya, interrupted only by the oases of Merv and Tejeñ. But the terrible shifting sands, blown into *barkhans*, or elongated hills, sometimes 50 and 60 ft in height, are accumulated chiefly in the west, where the country has more recently emerged from the sea Farther east the barkhans are more stable

The saksaul (*Anabasis ammodendron*) of the Kara-kum has been almost destroyed within the last hundred years, and occurs only sporadically, but the borders of the spaces covered with saline clay are brightened by forests of tamarisk, which are inhabited by great numbers of the desert warbler (*Atraphornis aralensis*)—a typical inhabitant of the sands—sparrows and ground-choughs (*Podoces*); the *Houbara macqueeni*, is characteristic of the region Hares and foxes, jackals and wolves, marmots, moles, hedgehogs and one species of marten live in the steppe

The Uzboi.—A feature distinctive of the Turkmen desert is the very numerous *shors*, or elongated depressions, the lower portion of which are mostly occupied with moist sand. They are obviously the relics of brackish lakes, and, like the lakes of the Kirghiz steppes, they often follow one another in quick succession, thus closely resembling river-beds. As the direction of the *shors* is generally from the higher terraces drained by the Amu-darya towards the lowlands of the Caspian, they led to the idea that the Amu-darya once flowed across the Turkmen desert towards what is now the Caspian sea. It was assumed, not only that that river (*see* Oxus) flowed into the Caspian, but that after having ceased to do so in the 7th century, its waters were again diverted to the Caspian about 1221. A chain of similar depressions was traced from Urgenj to the gap between the Great and the Little Balkans, this was marked on the maps as the Uzboi, or old bed of the Oxus. The idea of again diverting the Amu into the Caspian was thus set afloat, but the investigations of Russian engineers, especially A. E Hedroitz, A. M. Konshin, I. V. Mushketov, P. M. Lessar and Svintsov[1], went to show that the Uzboi is no river bed at all, and that no river has ever discharged its waters in that direction. The existence of an extensive lacustrine depression, now represented by the small Sary-kamysh lakes, was proved, and it was evident that this depression, having a length of more than 130 m., a width of 70 m., and a depth of 280 ft. below the present level of Lake Aral, would have to be filled by the Amu before its waters could advance farther to the south-west.

The ancient texts (of Pliny, Strabo, Ptolemy) about the Jaxartes and Oxus only become intelligible when it is admitted that, since the epoch to which they relate, the outlines of the Caspian Sea and Lake Aral have undergone notable changes, commensurate with those which are supposed to have occurred in the courses of the central Asian rivers. The desiccation of the Aral-Caspian basin proceeded with such rapidity that the shores of the Caspian cannot possibly have maintained for some twenty centuries the outlines which they exhibit at present. The general configuration of the Trans-Caspian region leaves no doubt that both the Jaxartes and the Oxus, with its former tributaries, the Murghab and the Tejeñ, *once* flowed toward the west; but the Caspian of that time was not the sea of our days; its gulfs penetrated the Turkmen steppe, and washed the base of the Ust-Urt plateau. (*See* Caspian Sea and Aral.)

Climate, etc.—The region between the Heri-rud and the Murghab is a plateau, 2,000 ft. above the sea, with hills 500 and 600 ft. high covered with sand, the spaces between being filled with loess. The Borkhut Mountains which connect the Kopet-dagh with the Sefid-kuh in Afghanistan reach 3,000 to 4,000 ft., and are cleft by the Heri-rud. Thickets of poplar and willow accompany both the Murghab and the Heri-rud. Pistachio and mulberry trees grow in isolated clumps on the hills; but there are few places available for cultivation. The climate is continental and the maximum temperature in the shade in summer varies between 105° F. at Tejend and 113° F. at Serakhs. The average summer temperature varies between 78° F. and 86° F. and winter between 34° F. at Merv and 37° F. at Termez. The rainfall is insignificant and falls in December, January, and February, summer being rainless and sultry. Thus cultivation depends entirely on irrigation.

Agriculture, etc.—The years of civil war and disorder following 1917 resulted in a sharp drop in the amount of cultivated land; irrigation canals were not cleaned or repaired and famine was widespread. As a result the number of cattle, especially sheep, was disastrously diminished, partly through slaughter and partly because herdsmen migrated into Persia and Afghanistan with their flocks. After the restoration of somewhat more settled conditions a complete revolution in social system was enforced, the old tribal holding of water rights was abolished and a new system of government control and distribution of water supply and of fertile land introduced. This involved much difficulty for the illiterate tribesmen, and conditions remained far from stable for many years, though a marked improvement began to be felt in the middle 1920s, especially in cotton growing, which was mechanized, and to which the soviet government attaches much importance. The grain and wheat crop is insufficient for the needs of the people. In the years following the revolution the number of agricultural machines increased greatly. The areas under cultivation are growing steadily. The Merv oasis (*q.v.*) is reviving, and an electric plant and new irrigation works have been constructed. Watermelons, fruits and vines are cultivated, and silkworm breeding is an ancient occupation, especially round Merv and Ashkhabad. In former times the silk was worked entirely as a peasant industry,

[1] Their original papers are printed in the *Izvestia* of the Russian Geographical Society, 1883 to 1887, also in the *Journal* of the Russian ministry of roads and communications.

but factories for large-scale silk manufacture have been constructed, particularly in Ashkhabad.

Peasant industries include the making of homespun and felt for local needs, the making of primitive agricultural implements and household goods, and the preparation of leather and silk goods. Carpet weaving is an ancient peasant industry for export, and each tribe has its own design, guarded as a secret from other tribes. The cutting off of income from carpet making during the civil war was a disaster. Horses, camels, working cattle, sheep (especially karakul), goats, asses and mules are bred. Their numbers are much below 1913 level, and sheep particularly have diminished.

Minerals.—Salt, Glauber's salt, ozokerite and naphtha exist. In pre-1914 times the output of salt was about 58,000 tons, during the civil war production ceased, but by 1926–7 it had risen to 31,600 tons. Ozokerite production in that year surpassed the previous level, reaching 700 tons as against 450 tons. The naphtha of the Ashkhabad district is little exploited, but that on Cheleken Island, which is obtained from natural fountains, yielded 450,000 tons in 1938. Rock salt is exported to Transcaucasia, Iran and Afghanistan, while Glauber's salt from the Kara-bugaz gulf is increasingly worked, and plans are under consideration for developing a superphosphate manure industry in the region. Vast resources of sulphur exist in the Kara-Kum desert north of Ashkhabad, and a recently constructed plant, reached by 155 mi. of motor road, has lessened Russia's dependence on imported sulphur. The chief town and administrative centre is Ashkhabad, the population of which increased from 13,737 in 1897 to 126,580 in 1939. Other towns are Krasnovodsk (29,600) and Merv (30,600), the last town grew rapidly after the construction of an electric power plant.

Industries.—Factory industries include cotton and wool cleaning, glass manufacture, flour milling, brewing and distilling; the preparation of dried fruit is increasing. Krasnovodsk on the Caspian is the port for the republic, its chief exports being cotton and dried fruits and its imports naphtha, timber, grain and sugar. During the civil war dredging operations ceased and the town consequently suffered. A fishing industry exists along the coast, especially near Chikishlar and Hassan-Kuli, but it is still considerably below the pre-World War I output of 10,000 tons. The Transcaspian railway is the chief means of communication, and there is a branch from Merv to Kushka on the southern frontier. The Amu-darya is difficult for steam navigation, and camel caravan is the chief trading link. Caravan routes cross the desert to the oasis of Khiva, to the various stations on the railway, to the port of Krasnovodsk and to the towns of north Iran. Much of the present income of the republic is going toward the provision of new irrigation canals and the sinking of wells. Its financial prospects are good in view of its trade with Iran and Afghanistan and the development of its mineral resources. The literacy rate among Turkomans rose from 2% in 1925, prior to the adoption of the Latin alphabet, to 61% in 1932.

Population.—The population consists of Turkmens 70.2%, Uzbeks 11.7%, Russians, Ukrainians and White Russians (chiefly in towns) 9.1%, Armenians 1%, Kirghiz 0.7%, with a few Iranians and Bokhara Jews. About half of the Turkmen tribes live in the republic, the rest being found in Iran and Afghanistan. Turkmen tribes seem to have been settled in the steppe between the Oxus (Amu-darya) and the Caspian from time immemorial and are of the west-central Turkish group. They are mentioned by Arab writers of the 10th century and were noted even at that time as much feared by their neighbours owing to their warlike disposition. Up to the time of the defeat of the Tekke tribe at Geoktepe in 1881 by the Russians, they preserved their nomadic predatory life, frequently holding Russian and Persian captives for ransom, and were perpetually engaged in tribal warfare. Since the Russian conquest many have taken to settled life, though much semi-nomadism and some pure nomadism still exists. The Yamut tribe, which formerly wandered in the steppe to the southeast of the Caspian, is now mainly occupied at the naphtha works in Cheleken Island, while other Yamuts settled as agriculturalists in Khiva in the early 19th century. The Tekkes, who were the most important tribe at the time of the Russian occupation (1881) are much scattered; many have become settled cultivators. In early times they inhabited the Mangishlak peninsula, but were driven out by the Kalmucks in 1718. Later they occupied the Akkal and Merv oases. The most ancient tribe was the Salors, who occupied the western corner of the Paropamisus range, and with whom the Arabs came in contact on their march towards the Oxus in the 7th century. Intertribal strife, and emigration to the oases and to Iran have much reduced their numbers. The Ersaris, formerly a warlike tribe of the Mangishlak peninsula, were driven by the Uzbeks to the steppe south of the Ust-Urt plateau, and settled as peaceful cultivators on the left bank of the Oxus. The building of the Transcaspian railway further altered their habits, as did the introduction of naphtha and salt working. Up to the October 1917 revolution they preserved their tribes and clans, and, though these did not disappear at once, the confiscation of water and property from the chieftains drove a sharp wedge into traditional custom and paved the way for tribal disintegration. For history of Merv oasis *see* MERV.

See the researches of Andrusov, Bogdanovich, Konshin, Mushketov and Obruchev in the *Trav.*, the *Bulletin* (*Izvestia*) and the *Annals* of the Russian Geographical Society (1890–1900); P. M. Lessar, *L'Ancienne jonction de l'Oxus avec la mer Caspienne* (1889); Zarudnoi (zoology) in *Bulletin de la société des naturalistes de Moscou* (1889 *seq.*); N. L. Arkhipov, *Central Asiatic Republics*, 1927 (in Russian, with a bibliography).

TURKOMANS, a group of the Iranian Turks, found in Iran, Khiva, Bokhara, in the Caucasus, and in Transcaspia, and probably numbering about 1,000,000. They include the following clans, Chaudor, Yomut, Goklan, Akhal, Merv Tekkes, Sarik, Salor and Ersari. The clan divisions are endogamous, and owing to the scarcity of women a high bride price is paid, and many of the men are unmarried. A large number of the Turkomans are nomadic horse-breeders, although some have become agriculturists. All of them are Moslems. Some of the Turkomans of the steppes appear to preserve the old Proto-Nordic physical type, but in most places they have absorbed the physical type and much of the culture of the people among whom they live. (*See* TURKS; ASIA: *Anthropology and Ethnology.*) (L. H. D. B.)

TURKS. The term Turk is purely linguistic and refers to those peoples who speak Turkic languages, having no racial sense. The Turks may be divided into two groups: a western, which includes the Osmanli, the Turks of what was formerly "Turkey in Europe and Turkey in Asia," the old Ottoman empire, and the eastern Turks, including many of the peoples of Turkistan and central Asia, as far as the river Lena. There are also Turks in the Crimea, in the Caucasus, and along the Volga. The latter are culturally entirely associated with the eastern Europeans, as are the Osmanli with the southeastern Europeans and western Asiatics, but linguistically they are associated with the western Turks (For racial history *see* ASIA: *Anthropology and Ethnology.*) The eastern Turks include the Turks of Turkistan and the Caspian steppes, who have become largely absorbed culturally and physically in the Iranian peoples, and may be conveniently called Iranian Turks, and the Turanian Turks, many of whom are called Tatars (this rather than the more familiar "Tartar" is the more correct spelling), of the Steppes, of southern Siberia, Dzungaria and northern Mongolia. The Iranian Turks include the Turkomans, the Sarts, the Taranchi or Ili Tatars, the Uzbegs, the Kalzak and the Kara Kalpak. The Turanian Turks include the Khirghiz, a somewhat loose term, the Kakut and the Siberian Tatars.

The social organization of the Turks is based on a patriarchal system of sub-clans, all related by blood, and these sub-clans are gathered together in a loose confederacy of the clan (sok).

There is no definite mode of life which can be associated with the Turks as a whole; the western Turks and most of the Iranian Turks are sedentary agriculturalists, while those eastern Turks who have been most subject to migrations and live under steppe conditions have adopted the horse culture found in its most typical form among the Mongols (*see* MONGOLIA), while the Yakuts practise the reindeer culture of eastern Asia.

The western Turks are Moslems, but to the east, in spite of the superimposition of higher religions, including formerly Nestorian Christianity, which at one time was a serious rival of Islam, much

of the animistic old religions remain, and shamanism is a specially important feature among the eastern and northern tribes.

It is almost impossible to make any generalized statement about the Turks; their most potent bond is that of language, they have no uniform culture, no uniform religion or physique, and even the features of some of the ceremonies of the Kirghiz, considered by Czaplicka to be one of the purest of Turkic tribes, are almost exactly similar to those of the Mongols. Ethnologically, therefore, they must be referred to the regions in which they live.

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HISTORY

The discovery near the river Orkhon, to the south of Lake Baikal, of Turkish inscriptions dating from the 8th century A.D., and the publication of materials furnished by Chinese writers, has stimulated interest in the history of the Turkish movements in Asia.

Early Period.—From 1400 B.C. onwards, but especially about 200 B.C., Chinese history contains notices of warlike nomads called Hiung-nu or Hsiung-nu. Their political power broke up in the early centuries of this era before the advance of the Sien-pi and Tobas, who appear to have been Tunguses, and from whom arose the Wei dynasty of northern China. In A.D. 433 a Hiung-nu clan called Asena or A-shih-na, disliking the rule of the Wei, moved eastwards and sought the protection of a people called Jeu-Jen or Jwen-Jwen, who were also a kind of Hiung-nu They are the Geougen of Gibbon and others, and their identity with the Avars has been affirmed and disputed with equal confidence. The Asena served the Jwen-Jwen as workers in iron and lived not far from the modern city of Shan-Tan in Kan-suh. In this neighbourhood was a hill called from its shape Turkü, Durku or T'u-chueh, meaning helmet, and this is said to be the origin of the national name which has become so celebrated The name Tu-Kiue (Tou-Kiue) or Turk is first used by the Chinese in recording the events of A.D. 545, and the following years, when the Turks, or descendants of the Asena, revolted against the Jwen-Jwen. These latter were crushed and disappear from history, at least under that name. The victorious Turks advanced across their territory, came into collision with the Hephthalites or Ephthalites (*q.v.*), whom they defeated, and are heard of on the Oxus (*q.v.*), about A.D. 560. The period 546–582 marks the first brilliant epoch of early Turkish history. The tribes were not divided and made the most astounding advance Under Tumen (who took the title of Il-Khan), his brother Itsâmi or She-ti-mi (perhaps the Stembis of Greek writers), his son Mokan and Istâmi's son Tardu or Ta-t'eu. Though fifty years before only a servile clan in China, they sent an embassy in 567 to the East Roman emperor Justin II., as related by Menander Protector (C. Müller: *Fragm. hist. graec.*, vol. iv.). In 598 the khan Tardu wrote to the emperor Maurice, and in 620–28 the Turks assisted Heraclius in his campaigns against Persia. Meanwhile the Turks had themselves split into two divisions with separate princes. A tendency towards division, very natural in so loose and extended a community, had been visible for some time, and the rupture was precipitated in 582 by the jealousy of Ta-lo-pien or Dalobian, who was angry at not being chosen khan For a century and a half or so we hear of two khanates: the northern Turks, living near Lake Baikal and the southern tributaries of the Yenisei, and the western Turks, who appear to have had two headquarters, one near Urumchi and one near Aulieata, north of Tashkent. But their conquests, or at least their successful raids, extended very much farther to the west and south. In 630 the Chinese pilgrim Yüan Chwang (Hsüan Tsang) was well received by their khan, T'ung-she-ho, who exercised some kind of authority from Turfan to Merv. The Chinese followed a consistent policy of spreading dissension among these dangerous tribes and of supporting the factions that were weak or distant against those that were strong or near. Accordingly they were friendly to the western Turks until they had conquered the northern Turks. This western branch lasted until about 750 as a political name From about 550 till 650 they were independent, and, as mentioned. allies of the east Roman Empire against the Persians But about 650 the politics of the Nearer East were transformed by the conquests of the Arabs following on the preaching of Mahomet. After subduing Persia in 639 they spread to Transoxiana. At the same time dissension prevailed among the western Turks themselves: the five tribes called Nu-she-pi, who lived west of Issyk-kul, quarrelled with the five tribes called Tu-lu and in living to the east of it. The Chinese fomented the quarrel, and in 659 were able to declare that they annexed the whole territory of the western Turks, including at least Dzungaria, Tashkent, Ferghana, Bokhara, Khulm, Badakshan, Ghazni, Bamian, Udyana, Wakhan and Karateghin. But it would seem that neither the Turkish occupation nor the Chinese annexation of most of these countries was effective From 650 to 750 the possession of them was disputed not only by the Turks and Chinese but by the Tibetans in the east and the Arabs in the west In the west, the campaigns of Qotaiba b. Muslim or Kutaiba (705–14) completed the Mohammedan conquest of Transoxiana (*see* CALIPHATE, sect. B § 6).

For the history of the northern Turks our only authorities are the Orkhon inscriptions and Chinese writers The half-century following on the division was prosperous for the northern as well as for the western Turks, and they menaced China; but in 630 the Chinese conquered them. This is the Chinese servitude mentioned in the inscriptions. In 682 Kutluk (also called Elteres, which seems to be a title) re-established a Turkish state on the Orkhon He was succeeded by his brother Kapagan (or Me-Chuo), who subdued the Turgäsh, or perhaps merely drove them southwards, early in the 8th century, and was succeeded by Bilgä Kagan of the inscriptions.

This northern khanate was destroyed by a coalition of the Karluk, Uighur and Basmal in 744. These peoples, like the Turgäsh, appear to have been Turkish A succession of these pressed forward from the east. When first heard of, the Karluk inhabited the country on the Irtysh and the Urungu, and subsequently occupied Teles and Tokmak The Uighurs belonged to the group of tribes known as Tölös or T'ie-le and established themselves at Balasaghun (also known by the forms Kara-Balghasun, Kara-Balgassun and Balgasun· *see* KARAKORUM). This brings us to the middle of the 8th century For the next two hundred years the Turkish element in Central Asia, though it must have been numerous, does not cut any figure in history, which is filled with the chronicles of Arab and Persian dynasties (*see* CALIPHATE; SAMANIDS), but in the 10th century we begin to hear of it again. Turkish adventurers founded the dynasty of Ghaznevids at Ghazni, and there was a Uighur kingdom in the east comprising Kashgar and Khotan. Boghra Khan, the ruler of this kingdom, was converted to Islam at the end of the 10th century, and it continued under various branches of Uighurs until 1120. More important politically is the rise of the Seljuks. They were the princely family of the Kabaks, who were a section of the group of tribes called Ghuzz (Oghuz, Oğŭz), and are heard of in Transoxiana about 985 Their chieftains Toghrul and Chakir drove the Ghaznevids to India and established themselves as protectors of the Abbasid caliph, who formally ceded his temporal power to them. (For the history of the dynasty *see* SELJUKS.) Alp Arslan, the son of Chakir, defeated the Byzantines at Manzikert (1071), and prepared the way for the Ottoman conquests. His son Malik Shah ruled over nearly all the modern Turkey in Asia, and as far as the frontiers of China. On his death in 1092 his empire broke up into several pieces. Konia became the capital of the sultanate of Asia Minor and various Seljuk dynasties established themselves in Kerman, Irak and Syria. A new Turkish power was founded by the khans of Khiva, who are known as the Khwarizm-shahs. They were originally vassals of the Seljuks, with the title of tasdar or ewer-bearer, but became independent and conquered Khorasan and Irak. They had, however, to contend with yet another new arrival from the east, the Kara-Kitais. These also were probably Turks, and were pushed westwards from China by the Kins. They conquered Kashgar, Khotan, Yarkand and later Transoxiana, pushing the Ghuzz tribes before them into Persia and Afghanistan. Their prince bore the title of *gur-khan*, and the Khwarizm shahs did homage to him till

1208, when they unsuccessfully revolted. But all these squabbling principalities were swept away in 1219 by the extraordinary wave of invasion which surged across Asia to Europe under Jenghiz Khan (*q.v.*). After the death of Jenghiz his conquests were divided, and Transoxiana, Kashgar, Badakshan, Balkh and Ghazni were given to his second son Chagatai or Jagatai. Jenghiz and his family must have been Mongols, but the name Jagatai passed to the population and language of the countries about the Oxus. In 1321 the Jagatai khanate split into two khanates, Transoxiana and Dzungaria, and in 1370 collapsed before Timur. This great conqueror (1336–1405), who like Jenghiz had an extraordinary power of collecting and leading the hordes of Central Asia, was a native of the district of Samarkand and a Turk by descent. He conquered successively Dzungaria (1370), Persia and the Caucasus (1390), the Kipchaks on the Volga (1395), and Northern India (1398). He then invaded Syria and Asia Minor, where he defeated but did not annihilate the Osmanlis. The house of Timur did not retain his more distant conquests, but they ruled at Samarkand until 1499 with the usual struggles between different branches of the family. Their possessions included, at least from time to time, the northern parts of Afghanistan and Persia, as well as Transoxiana and Turkestan. They were one of the most enlightened and cultivated of Turkish dynasties. They beautified the cities of Central Asia and were patrons of literature. The literary languages were as a rule Arabic or Persian; Turkish was used more rarely and chiefly for poetry.

The Timurids were overthrown and succeeded by the Shaibani dynasty, a branch of the house of Juji, Jenghiz Khan's eldest son, to whom his father had assigned dominions in the region north of the kingdom of Jagatai. About 1465 a number of this clan migrated into the Jagatai khanate. They were given territory on the Chu River and were known as Uzbegs. About 1500 their chief, Mahommed Shaibani or Shahi Beg, made himself master of Transoxiana and founded the Uzbeg power. The chief opponent of the Uzbegs in their early days was Baber, who represented the house of Timur in the fifth generation, but he ultimately led his armies in another direction and invaded India (1526), where he founded the Mogul Empire, a far more important state than the principalities of the Oxus.

The Osmanlis, or house of Osman, the founders of the present Turkish Empire, appear to have been a clan similar to the early Seljuks or the present Turkomans of Transcaspia, who migrated into Asia Minor from Khorasan and made the neighbourhood of Brusa their headquarters. Their conspicuous position in history is mainly due to the fact that they attained pre-eminence very late and in districts very near Europe. Except for the invasion of Timur they did not suffer from the attacks of other Turks and they were able to concentrate their strength on the conquest of the decrepit Byzantine Empire. *See* TURKEY.

TURKS AND CAICOS ISLANDS, a group in the British West Indies, are geographically a part of the Bahamas but politically a dependency of Jamaica. The area is about 166 sq mi The population, mostly Negro, was 6,138 by the 1943 census and was estimated at 6,500 in 1950.

The Turks Islands, so named from a local cactus resembling a Turkish fez, are eight in number, but only two, Grand Turk (9 4 sq.mi., pop. 1,800) and Salt Cay (5½ sq.mi., pop. 400) are regularly inhabited. These two and Cockburn Harbour on South Caicos are ports of entry. The Caicos group, northwest of the Turks, includes six principal islands, South Caicos and North Caicos being the most important. The mean temperature is 82° F, but due to the prevailing trades the climate is not oppressive. Rainfall averages only 29¾ in. annually and drinking water is scarce, being rationed at times. Hurricanes are not infrequent. An unusually violent one in 1945 caused great damage.

Salt raking is the staple industry, with an average annual export of 43,000 tons, about half from South Caicos. Conchs and crayfish are also exported. Grand Turk, the seat of government, is an important cable junction, with cables to Jamaica, Bermuda and Barbados. There is frequent shipping and air service to Kingston, Jamaica. The islands were discovered by Juan Ponce de Leon in 1512 but were uninhabited until 1678, when Bermudians arrived and began the salt-raking industry. They were expelled by the Spanish in 1710 but soon returned, remaining despite Spanish and French attacks. In 1799 the islands were given representation in the Bahamas assembly but in 1848, on petition from the inhabitants, they were placed under Jamaica as a separate colony. In 1873 they were annexed by Jamaica. They are governed by a commissioner assisted by a legislative board. A small American air base was maintained on South Caicos from 1944 to 1947 and a guided missile base was established on Grand Turk in 1952.

(L. W. BR.)

TURKU (Swedish *Åbo*), a seaport of Finland on the Gulf of Bothnia. Pop. (1940) 75,419. It is the second largest town in Finland, and has a shipbuilding and repairing industry. An ice-breaker keeps the port open throughout the winter.

There are four entrances to the harbour, with lighthouses for each, and there are four patent slips capable of taking vessels up to 1,200 tons. The chief imports are salt, salt fish, pig iron, oils, coal, cotton, machinery and colonial goods, and the exports timber, grain, butter, bar iron, pork, beef and game. There is a considerable coasting trade.

After the Diet of Borgå in 1809, Turku became capital of the Russian Grand Duchy of Finland, but in 1819 the government was moved to Helsinki. It was founded in 1229 and has been a centre of Swedish culture, having a Swedish as well as a Finnish college.

TURKU-PORI (ÅBO-BJÖRNEBORG), a department in the southwest of the republic of Finland. Area (in English square miles), 8,500. Pop. (1940) 513,346. It is a lowland region containing much boulder-clay soil and a consequent imperfect drainage. The department, together with most of Finland, has not yet recovered from the effects of severe glaciation. Finnish and Swedish are spoken. The chief towns are Turku (Åbo), pop. (1940) 75,419; and Pori (Björneborg), 22,661.

TURMERIC, the tuberous rhizomes of *Curcuma longa,* an herbaceous perennial plant belonging to the family Zingiberaceae. It is a native of southern Asia, being cultivated on a large scale both on the mainland and in the islands of the Indian Ocean. Turmeric has been used from a remote period both as a condiment and as a dyestuff, and was once employed to a more limited extent as a medicine. In Europe it is employed chiefly as a dye, also as an ingredient in curry powder and as a chemical test for alkalies. The root (rhizome) is prepared by cleaning it and drying it in an oven. There are several varieties (Madras, Bengal, Gopalpur, Java, China and Cochin turmeric), differing chiefly in size and colour of the tubers and to a slight degree in flavour. All are hard and tough, but break with a short resinous or waxy fracture; the exposed surface varies in tint from an orange brown to a deep reddish brown. The colour is due to *curcumin,* $C_{21}H_{20}O_6$, of which the drug contains about 0·3%. When pure it forms yellow crystals having a vanilla odour and exhibiting a fine blue colour in reflected light. On oxidation with potassium permanganate it gives vanillin, the flavouring and odorous material of vanilla (*q.v.*). It is soluble in alcohol, in chloroform, but only sparingly in water. Paper tinged with a tincture of turmeric exhibits on the addition of an alkali a reddish brown tint, which becomes violet on drying, a test for alkalinity discovered by H. A. Vogel in 1815.

TURNEBUS, ADRIANUS [ADRIEN TURNEBE] (1512–1565), French classical scholar, was born at Les Andelys in Normandy, and at the age of 12 was sent to Paris to study. After having held the post of professor of belles-lettres in the University of Toulouse, in 1547 he returned to Paris as professor (or royal reader) of Greek at the Collège Royal. In 1552 he was entrusted with the printing of the Greek books at the royal press, in which he was assisted by his friend, Guillaume Morel (*q.v.*). He died of consumption on June 12, 1565. His works chiefly consist of philological dissertations, commentaries (on Aeschylus, Sophocles, Theophrastus, Philo and portions of Cicero), and translations of Greek authors into Latin and French. His son, Etienne, published his complete works, in three volumes (Strasbourg, 1600), and his son Adrien his *Adversaria,* containing explanations and emendations of numerous passages in classical authors.

See *Oratio funebris* by Léger du Chesne (Leodegarius a Quercu) prefixed to the Strasbourg edition; L. Clément, *De Adriani Turnebi praelaudibus et poematis* (1899); J. E. Sandys, *History of Classical Scholarship* (1908) iii.

TURNER, CHARLES (1774–1857), English engraver, was born at Woodstock on Aug. 31, 1774. He entered the schools of the Royal Academy in 1795; and, engraving in stipple in the manner of Bartolozzi, he was employed by Alderman Boydell. His finest plates, however, are in mezzotint, a method in which he engraved J. M. W Turner's "Wreck" and 24 subjects of his *Liber studiorum*, Reynolds's "Marlborough Family," and many of Raeburn's best portraits, including those of Sir Walter Scott, Lord Newton, Dr Hamilton, Professors Dugald Stewart and John Robinson, and Dr. Adam. He also worked after Lawrence, Shee and Owen. He was an admirable engraver, large, broad and masterly in touch. He died on Aug. 1, 1857.

TURNER, FREDERICK JACKSON (1861–1932), American historian, was born at Portage, Wis., on Nov. 14, 1861, and educated at the University of Wisconsin (A.B., 1884, A.M., 1888) and Johns Hopkins (Ph.D., 1890). He was assistant professor, 1889–91 and professor, 1892–1910, of American history at the University of Wisconsin. From 1910 to 1924 he was professor of history at Harvard, and afterwards professor emeritus. In 1927 he went to San Gabriel, Calif., to assume direction of research in the *Americana* of the large Henry E. Huntington library. His publications are few but they have been of great importance in their influence upon the interpretation and the writing of American history. In his essay "The Significance of the Frontier in American History," first published in the *Report of the American Historical Association* for 1893, he set forth the thesis that the frontier was up to that date the most influential factor in American history and in the development of a distinctly national character. Various other essays collected in *The Frontier in American History* (1921) amplify various phases of his thought and illustrate it by type studies. His viewpoint was also illustrated in his excellent study *The Rise of the New West* (1906) in the American nation series. Turner's students are numerous among American history teachers and writers of mid-west universities and historical societies, and through their agency, perhaps more than through his writings, his ideas have been made vital in American historiography.

TURNER, JOSEPH MALLORD WILLIAM (1775–1851), English painter, was born in London on April 23, 1775. His father, William Turner, a native of Devonshire, kept a barber's shop at 26 Maiden Lane, Covent Garden. His mother died insane. The earliest known drawing by Turner, a view of Margate Church, dates from his ninth year. His father taught him to read, and this and a few months at a school at New Brentford and afterwards at Margate were all the schooling he ever had; he never mastered his native tongue. Yet, one of his strongest characteristics was a taste for associating his works with personages and places of legendary and historical interest.

Early Training.—By the time Turner was thirteen he had chosen an artist's career. In 1788–89 he was receiving lessons from Palice, "a floral drawing master;" from T. Malton, a perspective draughtsman, and from Hardwick, an architect. He also attended Paul Sandby's drawing school in St. Martin's Lane. Part of his time was employed in making drawings at home, which he exhibited for sale in his father's shop window, two or three shillings being the usual price. He coloured prints for engravers, washed in backgrounds for architects, went out sketching with Girtin, and made drawings in the evenings for Dr Munro "for half a crown and his supper." In 1789 Turner became a student of the Royal Academy. He also worked for a short time in the house of Sir Joshua Reynolds. In 1790 he exhibited for the first time at the Royal Academy, a "View of the Archbishop's Palace, Lambeth." About 1792 he received a commission from Walker, the engraver, to make drawings for his *Copper-Plate Magazine*, and this topographical work took him to many interesting places. A year or two after he accepted a similar commission for the *Pocket Magazine*, and before his twentieth year he had travelled over many parts of England and Wales. None of these magazine drawings is remarkable for originality or for artistic feeling.

Until 1792 Turner's practice had been almost exclusively in water colour, and his early works show how much he was indebted to some of his contemporaries, such as J. R. Cozens. His first exhibited oil picture appeared in the Academy in 1793. In 1794–95 Canterbury Cathedral, Malvern Abbey, Tintern Abbey, Lincoln and Peterborough Cathedrals, Shrewsbury, and King's College Chapel, Cambridge, were among the subjects exhibited, and during the next four years he contributed no less than thirty-nine works to the Academy. In the catalogue of 1798 he first began to add poetic quotations to the titles of his pictures, showing that his mind was now occupied with something more than the merely topographical element of landscape. Milton's *Paradise Lost* and Thomson's *Seasons* being laid under frequent contribution for descriptions of sunrise, sunset, twilight or thunderstorm. Turner's first visit to Yorkshire took place in 1797. It seems to have braced his powers and possibly helped to change the student into the painter. Until then he was little more than a painstaking and tolerably accurate topographer, but even under these conditions he had begun to attract the notice of his brother artists and of the critics. The only formidable rivals Turner had to contend with were De Loutherbourg and Girtin, and after the death of the latter in 1802 he was left undisputed master of the field.

(1799–1804).—In 1799 he was elected A.R.A. (age 24), and by 1800 had moved to Harley Street. He was elected R.A. in 1802. He enjoyed the dignity of Academician for nearly half a century, and he took an active share in the direction of the Academy's affairs. His speeches are described as "confused, tedious, obscure, and extremely difficult to follow"; but at council meetings he was ever anxious to allay anger. His opinions on art were always listened to with respect; but on matters of business it was often difficult to know what he meant. His friend Chantrey used to say, "He has great thoughts, if only he could express them." When appointed professor of perspective to the Royal Academy in 1808, this painful lack of expression stood greatly in the way of his usefulness. Ruskin says, "The zealous care with which Turner endeavoured to do his duty is proved by a series of large drawings, exquisitely tinted, of the most difficult perspective subjects, illustrating not only directions of line, but effects of light, with a care and completion which would put the work of any ordinary teacher to utter shame." With his election to the associateship of the Academy Turner's early struggles may be considered to have ended. He abandoned topographical fidelity and began to paint his dreams, the visionary faculty—the true foundation of his art—asserting itself, nature being used to supply suggestions and materials. His work is described by Ruskin as "stern in manner, reserved, quiet, grave in colour, forceful in hand."

Turner's visit to Yorkshire in 1797 was followed a year or two later by a second, when he made the acquaintance, which afterwards ripened into a long and staunch friendship, of Fawkes of Farnley Hall. From 1803 till 1820 Turner was a frequent visitor at Farnley. The large number of his drawings still preserved there—English, Swiss, German and Italian, the studies of rooms, outhouses, porches, gateways, of birds shot while he was there, and of old places in the neighbourhood—prove the frequency of his visits and his affection for the place. Turner visited Scotland in 1800, and in 1801 or 1802 he made his first tour on the Continent. In the following year, of the seven pictures he exhibited, six were of foreign subjects, among them "Bonneville," "The Festival upon the Opening of the Vintage of Mâcon," and the well-known "Calais Pier" in the National Gallery. The last-named picture, although heavily painted and somewhat opaque in colour, is magnificently composed and full of energy. In 1802 he took his father, who still carried on the barber business in Maiden Lane, to live with him. Turner was never the same man after his father's death in 1830, when he lived a solitary life.

The Liber Studiorum.—In 1804 Turner made a second tour on the Continent, and in the following year painted the "Shipwreck" and "Fishing Boats in a Squall" (in the Ellesmere collection), seemingly in direct rivalry of Vandervelde, in 1806 the "Goddess of Discord in the Garden of the Hesperides" (in rivalry of Poussin), and in 1807 the "Sun rising through Vapour" (in

rivalry of Claude) The last two are notable works, especially the "Sun." In after years it was one of the works he left to the nation, on the special condition of its being hung beside the Claudes in the National Gallery. In this same year (1807) Turner commenced his most serious rivalry Possibly it arose out of a desire to break down Claude worship—the then prevailing fashion—and to show the public that there was a living artist not unworthy of taking rank beside him. That the *Liber studiorum* was suggested by the *Liber veritatis* of Claude, and was intended as a direct challenge to that master, is beyond doubt. There is, however, a certain degree of unfairness to Claude in the way in which the challenge was given Claude made drawings in brown of his pictures as they left the easel, not for publication, but merely to serve as private memoranda Turner's *Liber* drawings had no such purpose, but were intended as a direct appeal to the public to judge between the two artists. The first of the *Liber* drawings was made in the autumn of 1806, the others at intervals till about 1815 They are of the same size as the plates and carefully finished in sepia He left over fifty of these to the National Gallery. The issue of the *Liber* began in 1807 and continued at irregular intervals till 1819, when it stopped at the fourteenth number Turner had resolved to manage the publishing business himself, but in this he was not very successful He soon quarrelled with his engraver, F. C Lewis, on the ground that he had raised his charges from five guineas a plate to eight. He then employed Charles Turner, who agreed to do fifty plates at the latter sum, but, after finishing twenty, he too wished to raise his price, and, as a matter of course, this led to another quarrel. Reynolds, Dunkarton, Lupton, Say, Dawe and other engravers were afterwards employed—Turner himself etching and mezzotinting some of the plates

Each part of the *Liber* contained five plates, the subjects, divided into "historical," "pastoral," "marine," etc, embracing the whole range of landscape art Seventy-one plates in all out of one hundred were published (including one as a gift of the artist to his subscribers); ten other plates—more or less completed—intended for the fifteenth and sixteenth numbers were never published, the work being stopped for want of encouragement. The merit of the plates is unequal; some—for example, "Solway Moss," "Inverary Pier," "Hind Head Hill," "Ben Arthur," "Rizpah," "Junction of the Severn and Wye" and "Peat Bog"—are of great beauty, while a few are comparatively tame and uninteresting. Among the unpublished plates "Stonehenge at Daybreak," "The Stork and Aqueduct," "The Via Mala," "Crowhurst," and "Moonlight off the Needles" take a high place. The *Liber* shows strong traces of the influence of Cozens and Girtin, and, as a matter of course, of Claude A good deal has been written about Turner's intention, and the "lessons" of the *Liber studiorum*. Probably his only intention in the beginning was to show what he could do, to display his art, to rival Claude, perhaps to educate public taste, and at the same time make money Already in this work are seen strong indications of one of his most remarkable characteristics—a knowledge of the principles of structure in natural objects; mountains and rocks are drawn, not with topographical accuracy, but with what appears like an intuitive feeling for geological formation; and trees have also the same expression of life and growth in the drawing of stems and branches This instinctive feeling in Turner for the principles of organic structure is described in the fourth volume of *Modern Painters*.

A curious example of the *reasonableness* accompanying his exercise of the imaginative faculty is to be found in his creations of creatures he had never seen, as, for example, the dragon in the "Garden of the Hesperides" and the python in the "Apollo," exhibited in 1811. Both these monsters are imagined with such vividness and reality, and the sense of power and movement is so completely expressed, that the spectator never once thinks of them as otherwise than representations of actual facts in natural history. He was further aided by a memory of the most retentive kind. A good illustration of this may be seen at Farnley Hall in a drawing of a "Man-of-War taking in Stores." Some one, who had never seen a first-rate, expressed a wish to know what it looked like. Turner took a blank sheet of paper, outlined the ship, and finished the drawing in three hours.

From 1813 till 1826, in addition to his Harley Street residence, Turner had a country house at Twickenham He kept a boat on the river, also a pony and gig, in which he used to drive about the neighbouring country on sketching expeditions. The pony, for which Turner had a great love, appears in his well-known "Frosty Morning" in the National Gallery In 1813 Turner commenced the series of drawings, forty in number, for Cooke's *Southern Coast* This work was not completed till 1826. The price he at first received for these drawings was £7, 10s each, afterwards raised to £13, 2s. 6d.

"Crossing the Brook" appeared in the Academy of 1815. It marks the transition from his earlier style to that of his maturity It represents a piece of Devonshire scenery, a view on the river Tamar. In design and execution this work is founded upon Claude. The colour scheme is limited to greys and quiet greens for the earth and pale blues for the sky. It is a sober but very admirable picture, full of diffused daylight "Dido Building Carthage" also belongs to this period It hangs beside the Claudes in the National Gallery Towering masses of Claudesque architecture piled up on either side, porticoes, vestibules, and stone pines, with the sun in a yellow sky, show the Carthage imagined.

Middle Period.—In 1818 Turner was in Scotland making drawings for the *Provincial Antiquities*, for which Sir Walter Scott supplied the letterpress, and in 1819 he visited Italy for the first time. From this time his works became remarkable for their colour Hitherto he had painted in browns, greys and blues, using red and yellow sparingly He had gradually been advancing from the sober grey colouring of Vandervelde and Ruysdael to the mellow and richer tones of Claude. His works now began to show a heightened scale of colour, gradually increasing in richness and splendour and reaching its culminating point in such works as "Ulysses," "Childe Harold's Pilgrimage," "The Golden Bough," and "The Fighting Téméraire." All these works belong to the middle period of Turner's art (1829–1839), when his powers were entirely developed. Much of his most beautiful work at this period is to be found in his water-colour drawings: those executed for Whitaker's *History of Richmondshire* (1819–1821), for Cooke's *Southern Coast* (1814–26), for *The Rivers of England* (1824), for *England and Wales* (1829–38), *Provincial Antiquities* (1826), Roger's *Italy* (1830), Scott's *Works* (1834), and *The Rivers of France* (1833–35) are in many instances of the greatest beauty.

One of the great services Turner rendered to the art of England was the education of a whole school of engravers. His best qualities as a teacher came from the union of strength and delicacy in his work; subtle and delicate tonality was almost a new element for the engraver to deal with, but with Turner's teaching and careful supervision his engravers by degrees mastered it more or less successfully, and something like a new development of the art of engraving was the result. No better proof can be found of the advance made than by comparing the work of the landscape engravers of the pre-Turnerian period with the work of Miller, Goodall, Willmore, Cooke, Wallis, Lupton, C. Turner, Brandard, Cousen, and others who worked under his guidance The art of steel engraving reached its highest development in England at this time Roger's *Italy* (1830) and his *Poems* (1834) contain perhaps the most beautiful and delicate of the many engravings executed after Turner's drawings. They are vignettes, a form of art which Turner understood well "The Alps at Daybreak," "Columbus Discovering Land," and "Datur Hora Quieti" are superb

In 1828 Turner paid a second visit to Italy, this time of considerable duration, on the way visiting Nîmes, Avignon, Marseilles, Genoa, Spezzia and Siena, and in the following year he exhibited the "Ulysses Deriding Polyphemus," now in the National Gallery. It marks the beginning of the central and best period of Turner's power. The picture is of great power and splendour The painting throughout is magnificent, especially in the sky. From this period till 1840 Turner was entirely absorbed in his art, and so isolated. Between 1829 and 1839 he sent fifty-five pictures to the Royal Academy, painted many others on private commission, made over four hundred drawings for engravers, besides thousands of studies and sketches from nature.

Later Work.—The first of Turner's Venetian pictures ("Bridge of Sighs, Ducal Palace and Custom House, Venice, Canaletto Painting") appeared in the Academy in 1833 Compared with the sober work of Canaletto, Turner's pictures of Venice appear like poetic dreams. Splendour of colour generally characterize them Venice appeared to him "a city of rose and white, rising out of an emerald sea against a sky of sapphire blue." Many of these Venetian pictures belong to his later manner, and some of them, "The State Procession bearing Giovanni Bellini's Pictures to the Church of the Redeemer" (exhibited in the Royal Academy, 1841), "The Sun of Venice Going to Sea" (1843), "Approach to Venice" (1844), and "Venice, Evening, Going to the Ball" (1845), to his latest. As Turner grew older his love of brilliant colour and light became more and more a characteristic

"The Fighting Téméraire Tugged to her Last Berth to be Broken Up" was exhibited in the Academy of 1839 Turner had all his life been half a sailor at heart many of his best pictures are sea pieces Hence the pathetic feeling he throws around the old three-decker, looking ghostly and wan in the evening light. "The Slave Ship," another important sea picture, was exhibited in the following year, and in 1842 "Peace. Burial at Sea," commemorative of Wilkie. His faculty for colour remained unimpaired almost to the end. He paid his last visit to the Continent in 1843, avoiding his own countrymen, an old and solitary man.

In 1850 he exhibited for the last time. He had given up attending the meetings of the Academicians, none of his friends had seen him for months; and even his old housekeeper had no idea of his whereabouts. Turner's mind had evidently given way, and with that love of secrecy which in later years had grown into a passion he had gone to hide himself in a corner of London He had settled as a lodger in a small house in Chelsea, overlooking the river, kept by his old Margate landlady, Mrs. Booth. To the children in the neighbourhood he was known as "Admiral Booth." His short, sailor-like figure may account for the idea that he was an impoverished old naval officer. He had been ill for some weeks, and when his Queen Anne Street housekeeper at last discovered his hiding-place she found him sinking, and on the following day, Dec. 19, 1851, he died. He was buried in St Paul's Cathedral, in deference to his wish He left a large fortune (about £140,000) to found a charity for the "maintenance and support of male decayed artists, being born in England, and of English parents only; and of lawful issue" His pictures he bequeathed to the nation, on condition that they were exhibited in rooms of their own, and that these rooms were to be called "Turner's Gallery." The will and its codicils were so confused that after years of litigation, during which a large part of the money was wasted in legal expenses, it was found impossible to decide what Turner really wanted. A compromise was effected, his next-of-kin inheriting the bulk of his property. The Royal Academy got £20,000 and the nation got all the pictures and drawings (now housed in the National Gallery and in the Tate gallery in rooms erected by the generosity of Sir Joseph Duveen. Of the 282 pictures and studies, 199 are now framed and exhibited. Of the collection of drawings numbering over 19,000 only a part are on exhibition).

In 1843 a champion, in the person of John Ruskin, arose to defend Turner against the unjust and ignorant attacks of the press, and what at first was intended as a "short pamphlet, reprobating the manner and style of these critics," grew into the five volumes of *Modern Painters*. Ruskin employed all his eloquence and his great critical faculty to prove how immeasurably superior Turner was to all who had ever gone before, hardly restricting his supremacy to landscape art, and placing him among the "seven supreme colourists of the world."

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(G. RE.; X.)

TURNER, NAT (1800–1831), the Negro leader of a slave insurrection in Virginia, known as the "Southampton insurrection," was born in Southampton county, Va., in 1800. From his childhood he claimed to see visions and hear voices, and he became a Baptist preacher of great influence among the Negroes. In 1828 he confided to a few companions that a voice from heaven had announced that "the last shall be first," which was interpreted to mean that the slaves should control. An insurrection was planned, and a solar eclipse in Feb. 1831, and peculiar atmospheric conditions on Aug. 13, were accepted as the signal for beginning the work.

On the night of Aug. 21, 1831, with seven companions, he entered the home of his master, Joseph Travis, and murdered the inmates. After securing guns, horses and liquor they visited other houses, sparing no one. Recruits were obtained in some cases by compulsion, until the band numbered about 60. About noon on the 22nd they were scattered by a small force of whites, hastily gathered Troops, marines and militia were hurried to the scene, and the Negroes were hunted down. In all 13 men, 18 women and 24 children had been butchered

After hiding for several weeks Turner was captured on Oct. 30 and was tried and hanged, having made, meanwhile, a full confession. Nineteen of his associates were hanged and 12 were sent out of the state. The insurrection, which was attributed to the teachings of the abolitionists, led to the enactment of stricter slave codes.

See S. B. Weeks, "Slave Insurrections in Virginia," in *Magazine of American History*, vol. xxxi, (1891) and W. S. Drewry, *The Southampton Insurrection* (1900).

TURNER, SHARON (1768–1847), English historical writer, was born in London, Sept. 24, 1768. He was educated as an attorney there and practised with success from 1789–1829, when he retired because of his health He is most noted, however, for his historical writing, in which he was engaged from the time he was a young man until his death. His *History of England from the Earliest Period to the Death of Elizabeth* was a monumental work, which appeared in parts, as each section was completed It began with a *History of the Anglo-Saxons; comprising the History of England from the Earliest Period to the Norman Conquest* (4 vol., 1799–1805), much of the information for which he took from original Anglo-Saxon manuscripts, a source previously untapped by British authors This work was followed by the *History of England from the Norman Conquest to 1509* (3 vol., 1814–23); *History of the Reign of Henry VIII; comprising the Political History of the Commencement of the English Reformation* (4 vol , 1826) and *History of the Reigns of Edward VI, Mary and Elizabeth* (4 vol , 1829) The entire work was published in 12 volumes in 1839.

Turner was also the author of a *Sacred History of the World, as Displayed in the Creation and Subsequent Events to the Deluge, Attempted to be Philosophically Considered in a Series of Letters to a Son* (3 vol., 1832), a book of patriotic poems, *Prolusions on the Recent Greatness of Britain, on Modern Poetry and on the Present Greatness of the World* (1819); and several pamphlets.

Of his history of England, the section on the Anglo-Saxons is generally considered to be by far the best, both from the point of view of historical accuracy and of excellence of style. Turner died in London, Feb. 13, 1847.

TURNHOUT, town in the province of Antwerp, Belgium, 26 mi. N.E. of that city. Pop. (est. 1939) 30,088. It carries on an active industry in cloth, playing cards and other manufactures. There is a breeding establishment for leeches The town hall was formerly a palace of the dukes of Brabant. Two miles west of Turnhout is the curious penal or reformatory colony of

Merxplas. The system of this establishment is to allow certain approved prisoners to follow their usual occupations within a defined area.

TURNIP (*Brassica rapa*), a hardy biennial, of the family Cruciferae, which has been cultivated from a remote period for its fleshy roots. The tender growing tops are also used widely as a green vegetable. The so-called "root" is formed by the thickening of the primary root of the seedling together with the base of the young stem (hypocotyl) immediately above it. The great mass of the "root" consists of soft "wood" developed internally by the cambium layer and composed mainly of thin-walled, unlignified, wood-parenchyma.

The stem remains short during the first year, the leaves forming a rosette-like bunch at the top of the root; they are grass-green and bear rough hairs In the second season the bud in the centre of the rosette forms a strong erect branched stem bearing somewhat glaucous smooth leaves. The stem and branches end in corymbose racemes of small, bright yellow flowers, which are succeeded by smooth, elongated, short-beaked pods.

The turnip probably originated in Europe or western Asia and by cultivation has spread throughout the temperate zone

The varieties of turnip are classified according to their shape as (1) long varieties, with a root three or more times as long as broad; (2) tankard or spindle-shaped varieties, with a root about twice as long as broad; (3) round or globe varieties with an almost spherical root; (4) flat varieties with a root broader than long; there are also many intermediate forms. Turnips are also grouped according to the colour of the upper part of the root, which comes above ground, and according to the colour of the flesh, which is white or yellow.

The *yellow-fleshed varieties*, which are not hybrids between the turnip and swede, are more robust, of slower growth and superior feeding value to the white-fleshed turnips and are less injured by frost. The foliage turnip produces no enlarged root but only a profusion of leaves which are used as a pot-herb A variety of this form called Seven-Top is widely grown in the southern United States.

The swede-turnip (*Brassica napobrassica*) or rutabaga differs from the turnip proper in having the first foliage-leaves glaucous, not grass-green, in colour and the later leaves smooth and glaucous; the root bears a distinct neck with well-marked leaf-scars, the flesh is white or yellow, firmer and more nutritious; and the roots keep much better during winter.

The white-fleshed forms have a rough, green skin, firm white flesh and are of irregular form. The flowers are of a bright canary colour.

The yellow-fleshed swede-turnips have a firm yellow flesh, a smooth skin of a green, purple or bronze colour. The flowers are buff yellow or pale orange. (X.)

CULTIVATION AND TRADE

Both the turnip and rutabaga are cool-season crops, intolerant of the hot weather of the lower latitudes The rutabaga grows less rapidly, requiring a longer season. In the lower latitudes turnips are sown either in early spring or in late summer, developing rapidly enough to make a crop before extremes of summer or late fall weather occur. Rutabagas, however, are sown only as a main or late crop and are the more hardy to cold. Rutabagas are little grown in the United States except in the northernmost states, but are grown extensively in Canada, Great Britain and northern Europe. Turnips are grown in the cooler regions during the summer.

Both species are extensively grown as livestock feed in northern climates but in the United States are grown almost entirely as a vegetable.

Extensive culture of turnips as a forage crop for sheep and cattle began in Great Britain about 1724 and increased rapidly because it fitted so well into the system of crop rotation and stock feeding that was developing in the 18th century. Turnips afforded large quantities of winter feed, thus increasing the conversion of straw into barnyard manure for the improvement of the lighter soils. They are generally grown in rotation with grain crops and are well adapted to clean row culture designed to free the land of weeds that interfere with grain production. Animal manures are generally applied, although chemical fertilizers alone may be used. About 850 lb per acre of a mixture analyzing approximately 5% nitrogen, 10% phosphoric acid and 7% potash is commonly applied

White turnips are often sown broadcast, in both Europe and America, and neither cultivated nor thinned Swedes and yellow turnips are usually sown in rows about 2 ft apart. When large stock-feeding varieties are grown, they are thinned to about 10 in apart in the row, but when swedes or turnips are grown for human food they are thinned to only 3-6 in. apart in the rows

Although considerable quantities of these species are grown in home and market gardens, and are even shipped long distances in the United States, the total volume of trade in them remains comparatively small. (V R B.)

TURNSTONE (*Arenaria interpres*), a shore-bird found on the coasts of every part of the world, but breeding only in the high Arctic. About the size of a snipe, and allied to the plovers (*q v*), the turnstone has short legs and a heavy build. The white face, striped with black, the black gorget and white band on the wings are characteristic features. The sexes are alike. The bird feeds on small crustacea, worms, etc, which it seeks under stones. The nest contains four olive-green eggs, closely blotched with brown. Both male and female incubate

TURNTABLE. A rotary platform which turns wagons, carriages and locomotives. The smallest sizes are less than three feet in diameter and are without rails, being used for light temporary work or with portable tracks. In other cases rails are mounted, flush with the surface, for use inside factories or other places subject to foot or wheeled traffic. A circle of small rollers or a ring of balls supports these tables. An automatic catch prevents the table from making more than a quarter of a revolution at a time, unless it is desired to move further.

In the large tables for carriages and wagons the load is carried upon a centre pivot, and the two rollers at each end run on a circular rail or *race*, and function when the load is unbalanced The rollers are attached to steel joists bolted to the main girders and the rollers can be taken off for cleaning at any time. A hand lever enables the table to be readily pulled around, then locked with a wedge which also blocks up the end, so taking the load off the wheels. When there is insufficient depth available for the pit of an ordinary turntable, the "inverted girder" or "surface type" is installed, the girders being placed upside down in this type of construction. If locomotives cannot be well balanced, or rapid handling is important, power-driven turntables are chosen. In the electric tractor system, a wheel resting on the circular race is driven by a motor so as to turn the table in about a minute Rotating gear on the winch system comprises a barrel pulling on two steel wire ropes so that one pays out while the other winds in. These operate a wheel on the race. Some turntables, for locomotive manufacturing works, carry three tracks (*e.g*, 2 ft. 6 in., 4 ft. 8½ in., and 5 ft. 6 in). The centre-pivot support is not applied in this case, but the uneven loads are sustained by a ring of cast-steel rollers running on the 50-foot diameter race Some tables are about 85 ft. in diameter and take engines up to 267 tons, 5 ft. 6 in gauge. The electric tractor drive is fitted to these. Turntables are also used in motor garages and works.

TURNU SEVERIN, the capital of the department of Mehedinti, Rumania, on the main Walachian railway, and on the left bank of the river Danube, below the Iron Gates cataracts. Pop. (1936) 21,073. It is a modern commercial town, having a school of arts and crafts, several churches, and large government yards for the building of river steamers, lighters and tug-boats. There is a considerable trade in livestock, preserved meat, petroleum and cereals. The town, which was originally called Drobetae by the Romans, took its later name of Turris Severi, or the "Tower of Severus," from a tower built to commemorate a victory over the Quadi and Marcomanni, by the Roman emperor Severus (A.D. 222–235). Near Turnu Severin are the remains of the celebrated Trajan's bridge, the largest in the Roman empire, built in

A.D. 103 by Apollodorus of Damascus. The river is about 4,000 ft broad at this spot The bridge of twenty arches was supported by stone pillars, several of which are still visible at low water

TURNVEREIN, a German institution founded in the early part of the 19th century by Friedrich Ludwig Jahn for the purpose of furthering physical education. German settlers established branches in the United States and later their objectives were extended to include the discussion of intellectual, political, social and religious ideas. In 1925, there were in the United States 160 local societies, with a total membership of more than 30,000, not including 6,000 members of women's auxiliaries. Since 1866 they have maintained a normal college at Indianapolis, Ind., for the training of teachers of physical education.

TURPENTINE, the oleo-resins which exude from some conifers—such as *Pinus sylvestris*—and from the terebinth tree, *Pistacia terebinthus, L.* It was to the product of the latter, now known as Chian turpentine, that the term was first applied. The tree is a native of the islands and shores of the Mediterranean, passing eastward into central Asia; but the resinous exudation found in commerce is collected in the island of Chios. Chian turpentine is a tenacious semi-fluid transparent body, yellow to dull brown in colour, with an agreeable resinous odour and little taste. On exposure to air it becomes dry, hard and brittle. Turpentines are semi-fluid bodies, consisting of resins dissolved in turpentine oil, the chief constituent of which is pinene They are largely used in the arts, being separated by distillation into rosin or colophony (*see* ROSIN), and oil or spirit of turpentine.

Crude or *common turpentine* is the commercial name for the oleo-resin yielded by several coniferous trees, both European and American. The principal European product (Bordeaux turpentine) is obtained from the cluster pine, *Pinus Pinaster,* in the Landes department of France. Crude turpentine is further yielded by the Scotch fir, *P. sylvestris,* and by the Corsican pine, *P. Laricio.* In the United States the turpentine-yielding pines are the long leaf pine, *P. palustris,* and slash pine, *P. caribaea,* both inhabiting North and South Carolina, Georgia, Florida, and Alabama. *Venice turpentine* is yielded by the larch, *Larix europaea; Strassburg turpentine* is obtained from the bark of the silver fir. Less known turpentines are obtained from the mountain pine, *P. Pumilio,* the stone pine, *P. Cembra,* the Aleppo pine, *P. halepensis,* etc. The so-called *Canada balsam,* from *Abies balsamea,* is also a true turpentine.

"Turps."—*Oil of Turpentine,* or *Turps,* as a commercial product is obtained from all or any of these oleo-resins, but on a large scale only from crude turpentine. The essential oil is rectified by redistillation with water and alkaline carbonates, and the water which the oil carries over with it is removed by a further distillation over calcium chloride. Oil of turpentine is a colourless, oily liquid, with a strong odour and a hot disagreeable taste. It begins to boil at about 155° C, and its specific gravity is between 0·860 and 0·880. It rotates the plane of polarized light either to right or left in varying degrees according to the species of tree, the American product from *P. palustris* being dextrorotatory and *P. caribaea* laevorotatory and the French laevorotatory. It is almost insoluble in water, is miscible with absolute alcohol and ether, and dissolves sulphur, phosphorus, resins and caoutchouc. On exposure to the air it dries to a solid resin, and absorbing oxygen gives off ozone. Agitated with successive quantities of sulphuric acid and distilled in a current of steam, it yields terebene, a mixture of dipentene and terpinene mainly, which is used in medicine. Chemically, oil of turpentine is a mixture of terpenes (*q.v.*). It is largely used in the preparation of varnishes and as a medium by painters in their "flat" colours.

Pharmacology and Therapeutics.—Oil of turpentine (*Oleum terebinthinae*) is used internally as an anthelmintic to kill tapeworm. Externally it acts as a rubefacient, an irritant and a counter-irritant. It is an antiseptic and, in small quantities, a feeble anaesthetic. It is absorbed by the unbroken skin. It is largely employed as a counter-irritant, the pharmacopoeial liniments being useful in myalgia, bronchitis, "chronic rheumatism" and pleurisy. In large doses oil of turpentine causes purging and may induce haemorrhage from the bowel or kidneys. It is absorbed unchanged and has a marked contractile action upon the blood vessels. It is a nervous depressant leading even to coma and total abolition of reflex action. The drug is excreted partly by the bronchi and partly in the urine. Glycuronic acid also appears in the urine. It may give rise to an erythematous rash. It must not be given to the subjects of Bright's disease. Its chief uses are as constituents of fomentations and enemata and as a local disinfectant in bronchiectasis (*q.v.*). Old turpentine and French oil of turpentine are antidotes to phosphorus, forming turpentine-phosphoric acid, which is inert.

(A. D. J.)

TURPIN (d. *c.* 800), archbishop of Reims, was for many years regarded as the author of the legendary *Historia de vita Caroli Magni et Rolandi,* and appears as one of the twelve peers in a number of the *chansons de geste.* He is probably identical with Tilpin, archbishop of Reims in the 8th century, who is alluded to by Hincmar, his third successor in the see. According to Flodoard, Charles Martel drove Rugobert, archbishop of Reims, from his office and replaced him by a warrior clerk named Milo, afterwards bishop of Trier. The same writer represents Milo as discharging a mission among the Vascones, or Basques, the very people to whom authentic history has ascribed the great disaster which befell the army of Charlemagne at Roncesvalles.

Flodoard says that Tilpin was originally a monk at St. Denis, and Hincmar tells how after his appointment to Reims he occupied himself in securing the restoration of the rights and properties of his church, the revenues and prestige of which had been impaired under Milo's rule. Tilpin was elected archbishop between 752 and 768, probably in 753; he died, if the evidence of a diploma alluded to by Mabillon may be trusted, in 794, although it has been stated that this event took place on Sept. 2, 800 Hincmar, who composed his epitaph, makes him bishop for over forty years, and from this it is evident that he was elected about 753, and Flodoard says that he died in the forty-seventh year of his archbishopric Tilpin was present at the Council of Rome in 769, and at the request of Charlemagne Pope Adrian I. sent him the pallium and confirmed the rights of his church.

The *Historia Caroli Magni* was declared authentic in 1122 by Pope Calixtus II. It is, however, entirely legendary, being rather the crystallization of earlier Roland legends than the source of later ones, and its popularity seems to date from the latter part of the 12th century. Gaston Paris, who made a special study of the *Historia,* considers that the first five chapters were written by a monk of Compostella in the 11th century and the remainder by a monk of Vienne between 1109 and 1119. There are at least five French translations of the *Historia* dating from the 13th century and one into Latin verse of about the same time. According to Potthast there are about fifty manuscripts of the story in existence. The *Historia* was first printed in 1566 at Frankfort; perhaps the best edition is the one edited by F. Castets as *Turpini historia Karoli magni et Rotholandi* (Paris, 1880) It has been translated many times into French and also into German, Danish and English. The English translation is by T. Rodd and is in the *History of Charles the Great and Orlando, ascribed to Turpin* (London, 1812). *See* G. Paris, *De pseudo-Turpino* (Paris, 1865), and *Histoire poétique de Charlemagne,* new ed. by P. Meyer (1905); and V. Friedel, "Etudes compostellanes" in *Oita Mercelana* (Liverpool, 1899).

TURPIN, RICHARD [DICK] (1706–1739), English robber, was born in 1706 at Hempstead, near Saffron Walden, Essex, where his father kept an alehouse. He was apprenticed to a butcher, but, having been detected at cattle-stealing, joined a notorious gang of deer-stealers and smugglers in Essex. On the gang being broken up Turpin went into partnership with Tom King, a well-known highwayman. To avoid arrest he finally left Essex for Lincolnshire and Yorkshire, where he set up under an assumed name as a horse dealer. He was convicted at York assizes of horse-stealing and hanged on April 7, 1739. Harrison Ainsworth, in his romance *Rookwood,* gives a spirited account of a wonderful ride by Dick Turpin on his mare, Black Bess, from London to York But as far as Turpin is concerned the incident is pure fiction. A somewhat similar story was told about a certain John Nevison, known as "Nicks," a well-known highwayman in the time of Charles II, who to establish an alibi rode from Gad's Hill to York (some 190 m.) in about 15 hours.

TURQUOISE, a mineral much used as an ornamental stone for the sake of its blue or bluish-green colour. It is generally held that the name indicates its source as a stone from Turkey,

the finest kinds having come from Persia by way of Turkey

Turquoise is a crypto-crystalline mineral, occurring in small reniform nodules or as an incrustation, or in thin seams and disseminated grains Its mode of occurrence suggests its formation by deposition from solution, and indeed it is sometimes found in stalactitic masses. The typical colour is a delicate sky-blue, but the blue passes by every transition into green. In some cases the colour deteriorates as the stone becomes dry, and may be seriously affected by exposure to sunlight; whilst with age there is often a tendency to become green, as seen in examples of ancient turquoise. The mineral is always opaque in mass, but generally translucent in thin splinters. Turquoise takes a fair polish, but the lustre is feeble, and inclines to be waxy; the hardness is nearly 6, the specific gravity between 2.6 and 2 8

Much discussion has arisen as to the chemical composition of turquoise. It is commonly regarded as a hydrous aluminium phosphate having the composition $2Al_2O_3.P_2O_5.5H_2O$ or rather $Al_2HPO_4(OH)_4$, coloured with a variable proportion of a copper phosphate, or perhaps partly with an iron phosphate. S. L. Penfield (1900), however, was led by careful analysis of turquoise from Nevada to propose the general formula:

$$[Al(OH)_2]_2Fe(OH)_2Cu(OH)_2H]_3PO_4.$$

An analysis of minute crystals from Virginia gave the formula $CuO.3Al_2O_3.2P_2O_5.9H_2O$. An ingenious counterfeit of turquoise has been formed by compressing a precipitate of cupriferous aluminum phosphate.

Turquoise is usually cut as an ornamental stone in circular or elliptical form, with a low convex surface. In the East, where it is used not only for personal ornament but for the decoration of dagger-handles, horse-trappings, etc., the pieces are usually of irregular shape. In Persia, where the finest turquoise is found, the mines have been worked for at least eight centuries. The principal locality is near Nishapur, in the province of Khorasan Here the turquoise occurs in narrow seams in a brecciated trachyte-porphyry. It is found also in some other localities in Persia and in Turkestan. In the Sinai Peninsula relics of extensive ancient mining operations for turquoise show that the rock was at one time worked with flint implements. The mineral here occurs as nodules in a red sandstone and as an incrustation on the joint-faces.

In ancient Mexico much use was made of turquoise as an inlay for mosaic work, with obsidian, malachite, shell and iron pyrites. Relics of extensive workings are found in the mountains of Los Cerillos near Santa Fé in New Mexico, where mining for turquoise is now actively carried on. One of the hills in which old workings occur has been called Mt. Chalchihuitl, since it is believed that the turquoise was known by the name chalchihuitl, which in some places was applied also to jade. The matrix at Los Cerillos is an altered augite-andesite, in which the turquoise occurs in thin veins and in small nodules in patches of kaolin

Turquoise is sometimes termed by mineralogists callaite, since it is believed to be the *callas* of Pliny. The name callamite was suggested by J. D. Dana for a bright green mineral which was found in the form of beads, with stone hatchets, in ancient graves near Mané-er-H'roek (Rock of the Fairy), near Locmariaquer in Brittany, and which A. Damour sought to identify with Pliny's *callais*. The mineral seems to be identical with variscite.

"Bone-turquoise" or odontolite, also known as "occidental turquoise," is merely fossil bone or ivory coloured by iron phosphate (vivianite) or perhaps stained in some cases by cupriferous solutions, and is readily distinguished from true turquoise by showing organic structure under the microscope.

TURRETIN, or **TURRETINI,** the name of three Swiss divines

BENOÎT TURRETIN (1588–1631), was born at Zurich Nov. 9, 1588. He was ordained a pastor in Geneva in 1612, and became a professor of theology in 1618. In 1620 he represented the Genevan church at the national synod of Alais, when the decrees of the synod of Dort were introduced into France; and in 1621 he was sent on a successful mission to the states-general of Holland, and to the authorities of the Hanseatic towns, with reference to the defense of Geneva against threatened attacks of the duke of Savoy. He published in 1618–20 (2 vols.) a defense of the Genevan translation of the Bible, *Eine Verteidigung der genfer Bibeluebersetzung.* He died March 4, 1631.

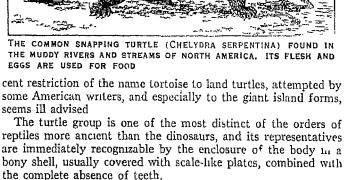
FRANÇOIS TURRETIN (1623–1687), son of the preceding, was born at Geneva Oct. 17, 1623. He became pastor of the Italian congregation in Geneva in 1647, after a brief pastorate at Lyons he again returned to Geneva as professor of theology in 1653. He was one of the most influential supporters of the *Formula Consensus Helvetica* and of the particular type of Calvinistic theology which that symbol embodied. His *Institutio theologicae elencticae* (3 vols., Geneva 1680–83) passed through frequent editions. He died Sept 28, 1687.

JEAN ALPHONSE TURRETIN (1671–1737), son of the preceding, was born at Geneva Aug. 13, 1671. After travel in Holland, England and France he was received into the "Vénérable Compagnie des Pasteurs" of Geneva in 1693 Here he became pastor of the Italian congregation, and in 1697 professor of church history, and later (1705) of theology. During the next 40 years he was an influential advocate of a more liberal theology, and it was largely through him that the rule obliging ministers to subscribe to the *Formula Consensus Helvetica* was abolished. He died May 1, 1737.

TURRIFF, small burgh, Aberdeenshire, Scotland. Pop (est 1938) 2,562, 38½ mi. N W. of Aberdeen. Only the choir and belfry of the ancient church remain. On May 14, 1639, the national struggle for civil and religious liberty was inaugurated in the county with the skirmish known as the Trot of Turriff. Some 4 mi. S. are the remains of the castle of Towie Barcley.

TURRIS LIBISONIS (modern Porto Torres, an ancient seaport at the N W. extremity of Sardinia. It was probably of Roman origin, and in Pliny's time it was the only colony in the island. A Roman bridge of seven arches, the ruins of a temple (now known as Il Palazzo del Re Barbaro), which an inscription found there shows to have been restored (AD 247–249) by the *praefectus* of the province, together with the basilica, an aqueduct, various buildings and some rock tombs, still exist.

TURTLE, the common name most widely applied to the members of the reptilian order Chelonia (*see* REPTILES), for which the noun and adjective chelonian are also appropriate There is much confusion in the usage of the term "tortoise," which is commonly used in Britain for both land and fresh-water turtles, the term "turtle" being restricted to the marine forms with paddle-shaped fore limbs. In America, with its rich fauna of these creatures, the name turtle was broadened in common usage, as in sea turtle, land turtle, snapping turtle (never "snapping tortoise"), etc, with the addition of the word "terrapin," which is loosely applied to some of the edible fresh-water and brackish-water species that come to markets The relatively re-



THE COMMON SNAPPING TURTLE (CHELYDRA SERPENTINA) FOUND IN THE MUDDY RIVERS AND STREAMS OF NORTH AMERICA. ITS FLESH AND EGGS ARE USED FOR FOOD

cent restriction of the name tortoise to land turtles, attempted by some American writers, and especially to the giant island forms, seems ill advised

The turtle group is one of the most distinct of the orders of reptiles more ancient than the dinosaurs, and its representatives are immediately recognizable by the enclosure of the body in a bony shell, usually covered with scale-like plates, combined with the complete absence of teeth.

The "Shell."—The characteristic "shell" consists of an upper *carapace* and a lower *plastron*, the two being more or less firmly

united at the sides by a bony bridge. Both carapace and plastron proper are structures built up from a number of bone elements firmly united by sutures; the carapace consists of a central row of from 10–12 plates most of which are fused to the vertebrae, a lateral row of 8 plates on each side fused to the ribs and about 23 small plates bordering its free edge; the plastron contains five paired elements and one unpaired. The union of the upper and lower halves of the shell may be rigid and bony or cartilaginous and flexible and in some forms transverse hinges are developed. In the majority of chelonians the bony shell is overlaid by horny plates, but these do not correspond with the underlying bones although their general arrangement is similar; they are of exactly the same nature as the horny scales covering the head, limbs and exposed soft parts.

The shape of the "shell" varies in conformity with the habits of the animal; in strictly terrestrial forms it is usually high, domed, and sufficiently large to permit the head and limbs to be withdrawn into it, whereas in aquatic species, it is generally depressed and so much reduced in size that it may offer little protection for the limbs. Correlated also with the habitat is the shape of the limbs; in terrestrial species they are club-shaped, all the digits being bound together and only externally distinguishable by their claws, whereas in the fresh-water dwellers the digits remain distinct and are connected by a web; the marine turtles have the fingers and toes of the fore limb all bound together and the number of claws reduced, but the whole limb is here transformed into a paddle.

Breathing.—As a result of the development of the shell and the consequent fixation of the ribs the method of breathing is rather different in the Chelonia as compared with other reptiles and resembles that of the Amphibia, air is pumped into the lungs by movements of the hyoid apparatus, which alternately distends and compresses the neck and floor of the mouth and this action is assisted to some extent by the piston-like movements of the head and limbs in and out of the shell when the creature is active. Additional respiratory mechanisms in some aquatic species utilize the oxygen dissolved in the water.

No recent chelonian has teeth, the beak-like jaws being covered with horny plates, which usually have sharp cutting edges, terrestrial species are, as a rule, strictly herbivorous and though many aquatic species are impartial in their feeding habits the majority are carnivorous, many raptorial. The voice is not well developed, females as a rule only being able to hiss; males, however, in the breeding season at least utter cries which in smaller species may be only a feeble piping but in the giant land turtles are hoarse bellows. Reproduction is always by means of eggs. These are spherical and covered by a parchment-like or calcareous shell; they are buried in sand or loose earth.

Species.—There are living at the present day some 225 species but these are probably only the surviving remnant of a formerly much more numerous group. They are cosmopolitan in their distribution except for the more recent oceanic islands and those northern and southern countries where the winter is too severe; in England their extermination seems to have been relatively recent.

One recent chelonian differs from all others in structure of its shell, the elements that normally compose this structure being almost all absent and their function being assumed by a mosaic of small polygonal plates. On this account the animal was placed in a separate group, the ATHECAE, to contrast with the others which are united as the THECOPHORA. This creature, the luth or leathery turtle (*Dermochelys coriacea*) is a marine turtle inhabiting tropical seas and is the largest living chelonian; it reaches a length of 8 feet and may weigh nearly a ton; the back is devoid of horny plates and is covered by soft skin, the food consists of molluscs, crustaceans and fishes. The eggs, like those of other marine turtles, are laid on land; the female repairs to a sandy beach during the night, digs a shallow hole in which the eggs are deposited, covers them up, and returns to the sea; the chief breeding places appear to be on the coasts of tropical islands.

Thecophora.—The remaining turtles are subdivisible into 3 main groups: the Trionychoidea, aquatic forms with a bony carapace and plastron but without horny plates; the Cryptodira, terrestrial and aquatic forms with a bony carapace and plastron covered with horny epidermal shields and retracting the neck by a vertical S-shaped bend; and the Pleurodira, resembling the Cryptodira but retracting the neck by a simple lateral flexure. Of these groups the Cryptodira contains the largest number and the majority of the typical tortoises; its various families, based largely on characters of the bony shell, may be recognized by the following key based on external characters only.

I. Digits more or less distinct with 4 or 5 claws, terrestrial or fresh-water.

A. Pectoral shield (the 3rd paired shield of the plastron) separated from the marginal shields of the carapace by a series of small "infra-marginal" plates.

(1) Tail long and crested; plastron small and cruciform. American. *Chelydridae*

(2) Tail long, covered with rings of scales; plastron large. Asiatic. *Platysternidae*

(3) Tail short. North American. *Kinosternidae.* *Dermatemydidae.*

B. Pectoral shields in contact with the marginals of the carapace. *Testudinidae*

II. Fore limbs paddle-shaped with one or two claws, marine. *Chelonidae.*

Chelydridae.—The snapping turtles are fresh-water forms of North and Central America, characterized by relatively huge heads, long alligator-like tails, rough shells and numerous soft projecting folds of skin on the neck and limbs. The two better known species, the common snapper (*Chelydra serpentina*) of the eastern United States and the alligator snapper (*Macrochelys temminckii*) of the Mississippi and Missouri basins, are both large, powerful creatures, and notorious for their aggressive nature and the power of their jaws.

Platysternidae.—A single species (*Platysternon megacephalum*), the big-headed turtle, is found in fresh waters in S. China, Burma and Siam. The head is relatively very large and the neck short.

Kinosternidae.—These are the musk turtles of North and Central America, so called from the rather offensive odour of the secretion of their inguinal glands; they are small, aquatic creatures, rarely exceeding a total length of one foot and in many the front and hind lobes of the plastron are hinged and close the shell completely. *Sternotherus odoratus*, the stinkpot of eastern North America, is the best known species

Dermatemydidae.—A single type of large Central American fresh-water turtle allied to the preceding family

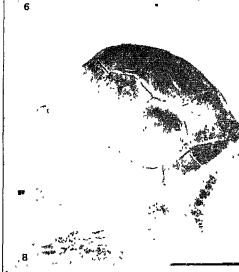
Testudinidae.—This family, containing the majority of turtles, is world wide in its distribution except the Australian region, and its members show all gradations between thoroughly aquatic and exclusively terrestrial species. The batagur (*Batagur baska*) of Bengal, Burma and the Malayan region is exclusively aquatic; it attains a length (carapace only) of nearly 2 feet, is rather flattened and has the digits fully webbed. *Chrysemys* of eastern N. America is also exclusively aquatic and the species of this and allied genera are extensively eaten; they are sold as "slider terrapins" to distinguish them from the diamond back terrapins (*Malaclemys*) beloved by epicures.

Clemmys, with species in S. Europe and N. Africa (*C. leprosa*), Asia and N. America (e.g., *C. insculpta* the wood turtle), is less aquatic than the preceding and the digital webs are correspondingly reduced. Still less aquatic are the species of *Emys*, *E. orbicularis* of Central Europe and Western Asia and *E. blandingi* of southern Canada and the north-eastern United States, which have indications of a transverse hinge across the plastron. This plastral hinge reaches a high degree of development in the North American box turtles (*Terrapene*) which can withdraw completely into their shell and close both openings; these animals are terrestrial in habits and have the high, domed shell of the exclusively terrestrial genera such as *Kinixys*, *Pyxis* and *Testudo*. *Testudo* is an assemblage of herbivorous, terrestrial forms and contains, among others, the well-known giant land turtles, some of which reach a shell length of over 4 feet and may weigh over








BY COURTESY OF (1, 5, 6, 8) THE AMERICAN MUSEUM OF NATURAL HISTORY, (2) THE METRO GOLDWYN MAYER CORPORATION, (3, 4, 7, 9) RAYMOND L. DITMARS AND THE AMERICAN MUSEUM OF NATURAL HISTORY

MARINE, FRESH-WATER AND TERRESTRIAL TURTLES

1. A museum group showing a loggerhead turtle swimming amongst sharks
2. Green turtle, caught by natives off the island of Tahiti. This is the species most frequently eaten
3. The Cumberland terrapin, an edible species inhabiting the fresh waters of central North America
4. The matamata, a large South American fresh-water turtle characterized by a rough shell and by fleshy filaments and appendages on the head and neck
5. Newly-hatched snapping turtles and eggs. These turtles, which inhabit the fresh waters of North America, have large heads and long tails
6. Soft-shelled turtle swimming. These animals, characterized by a disk-shaped body covered with soft skin, frequent slow-running rivers, lakes and ponds
7. Australian snake-necked turtle. This species and its allies are found only in fresh waters and are remarkable for their extremely long necks
8. Seychelles giant land turtle. Giant land turtles are now almost extinct, a few only surviving in a wild state on Aldabra and on the Galapagos Islands
9. Leathery turtle or luth (leatherback), the largest marine turtle. The bony shell is composed of numerous small bones instead of the usual regular plates

600 lb. There were three groups of these animals, one confined to the islands of the Galapagos Group where every small island had its own race and the largest several, another to the Mascarene Islands (Bourbon, Mauritius, Rodriguez) and the third to the Seychelles-Aldabra Group Before the advent of man these creatures abounded in almost incredible numbers, but it was soon discovered that, on account of their ability to live for months without food, they formed an excellent supply of easily transported fresh meat for sailing vessels and their numbers were rapidly decimated

Somewhat approaching the giant island forms in size are the African *T. calcarata* and the South American *T. tabulata* but the remaining species of the genus are relatively small, *T elegans*, the Indian star turtle, is black with yellow streaks radiating from the centre of each shield and the South African *T. geometrica* has a similar pattern; in Europe there are 2 species, *T. hermanni* of S. Europe and Asia Minor and *T. margmata* of Greece, the species commonly imported into England being *T. graeca* of northern Africa and Asia Minor. The N. American gopher turtles (*T. polyphemus*, *T. berlandieri* and *T. agassizii*) are burrowing creatures inhabiting dry, sandy country and constructing their own burrows, but the greatly flattened and soft-shelled East African *T. tornerı* is cryptozoic in rocky country and hides in crevices.

Chelonidae.—The three common species are the hawksbill (*Eretmochelys imbricata*), the green turtle (*Chelonia mydas*) and the loggerhead (*Caretta caretta*). Of these, the first mentioned may be distinguished by its smaller size, the overlapping horny plates of the back and the hooked beak; it occurs in all tropical seas and is the source of the "tortoise shell" of commerce. The horny shields of the carapace are stripped off by heat and when heated in oil or by steam they can be welded together to form slabs thick enough for manufacturing purposes. The green turtle is the species used so much in the manufacture of turtle soup; it is a larger species than the hawksbill, attaining a length of close to 4 feet and the horny plates of the back do not overlap but meet edge to edge. All these turtles have the same general habits and distribution, the green turtle only is partially or entirely herbivorous, feeding on *Zostera* the marine grass, the others preferring fish or molluscs. All lay their eggs in pits dug by the females on sandy beaches which are visited at night and it is then that large numbers are captured; the eggs, too, are edible so that in some regions the turtles are becoming scarce.

Pleurodira.—I. Neck completely retractile into the shell.
Pelomedusidae.

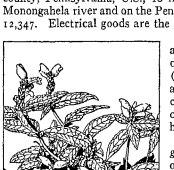
II. Neck long, not hidden by the shell when retracted.
Cheilidae.

Pelomedusidae, fresh-water dwellers in Africa and South America; *Pelusios* of Tropical Africa and Madagascar has the front lobe of the plastron hinged but *Pelomedusa* of the same regions lacks this character. *Podocnemis*, similar to *Pelomedusa*, inhabits the rivers of tropical S. America and reaches a considerable size.

Chelidae, the "Snake-Necked Turtles" of the fresh waters of S. America, Australia and Papua. They are all long-necked creatures with the typical depressed shells of aquatic tortoises, the many species are superficially very similar, the S. American matamata (*Chelys fimbriata*) alone showing any peculiarities

Trionychoidea.—This group contains the two families Carettochelidae, in which the complete carapace and plastron are covered with soft skin, and the soft-shelled turtles proper, the Trionychidae, in which the bony elements of the shell are much reduced and are enclosed in a flexible dermal and cartilagmous external covering. *Carettochelys insculpta*, of the Fly river in New Guinea, has paddle-shaped fore limbs, like a marine turtle. The soft-shelled turtles, with several genera in Africa and Asia, are represented in northern Asia, Africa, and North America by the genus *Trionyx*. These actively swimming turtles are remarkably flattened, with broadly webbed fore and hind feet, and emerge from the water only to sun themselves and for egg-laying. All are strictly confined to fresh waters, and mostly to sluggish streams and lakes. The snout is prolonged to form a short breathing tube. Most of the species are fish eaters, but mollusc-eating may produce the broad crushing jaws of certain individuals. A remarkable feature of the African *Cyclanorbis* and *Cycloderma* and the Indian *Lissemys* is the provision for retracting the hind limbs within the shell, the opening closing by a valve-like cartilaginous flap, while the front limbs can also be more or less completely withdrawn. (H. W. P ; K. P. S.)

TURTLE CREEK, a manufacturing borough of Allegheny county, Pennsylvania, U.S., 10 mi S E. of Pittsburgh, near the Monongahela river and on the Pennsylvania railroad Pop (1950) 12,347. Electrical goods are the principal products



BY COURTESY OF THE WILD FLOWER PRESERVATION SOCIETY
THE COMMON TURTLEHEAD, OR SNAKEHEAD, (CHELONE GLABRA)

TURTLEHEAD (*Chelone*), a genus of North American herbs of the family Scrophulariaceae (*q.v.*), comprising four species, all smooth perennials which bear clusters of showy flowers, the corolla resembling a turtle's head

The common turtlehead (*C. glabra*), with white flowers, occurs from Newfoundland to Manitoba and southward. *C Lyoni* and *C obliqua*, of the southeastern states, and *C. nemorosa*, found from California to Washington, have red or purple flowers.

TURTON, urban district, Darwen parliamentary division, Lancashire, England, 4 mi N of Bolton on the L M S R. Pop (1938) 11,190. Area 2·09 sq mi. It manufactures cotton goods and there are large stone quarries in the vicinity.

Turton tower, containing some fine contemporary woodwork, dates from the 16th century

TUSCALOOSA, a city of western Alabama, U S , the county seat of Tuscaloosa county; on the Warrior river and federal highways 11, 43 and 82 and state highways 171, 13 and 69; 58 mi. S W of Birmingham It is served by the Louisville and Nashville, the Gulf, Mobile and Ohio, and the Southern railways, by bus lines, federal barge lines and barge companies operating on a year-round route to the sea on Warrior-Tombigbee rivers There is a municipal airport, Hargrove van de Graaf field, and one private airport, Christian airport (airport facilities and seaplane base). Pop. (1950) 46,364; (1940) 27,493; (1930) 20,659 by federal census. The city lies at the edge of the great coal and mineral deposits of Alabama in a rich agricultural region.

Industrial development began after the removal of the state capital in 1846 In the county there are a large paper mill, a pipe foundry, cotton yarn mill, veneer mills, coke ovens, meat-packing plants, tire plant, roofing plant, oil refinery, chemical plant, furniture factory, feed mills and other plants. The cotton industry, lumbering, mining and forestry also flourish

There are many old residences and gardens, dating from the time Tuscaloosa was the capital of the state (1826–46). The streets are wide and lined with magnificent old oaks, planted in the early days of settlement. Tuscaloosa has often been referred to as "The Druid City"

In Tuscaloosa are the Bryce hospital and Partlow state school (major units of the Alabama state hospitals), a United States veterans' hospital; Stillman college (Presbyterian, endowed school for Negroes); and the University of Alabama.

The university was first opened to students in 1831. The campus proper covers 420 ac. and the Northington campus annex comprises 150 ac.

The name of the town and the river comes from two ancient Choctaw words, *tusha* ("warrior") and *lusa* ("black") Chief Tuskalusa was a gigantic, courageous Choctaw chieftain who was defeated by de Soto in 1540 He is commemorated by a granite monolith on the courthouse lawn at Tuscaloosa. The first white settlers arrived in 1816, the date the area became the property of the United States by a treaty with the Indians. The county of Tuscaloosa was created in 1818; the town of Tuscaloosa was incorporated Dec. 13, 1819, one day before the state of Alabama was admitted to the union.

TUSCANIA, a town of the province of Viterbo, Italy, 15 mi. N.E. of Corneto by road, 545 ft. above sea level Population (1936), 5,260 (town), 5,775 (commune) The ancient town lay on the Via Clodia; its Etruscan tombs have yielded valuable antiquities, and remains of a large thermal establishment of the Roman period have also been found. The mediaeval walls with their towers are still preserved

On the ancient citadel hill is the Romanesque church of S Pietro, belonging to four different periods—739, 1093 (the date of the reconstruction of the crypt), the middle of the 12th and the end of the 13th century.

It has the shape of a Roman basilica, with a nave and two aisles and one apse The elaborate façade with its rose window also belongs to the 12th century

S Maria in the valley below dates from 1050 to 1206, and has a similar façade and a massive square campanile. In the town are two other Romanesque churches. The town was called Toscanella until 1912, when it resumed the name which it bore in ancient Latin times.

TUSCANY (*Toscana*), a territorial division of Italy, consisting of the western part of the centre of the peninsula, bounded northwest by Liguria and Emilia, east by the Marches and Umbria, southeast by the district of Lazio and west by the Mediterranean.

It consists of nine provinces, Apuania, Arezzo, Firenze (Florence), Grosseto, Livorno (Leghorn), Lucca, Pisa, Pistoia and Siena, and has an area of 8,859 sq mi. Pop. (1936) 2,974,439 (showing a very low relative increase since 1901). The chief railway centre is Florence.

Except towards the coast and around Lucca, Florence and Arezzo, where the beds of prehistoric lakes form plains, the country is hilly, being intersected with sub-Apennine spurs, some of which have extensive forests

The most fertile country in Tuscany is in the valley of the Arno. In the neighbourhood of Lucca the irrigation system dates from 1376, while at Coltano, near Pisa, it goes hand in hand with land reclamation.

In strong contrast with this is the coast plain known as the Maremma, 850 sq mi. in extent, where malaria has been prevalent since the depopulation of the country in the middle ages An elaborate system of drainage, begun in the 19th century, is still being completed.

The greater part of the Maremma now affords pasture to large herds of horses and half-wild cattle, but the drier parts are cultivated. The hill country just inland, especially near Volterra, has poor soil, largely clayey, and subject to landslips, but is rich in minerals, boric acid and mineral springs.

But for the Maremma, Tuscany is one of the most favoured regions of Italy. The climate is temperate, and the rainfall not excessive.

The following is a list of the chief agricultural products in 1938 (the wine is largely produced in the district of Chianti, south-southwest of Florence):

	Area	Tons
	Acres	
Wheat	804,747	608,690
Rye	14,573	7,716
Barley	20,095	12,236
Oats	85,462	58,642
Maize	185,497	271,166
Beans	176,851	54,454
Sugar beets	12,597	105,821
Garden produce	377,910	99,979
Potatoes	58,045	183,423
Tobacco	4,199	
Forage	1,219,933	2,202,616
Vines	1,183,377	118,032,765 (wine, gal)
Olives	585,143	5,547,730 (olive oil, gal.)

The chief mineral products of the Florence district (including the provinces of Siena, Grosseto and Livorno [Leghorn]) are iron, manganiferous iron, copper, mercury (from Monte Amiata), iron pyrites, marble (chiefly from the Carrara or Apuania district), lignite (provinces of Arezzo and Grosseto) There are cotton mills at Florence, Leghorn, Prato and Pisa; Prato (*q.v.*) is an important centre of the wool industry, which furnished more in Florence in the middle ages than at present Hydro-electric power, mainly derived from the Serchio basin, is supplemented by the plants at Terni (*q.v.*) in Umbria Glass is made at Pisa. Porcelain and ceramic products are made, especially at Signa and Doccia, near Florence, where silk, straw hats, etc, are also manufactured, and much furniture is also produced. The Tuscans are, indeed, active, both in agriculture and industry There are universities at Florence, Pisa and Siena Viareggio and Leghorn are much frequented for sea-bathing, while the latter is a prosperous port.

The main art centres of Tuscany are Florence, Pisa and Siena, the headquarters of the chief schools of painting and sculpture from the 13th century onwards. While the first city, however, bore as prominent a part as any in Italy in the Renaissance, the art of Pisa ceased to advance at a comparatively early period, its importance being in ecclesiastical architecture in the 12th, and in sculpture in the 13th century. Siena, too, never accepted the Renaissance to the full, and art retained its individuality.

The Tuscan language is remarkable for purity of idiom, and its adoption by Dante and Petrarch probably led to its becoming the literary language of Italy. (*See* ITALIAN LANGUAGE, MODERN.)

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HISTORY

Etruria (*q.v.*) was finally annexed to Rome in 351 B.C and was later known as Tuscia, but was a larger area than the present Tuscany, comprising the northern part of Latium. Under Charlemagne the name of Tuscia or Toscana became restricted to the area north of Viterbo and Bolsena One of the earliest of the Frankish marquises in the 9th century was Boniface, who about 828 fought with success against the Saracens in Africa The male line of marquises ended with Boniface II (or III), who was murdered in 1052. His widow, Beatrice, in 1055 governed the country till her death in 1076, when she was succeeded by Matilda (*q.v.*), her only child by her first husband. Matilda died in 1115 without issue, bequeathing all her extensive possessions to the Church. The consequent struggle over her inheritance between the popes and the emperors enabled the principal cities of Tuscany gradually to assert their independence, so that Tuscany as a whole was no longer a state.

The Return of the Medici.—After the surrender of Florence to the Imperialists in Aug. 1530 the Medici power was re-established, and Alessandro de' Medici was made duke of Florence, the dignity to be hereditary in the family. In the reign of Cosimo III Siena was annexed (1559); the title of grand duke of Tuscany was conferred on that ruler in 1567 by Pope Pius V and recognized in the person of Francis I by the emperor Maximilian II in 1576.

Under his descendants Tuscany played but a small part in European history; a wave of degeneracy set in, affecting both the people and the new and shoddy nobility, and art and letters declined. Giovan Gastone, the last Medicean grand duke, being childless, it was agreed by the treaty of Vienna that at his death Tuscany should be given to Francis, duke of Lorraine, husband of the archduchess Maria Theresa, afterwards empress In 1737 Giovan Gastone died, and Tuscany was governed for Francis II, who resided in Austria, by a series of foreign regents. (The history of Tuscany from 1530 to 1737 is given in greater detail under MEDICI.)

Reforms of Leopold I.—Francis, who had been elected emperor in 1745, died in 1765 and was succeeded on the throne of the grand duchy by his younger son, Leopold I. Leopold resided in Tuscany and proved one of the most capable and remarkable of the reforming princes of the 18th century. He sub-

stituted Tuscans for foreigners in government offices, introduced a system of free trade in foodstuffs (at the suggestion of the Sienese Sallustio Bandini), and promoted agriculture. He reorganized taxation on a basis of equality for all citizens, reformed the administration of justice and local government, and suppressed torture and capital punishment. His reforms in Church matters made a great stir at the time, for he curbed the power of the clergy, suppressed some religious houses, reduced the mortmain, and rejected papal interference. With the aid of Scipione de' Ricci, bishop of Pistoia, he even attempted to reform Church discipline, but Ricci's action was condemned by Rome and he was forced to resign. (*See* PISTOIA, SYNOD OF.) At the death of his brother, Joseph II, in 1790, Leopold became emperor and removed to Vienna. After a brief regency he appointed his second son, Ferdinand III, grand duke

The French Occupation.—During the French revolutionary wars a French force entered Florence in 1799 and was welcomed by a small number of republicans. The grand duke was forced to fly, and a provisional government on French lines was established But the great mass of the people were horrified at the irreligious character of the new régime, and a counter-revolution broke out at Arezzo Bands of armed peasants marched through the country to the cry of "Viva Maria!" and expelled the French, not without committing many atrocities. With the assistance of the Austrians Florence was occupied and a government established in the name of Ferdinand. But after Bonaparte's victory at Marengo the French returned in great force, dispersed the bands, and reentered Florence (Oct. 1800) They, too, committed atrocities and sacked the churches, but they were more warmly welcomed than before by the people, after the experience of Austro-Aretine rule. Joachim Murat set up a provisional government, and by the peace of Lunéville (*q.v.*) Tuscany was made a part of the Spanish dominions and erected into the kingdom of Etruria under Louis, duke of Parma (1801). The new king died in 1803, leaving an infant son, Charles Louis, under the regency of his widow, Marie Louise of Spain Marie Louise ruled until 1807, when the emperor Napoleon obliged Charles IV of Spain to cede Tuscany to him, compensating Charles Louis in Portugal.

From 1807 to 1809, when Napoleon's sister, Elisa Baciocchi, was made grand duchess, Tuscany became a French department. French ideas had gained some adherents among the Tuscans, but to the majority the new institutions, although they produced much progress, were distasteful as subversive of cherished traditions After Napoleon's defeats in 1814, Ferdinand III returned, warmly welcomed by nearly everybody, for French rule had proved oppressive, especially on account of the heavy taxes and the dram of conscription. At the Congress of Vienna he was formally reinstated with certain additions of territory and the reversion of Lucca (incorporated in 1847).

The Restoration.—The restoration in Tuscany was unaccompanied by the excesses which characterized it elsewhere, and much of the French legislation was retained. Ferdinand was succeeded in 1824 by his son, Leopold II., who continued his father's policy of benevolent but enervating despotism When the political excitement consequent on the election of Pius IX spread to Tuscany, Leopold, in Feb. 1848, granted a constitution. A Tuscan contingent took part in the Piedmontese campaign against Austria, but the increase of revolutionary agitation in Tuscany, culminating in the proclamation of the republic (Feb. 9, 1849), led to Leopold's departure for Gaeta to confer with the pope and king of Naples. Disorder continuing, he was invited to return, and he did so, but accepted the protection of an Austrian army, by which act he forfeited his popularity (July 1849). In 1852 he formally abrogated the constitution, and three years later the Austrians departed When in 1859 a second war between Piedmont and Austria became imminent, the revolutionary agitation broke out once more. There was a division of opinion between the moderates, who favoured a constitutional Tuscany under Leopold, but forming part of an Italian federation, and the popular party, who aimed at the unity of Italy under Victor Emmanuel. At last a compromise was arrived at and the grand duke was requested to abdicate in favour of his son, grant a constitution, and take part in the war against Austria. Leopold having rejected these demands, the Florentines rose as one man and obliged him to quit Tuscany (April 27, 1859).

Union with the Italian Kingdom.—A provisional government, led by Ubaldino Peruzzi and afterwards by Bettino Ricasoli, was established. It declared war against Austria and then handed over its authority to Boncompagni, the Sardinian royal commissioner (May 9). A few weeks later a French force under Prince Napoleon landed in Tuscany to threaten Austria's flank, but in the meanwhile the emperor Napoleon III made peace with Austria and agreed to the restoration of Leopold and other Italian princes. Victor Emmanuel was obliged to recall the royal commissioners, but together with Cavour he secretly encouraged the provisional governments, and the constituent assembly of Tuscany voted for annexation to Sardinia The king accepted the annexation and appointed his kinsman, Prince Carignano, viceroy of Central Italy, with Ricasoli as governor-general (March 22, 1860). On Feb. 18, 1861, the kingdom of Italy, comprising Tuscany, was proclaimed.

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TUSCARORA, an Indian tribe of Iroquoian family, originally numbering 5,000, in North Carolina. Encroachments by the whites, including kidnapping of their children as slaves, led to a war with the settlers (1711–13), at the end of which the Tuscarora fled or drifted northward and were admitted into the League of the Iroquois as a sixth nation. About 700 survive in Canada and New York.

TUSCULUM, an ancient city of Latium, in a commanding position on the north edge of the outer crater ring of the Alban volcano, 1½ m. N.E of the modern Frascati. The highest point is 2,198 ft. above sea-level. It has a very extensive view of the Campagna, with Rome lying 15 m. distant to the north-west. Rome was approached by the Via Latina (from which a branch road ascended to Tusculum, while the main road passed through the valley to the south of it), or by the Via Tusculana.

According to tradition, the city was founded by Telegonus, the son of Ulysses and Circe. When Tarquinius Superbus was expelled from Rome his cause was espoused by the chief of Tusculum, Octavius Mamilius, who took a leading part in the formation of the Latin League, composed of the thirty principal cities of Latium, banded together against Rome. Mamilius commanded the Latin army at the battle of Lake Regillus (497 B.C.), but was killed, and the predominance of Rome among the Latin cities was practically established. In 381 B.C., the people of Tusculum received the Roman franchise. Several of the chief Roman families were of Tusculan origin, *e.g.*, the gentes Mamilia, Fulvia, Fonteia, Juventia and Porcia (to which the Catos belonged). By the end of the Republic, and still more during the imperial period, the territory of Tusculum was one of the favourite places of residence of the wealthy Romans. The number and extent of the remains is very great. Even in the time of Cicero we hear of eighteen owners of villas there. Much of the territory (including Cicero's villa), but not the town itself, which lies far too high, was supplied with water by the Aqua Crabra. On the hill of Tusculum itself are remains of a small theatre (excavated in 1839), with a reservoir behind it, and an amphitheatre. Both belong probably to the imperial period, while a temple (the substructures of which are preserved), often called the villa of Cicero, or of Tiberius, near the latter, is probably earlier. Between the amphitheatre and the theatre lay the Forum. The citadel—which stood on the highest point, an abrupt rock—was approached only on the side, towards the city. Upon it remains of the mediaeval castle, which stood here until 1191, are visible

It was here that Cicero composed his *Tusculan Disputations* and other philosophical works. His villa must have been at or near Grotta Ferrata and what is now known as Poggio Tulliano a little to the east (where remains of a villa exist) may well have been its site. After the transference of the seat of empire to

Constantinople, Tusculum became an important stronghold, and in the 10th–12th centuries its counts occupied a leading position in Rome. During the 12th century there were constant struggles with Rome, but in 1191 the Romans destroyed the city

See L. Canina, *Descr. dell' antico Tusculo* (Rome, 1841); A. Nibby, *Dintorni di Roma*, 2nd ed., iii, 203 (Rome, 1841); H. Dessau in *Corp. inscript. lat.*, pp 252 *seq* (Berlin, 1887); F Grossi-Gondi, *Il Tusculano nell' età classica* (Rome, 1907), T Ashby in *Papers of the British School at Rome*, iv, v (London, 1907, 1909). (T. A.)

TUSKEGEE, a city of Alabama, U S. Pop. (1950) 6,840; (1940) 3,937 It is the seat of a U S. veterans' hospital for Negroes and of Tuskegee institute (*q.v.*)

TUSKEGEE INSTITUTE, located in Macon county, Ala., about 40 mi. northeast of Montgomery, was founded in 1881 by Booker Tahaferro Washington (*q.v.*) as a coeducational industrial and normal school for Negroes. The institute, covering about 5,000 ac. in its campus and farming lands, had at mid-20th century an endowment of approximately $20,000,000, an enrolment of 2,500 and a faculty of more than 200. It is the home of the George Washington Carver foundation, created by Carver for research in natural sciences. There Carver carried on his own work from 1896 to 1943. Washington headed the institute from 1881 until the time of his death in 1915. During World War II, the army air forces established a training school for Negro pilots at the institute, and a reserve officers' training corps was installed.

(F. D. P.)

TUSSAUD, MARIE (1760–1850), founder of "Madame Tussaud's Exhibiton" of wax figures in London, was born in Berne in 1760, the daughter of Joseph Grosholtz She began to model figures for her uncle, J. C. Curtius, in Paris. Marie Grosholtz modelled the heads of many of the prominent leaders and victims of the Revolution, and was herself for three months a prisoner. In 1794 she married a Frenchman named Tussaud, from whom she was separated in 1800. She then moved to London, taking with her the nucleus of her collection. Her wax figures were first shown in the Strand and through the provinces, and finally the exhibition was established in permanent London quarters in Baker street in 1833. Here Mme. Tussaud died on April 16, 1850. The exhibiton was moved in 1884 to a large building in Marylebone road.

See J. T. Tussaud, *The Romance of Madame Tussaud* (1920).

TUSSER, THOMAS (*c.* 1524–1580), English poet, son of William and Isabella Tusser, was born at Rivenhall, Essex, about 1524. He was a chorister at Wallingford castle, and then at St. Paul's cathedral, and from there went to Eton college He was elected to King's college, Cambridge, in 1543, moved to Trinity hall, and on leaving Cambridge went to court in the service of William, 1st Baron Paget of Beaudesart, as a musician. After ten years of life at court, he married and settled as a farmer at Cattiwade, Suffolk, near the river Stour, where he wrote his *Hundreth Good Poinies of Husbandrie* (1557, 1561, 1562, etc). For his wife's health he moved to Ipswich. After her death he married again, and farmed at West Dereham. After farming at Fairsted, Essex, he moved to London. Thomas Fuller says he "spread his bread with all sorts of butter, yet none would stick thereon." He died on May 3, 1580.

The *Hundreth Good Poinies* was enlarged to *A Hundreth good poinies of husbandry, lately maried unto a hundreth good poynies of huswifery . . .* the first extant edition of which, "newly corrected and amplified," is dated 1570. In 1573 appeared *Five hundreth poinies of good husbandry . . .* (reprinted 1577, 1580, 1585, 1586, 1590, etc.). The numerous editions of this book, which contained a metrical autobiography, prove that the homely and practical wisdom of Tusser's verse was appreciated. The later editions include *A dialogue of wyuynge and thryuynge* (1562). Modern editions are by William Mavor (1812), by H. M. W. (1848), and by W Payne and Sidney J. Herrtage for the English Dialect Society (1878)

TUTBURY, town, Burton parliamentary division Staffordshire, England, 4½ mi N.W. of Burton-upon-Trent, picturesquely situated on the river Dove. Pop. of rural district (1938) 12,360. It is on the L.N.E. and L.M.S. railways, but the railway station is in Derbyshire. The fine church of St Mary has a nave of rich Norman work Glass is the staple manufacture. Alabaster is found in the neighbourhood.

Tutbury is said to have been a seat of the Mercian kings. It gave its name to an honour in Norman times Domesday shows it in the hands of Henry de Ferrers, in whose family the town and castle remained until 1266, when they were forfeited to the crown and granted to Edmund Crouchback, earl of Lancaster. They are still part of the duchy of Lancaster. John of Gaunt frequently resided at Tutbury castle Later it was, for a time, the prison of Mary Queen of Scots. During the Civil War it was held for the king but surrendered to the parliamentary forces (1646), and was reduced to ruins (1647), though the gateway still remains.

TUTENKHAMON (sometimes spelled TUTANKHAMUN, or TUT-ANKH-AMEN), son-in-law of the Pharaoh, Ikhnaton (*q.v.*), and himself Pharaoh for not less than six years in the middle of the fourteenth century B C. The fame of this politically unimportant sovereign is due to the discovery of his tomb still containing the larger part of its magnificent equipment Even in Egypt, the survival of royal burial equipment is unique; for the plundering of royal tombs began at a remote date. A pyramid is a gigantic husk of masonry to protect the body of the Egyptian sovereign; but not a single pyramid escaped plundering by the ancient tomb-robbers The Egyptian rulers, therefore, abandoned the pyramid and excavated the kings' tombs in the face of the Nile cliffs For four hundred years the excavation of these royal cliff-tombs continued; by 1150 B.C. there were over half a hundred

After the fall of the Empire about 1150 B C not a single known royal tomb was left intact.

The preservation of the burial of Tutenkhamon was due to accident, to its small size and to the unimportance of its occupant. The demoralisation of the government at the death of Tutenkhamon, about 1350 B.C., was such that the cemetery ghouls found no difficulty in robbing his cliff-tomb. Fortunately they were caught in the act, and much of their plunder was returned, although the heavy golden vessels and much other magnificent work was evidently too great a temptation for the officials. The tomb was never molested again, and two hundred years later, when the Empire was tottering, the architects of Rameses VI, excavating the tomb of this Pharaoh just above that of Tutenkhamon, ordered the workmen to throw their waste limestone chips down the slope below it, thus completely covering up the tomb of Tutenkhamon

The expedition which discovered the tomb of Tutenkhamon was maintained by Lord Carnarvon (*q.v.*), but the actual discovery was due to Howard Carter (*q.v.*), who on November 4, 1922 uncovered the steps leading down to the entrance gallery. For eight seasons (October to April) following, Carter salvaged this magnificent treasure, nearly all of which is now at the national museum in Cairo. The body of the youthful Pharaoh still lies in his beautiful stone sarcophagus in the burial chamber of his tomb The stone lid has not been replaced, and the gorgeous outer coffin, richly wrought in gold, is a unique and impressive sight.

The mortuary furniture of Tutenkhamon will continue to make his name a household word, notwithstanding his lack of political significance. He owed his succession to the throne to his marriage with Ikhnaton's third daughter, and he must have been hardly twelve years old when he was crowned. A helpless puppet in the hands of the priestly party which was vindictively striving to exterminate his father-in-law's memory, the boy king had little chance to survive. The examination of his mummy showed that he was about eighteen years old at his death, after a reign of probably not more than six years. The body showed no discernible traces of foul play.

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TUTICORIN, a seaport of British India in the Tinnevelly district of Madras. Pop. (1941) 75,614. It is the southern ter-

minus of the South Indian railway, 443 m. S.W. of Madras city. Tuticorn is an old town, long in possession of the Dutch, and has a large Roman Catholic population. It used to be famous for its pearl fisheries and pearl fishing was again engaged in successfully in 1926. There are industrial and training schools. Salt is manufactured, cotton woven, and there are cotton ginning and pressing factories. Tuticorin is the 2nd port of Madras. A deep-water harbour was in process of construction in 1927.

TUTTLINGEN, a town of Germany, in the *Land* of Württemberg, on the left bank of the Danube, 37 mi. by rail N.E. of Schaffhausen, and at the junction of lines to Stuttgart and Ulm. Pop. (1939) 18,096. Its chief manufactures are shoes, cutlery, surgical instruments and woollen goods.

TUXEDO, a town of Orange county, New York, U.S.A., 40 mi. N.N.W. of New York city; served by the Erie railroad. Pop 1950, 2,183 federal census. About 1¼ mi. from the station is Tuxedo lake, in a tract of 13,000 ac. which was taken for debt by the elder Pierre Lorillard in 1814 He built a shooting box here, and his grandson Pierre formed the Tuxedo Park Association, which resulted in the formation of the Tuxedo club and the opening (June 1, 1886) of Tuxedo park.

TÚY, a city of north-western Spain, in the province of Pontevedra, on the right bank of the river Miño, opposite Valença do Minho in Portuguese territory. Pop. (1940), 2,871 (mun, 13,500). During part of the 7th century Túy was the Visigothic capital. Túy is the southern terminus of the railways to Santiago de Compostela and Corunna; Valença do Minho is the northern terminus of the Portuguese railway to Oporto To the east of Túy is the river Louro; and beyond the Louro, on the railway to Corunna, are the hot mineral springs of San Martín de Caldelas. The cathedral is of a fortress-like architecture.

TUZLA or **DONJI SOLI,** a town of Bosnia, Yugoslavia, beautifully situated on the Jala or Julla. Pop. (1931) 16,711, almost all being Muslims. Tuzla is the seat of a district court and an Orthodox bishop, with several churches, many mosques, a hospital, gymnasium and commercial school. Besides a large ammonia soda factory, and the generating of electric power, it has a vigorous trade in grain, live stock, plums, bricks, etc.

TVA, the abbreviation for Tennessee Valley Authority. *See* ELECTRICAL POWER: NATIONAL AND REGIONAL SCHEMES; SOUTH, THE.

TVER (now KALININ), a region of the Russian S.F.S.R., surrounded by those of Smolensk, Leningrad, Vologda, Yaroslavl and Moscow, and not coinciding with the pre-1917 province of that name. Area 41,081 sq mi. Pop. (1939) 3,211,439 (urban 702,704; rural 2,508,735) mainly Great Russians, with Karelians in the north. The climate is continental, with severe winter frosts of five months' duration and an average July temperature of 67° F. Average rainfall 18–20 in. per annum. Coniferous forests, especially firs, cover 32.2% of the region, and 12% is marsh land In the remaining area meadow and grassland prevail, ploughed land occupying only 25%. There has been a marked diminution of grain production and a tremendous increase in the cultivation of long-fibred flax with the use of mechanized equipment on collective farms. Clover, sown alternately with flax to renew soil fertility, is the basis for a developing dairy industry.

Hunting and fishing supplement the income of the peasants, and there are koustar (peasant) industries of leather and fur preparation, textiles and wooden wares. Factory industries include sawmilling, flour-milling, leather goods, textiles, bricks, glass, machinery, oil-pressing and brewing. Main cities: Tver (Kalinin), pop. (1939) 216,131; Rzhev 54,081; Vyshni-Volochok 63,642.

The region is well drained by the upper Volga and its tributaries, especially the Tvertsa and Mologa; 17% of the rivers are available for steam navigation, and boats and rafts can be floated on many of the others. The Vyshni-Volochok system of canals connects the Volga with the Baltic and the Tikhvin system connects the Mologa with Lake Ladoga. Railways are comparatively good and the region is thus well situated for trade.

TVER (now KALININ), chief town of Tver region, on both banks of the Volga, at its confluence with the Tvertsa in 56° 52′ N., 35° 48′ E. The low right bank is protected from inundations by a dam. The town grew rapidly in the 20th century; pop. (1900) 45,644; (1939) 216,131. Its situation on the Moscow-Leningrad railway and on the navigable Volga has given it great trading importance as a centre for a productive region. Its chief manufactures are machinery, textiles and leather goods.

A fort was erected in 1180 at the mouth of the Tvertsa to protect the Suzdal principality against Novgorod. In the 13th century it became the capital of an independent principality, and remained so until the end of the 15th century. It long remained an open question whether Moscow or Tver would ultimately gain the supremacy in Great Russia. In 1486, when the city was almost entirely burned down by the Muscovites, the son of Ivan III became prince of Tver; the final annexation to Moscow followed four years later. In 1570 Tver had to endure, for some reason now difficult to understand, the vengeance of Ivan the Terrible, who ordered the massacre of 90,000 inhabitants of the principality. The town and region were renamed Kalinin in honour of **M. I. Kalinin,** president of the U.S.S.R.

TWAIN, MARK, the pen-name of SAMUEL LANGHORNE CLEMENS (1835–1910), American novelist and humorist, born at Florida (Mo.), Nov. 30, 1835. His father, a happy-go-lucky storekeeper and lawyer from Tennessee, popularly known as "Judge" Clemens, moved when the boy was four years old to Hannibal (Mo), dying eight years later and leaving the family all but destitute. Little Sam had virtually no formal education, but his imagination was early stored with the lore of the Mississippi river and the negroes who peopled the neighbourhood. As his brother's assistant on the Hannibal *Journal* he learned type-setting and became a journeyman printer, travelling as far eastward as New York and Philadelphia before he was 19. Drawn back to the Mississippi by the "permanent ambition" of his boyhood to become a pilot, he set to work "learning the river," getting "personally and familiarly acquainted," as he says in *Life on the Mississippi*, "with all the different types of human nature that are to be found in fiction, biography or history." At the beginning of the Civil War in 1861, the river trade came to an end, and young Clemens soon set out for the West with his brother Orion, who had just been appointed lieutenant governor of Nevada. There, in the neighbourhood of Carson City, he had a most hilarious but equally unlucrative experience as a gold miner, the record of which he has left in *Roughing It*. Soon he turned to journalism on the Virginia City *Enterprise*, adopting the *nom de plume* "Mark Twain," a call used by Mississippi pilots in taking soundings on the river. Moving to San Francisco, he became a member of the witty group that gathered about the *Golden Era* and included Artemus Ward, Charles Warren Stoddard, Bret Harte and Orpheus C. Ker, and with the publication of *The Celebrated Jumping Frog of Calaveras County* found himself famous overnight. On the wave of this notoriety he went to New York, where he delivered his "serio-humorous" lecture on the Sandwich Islands. In June, 1867, on a commission to contribute letters to the San Francisco *Alta California*, he joined the party embarking on the steamship "Quaker City" for the tour of the Mediterranean described in *The Innocents Abroad*. With the wide publication of these letters, Mark Twain became the most extensively read author in America. In 1870, he married Olivia L. Langdon and moved to Hartford, which became his home for the next 30 years.

He settled down at once to the trade of authorship, publishing *Roughing It* in 1872, collaborating in 1874 with Charles Dudley Warner in *The Gilded Age*, his sole novel of contemporary manners which contained the famous character portrait, Colonel Sellers, and writing *The Adventures of Tom Sawyer* (1875). In 1880 he visited Europe a second time, recording his experiences humorously in *A Tramp Abroad*. In 1882 he published his romance for children, *The Prince and the Pauper*, which was followed in successive years by *Life on the Mississippi* and his masterpiece, *The Adventures of Huckleberry Finn*, a sequel to *Tom Sawyer*. He became a partner of Charles L. Webster and Company which reaped immense profits from the *Memoirs of General Grant*, the *Life of Pope Leo XIII.*, but this firm failed and left him with heavy debts. Meanwhile he had published *A Con-*

necticut Yankee at King Arthur's Court (1889) and *The American Claimant* (1892), which were followed in 1894 by *The Tragedy of Pudd'nhead Wilson*, a story set in the Mississippi valley and containing much of the cynical philosophy that had become characteristic of its author

In 1891 Clemens went abroad again, and, after spending a winter in Berlin, settled in Florence, where he wrote his *Personal Recollections of Joan of Arc*, a book for which, as he later declared, he had spent 14 years in preparation, and which he published anonymously, observing to his wife that it meant more to him than anything he had ever undertaken, and that it would never be accepted seriously over his own signature. After spending two years at home, he set out, with the purpose of earning money to pay off his debts, on the journey round the world recorded in *Following the Equator*, lecturing on the way in Australia and India. Returning home in 1900, he settled in New York, and during this year a collected edition of his works in 22 volumes was issued by the American Publishing Company of Hartford He had published in 1897 a volume of miscellaneous essays entitled *How to Tell a Story;* and his further works included *The Man that Corrupted Hadleyburg* (1900), *The Double-Barrelled Detective Story* (1902), *Adam's Diary* (1904), *What is Man?* (privately printed, 1906), *Christian Science* (1907), *Captain Stormfield's Visit to Heaven* (1907) and *Is Shakespeare Dead?* (1909)

By the beginning of the last decade of his life Mark Twain had become a world celebrity and undoubtedly the most conspicuous and picturesque figure in America. In the year 1902 he made his spectacular return to the home of his childhood in Missouri, and in 1907, after having received honorary degrees from Yale and the university of his native state, he went to England to receive the degree of Doctor of Literature at Oxford In 1906 he had built a country-house, "Stormfield," at Redding (Conn), which became his home during the remaining years of his life, and there, shortly before he died, his daughter Clara, the only one of his four children who survived him, was married to the pianist Ossip Gabrilowitsch. His posthumous works comprise *The Mysterious Stranger* (1916), *What is Man? and Other Essays* (1917), *Mark Twain's Speeches* (1923), and two volumes of *Autobiography* (1924).

Mark Twain will always undoubtedly be regarded as the most characteristic American writer of his epoch. The first to represent the transition of the literary hegemony of the country from New England to the West, he was typical of the new democracy in his contempt for authority and for the sublimities as well as the commonplaces of 19th-century culture He was most widely popular in his own day as a humorist, but he will survive rather as the master folk-writer of the pioneering epoch who has left in *Roughing It* and *Life on the Mississippi* unrivalled pictures of the character and manners of the Middle and Far West in Civil War days, and in *Tom Sawyer* and *Huckleberry Finn* a veritable epic of that primitive civilization, poetic in feeling, strictly veracious in detail, abounding in colour, and, in the latter book especially, with a grasp of life that can only be described as classical

The standard biography of Mark Twain is by Albert Bigelow Paine (in three volumes, 1912). (V. W. B.)

TWAY-BLADE (*Listera*), a genus of small plants of the orchid family (Orchidaceae). The flower is green, with a downwardly directed, forked labellum Two species, the common tway-blade (*L. ovata*) and the heart-leaved tway-blade (*L. cordata*), are found in the British Isles, the last named occurring also in North America, where three other tway-blades are also native,—the broad-lipped (*L. convallarioides*), the southern (*L. australis*) and the western (*L. caurina*). For fertilization mechanism *see* C. Darwin, *Fertilization of Orchids*.

TWEED, WILLIAM MARCY ("Boss"), American politician and leader of the "Tweed Ring," was born in New York City Apr. 3, 1823. In 1852 he was elected an alderman of the New York City council. From 1854 to 1856 he served as U.S. Representative in Washington. His real power in municipal politics began in 1857 with his election to the board of supervisors, which he came to dominate. By working the downfall of Fernando Wood, a notoriously corrupt mayor, Tweed came into power under a cloak of respectability He fortified himself through his political appointments. From 1858 to 1871, while holding successively the positions of school commissioner, deputy street commissioner, State Senator and deputy commissioner of public works, Tweed, except for brief intervals, controlled the city administration In 1868 he also controlled the State Democratic Assembly at Albany, and in 1869, though he lost the Assembly, he secured the election of his nominee as governor The "Tweed Ring" of history, composed of Tweed, Mayor A. Oakey Hall, Peter B. Sweeny and Richard B Connolly, began its operations in Jan 1869 and lasted until Tweed's downfall in 1871. Conservative estimates place the amount stolen directly from the city during this period at $45,000,000, though including taxes lost through arbitrary reductions by the "ring" for money or favor and the issuance of bonds at extravagant rates of interest some authorities have estimated as high as $200,000,000. Exposure came through a book-keeper who placed evidence in the hands of the New York *Times* where it was printed. Tweed was tried, found guilty and sentenced to 12 years in the penitentiary In 1875 he escaped from the Ludlow Street gaol where he was confined, fled to Cuba and thence to Spain, where he was arrested by the Spanish Government and returned to the United States. He was again imprisoned in Ludlow Street gaol where he died Apr 12, 1878.

See D. Lynch, *"Boss" Tweed* (1927)

TWEED, a river in the south of Scotland. It rises in the south-west corner of Peeblesshire, in the hill country in which the Clyde and Annan also rise. The stream flowing from Tweed's Well, about 1,500 ft above the sea, is generally regarded as its source. For the first 36 m of its course the stream intersects the shire of Peebles in a north-easterly direction, and then, bending towards the south-east, passes Innerleithen, where it receives the Leithen (left) and the Quair (right). It then crosses Selkirkshire and, having received the Ettrick on the right, flows northward past Abbotsford, forming for about 2 m the boundary between the counties of Selkirk and Roxburgh After receiving the Gala on the left, the Tweed crosses the north-western corner of Roxburghshire past Melrose and, after being joined by the Leader on the left, winds past Dryburgh abbey round the south-western corner of Berwickshire The remainder of its course is in a north-easterly direction through Roxburghshire past Kelso, where it receives the Teviot on the right, and then between the counties of Berwick and Northumberland, past Coldstream, to the town of Berwick, where it enters the North sea. The last 2 m. of its course before reaching Berwick are in England

The Tweed is 97 m. long and drains an area of 1870 square miles Its bed is pebbly and sandy, and notwithstanding discolorations from manufactures, the stream, owing to its clear and sparkling appearance, still merits the epithet of the "silver Tweed "

TWEED, a term of very general application in the woollen and worsted trades. It is employed as a trade description for a very large variety of woollen and worsted fabrics that embody the same general textural features, but which differ in the minor details of their manufacture, construction and finish. They are described as "Scottish," "Harris," "Cheviot," "Irish," "Yorkshire," "Saxony" and "West of England" tweeds, according to the particular locality of their origin, the yarn used in their construction, their character of structure, texture, finish and other details

The description of this particular variety of worsted fabrics as "Tweeds" is commonly, but erroneously, associated with the Scottish river of that name The origin of the word "tweed" however, has no reference to the river Tweed, but is said to be due to an error on the part of a London clerk who, in the year 1826, when writing out an invoice for these goods, inadvertently wrote the word "tweeds" instead of "tweels," the Scottish for "twills " Orders were placed for more "Scottish tweeds"—a novel description which immediately won the popular favour and became firmly established in the clothing trade as a brand of quality.

The chief characteristic feature of the true type of "tweed" fabrics in general is, as the name suggests, their construction on a twill weave basis, although they are not restricted entirely to the simple regular twill weave structures, as many tweed fabrics are

based on the numerous modifications of those weaves Tweed fabrics are produced from Scottish, Cheviot, Saxony and many other types of worsted and woollen yarns of various counts and quality, and woven in solid colours, mingled "heather" tones, and coloured stripes and checks in endless variety of pattern and colour, and in every variety of texture suitable both for men's and women's clothing for outer wear, and for every season of the year.

"Herringbone" twills, "diamonds," "chevrons," "cross-twills" and "basket" weaves are popular styles for tweed designs, which are now more of a broken character than formerly, while more intricate patterns are introduced in textures of superior quality A new vogue of recent origin consists of printed tweed effects with the pattern printed on both sides of the fabric to give the impression of woven designs These printed tweeds are executed with such realistic effect that it is in some cases very difficult without close inspection to distinguish the printed imitation tweed effect from the genuine woven tweed patterns (H. N)

TWEEDDALE, JOHN HAY, 2ND EARL and 1ST MARQUESS OF (1626–1697), was son of John, 8th Lord Hay of Yester (*c* 1599–1654), created earl of Tweeddale in 1646 Before succeeding to the peerage in 1654 the second earl fought for Charles I during the Civil War, but he was in the Scottish ranks at Marston Moor. Changing sides again, he was with the royalists at Preston; but he was a member of Cromwell's parliament in 1656, and was imprisoned just after the restoration of Charles II. He was soon, however, in the king's favour, and in 1663 was appointed president of the Scottish council, and in 1664 an extraordinary lord of session. In Scotland he sought to mitigate the harshness shown by the English government to the Covenanters, and for this attitude he was dismissed from his offices in 1674; but he regained an official position in 1680 and held it during the reign of James II. A supporter of William of Orange, he was made lord high chancellor of Scotland in 1692, and two years later was created marquess of Tweeddale and earl of Gifford He favoured the scheme for the expedition to Darien, and as lord high commissioner during William's absence he formally assented to the act establishing the trading company in 1695; for this action he was dismissed from office when the king returned to England in 1696. He died on Aug. 11, 1697.

TWEED RIVER: *see* RICHMOND RIVER AND BASIN.

TWEEDSMUIR, 1ST BARON *see* BUCHAN, JOHN.

TWELVE TABLES, the tables of wood on which was engraved or painted the earliest codification of the Roman law Originally ten in number, two supplementary tables were added, and the whole code was termed the *Lex XII Tabularum* (Law of the Twelve Tables). (*See* ROMAN LAW and ROME)

TWENTY-FOUR PARGANAS, THE, a former district of British India, in the Presidency division of Bengal; area 3,696 sq.mi. Pop. (1941) 3,536,386. It occupied part of the Gangetic delta, east of the Hooghly, surrounding (but not including) the city of Calcutta. It also included the greater part of the almost uninhabited Sundarbans (*q v*), so that within its confines were found virgin forest, settled tilth and the busy life of the suburb of a great city. The administrative headquarters were at Alipur, a southern suburb of Calcutta. The country consists for the most part of an alluvial plain with a population devoted to agriculture and almost entirely rural, but a chain of industrial towns stretches along the bank of the Hooghly from Garden Reach northward. Rice is the staple crop, followed by jute, pulses and sugar cane. The riparian strip is crowded with towns, factories and mills; Bhatpara has 117,044 and Titagarh 57,416 inhabitants. Other industrial towns are Baranagar (54,451), Budge-Budge, Naihati, Kamarhati, South Dum-Dum and Kanchrapara, in the last of which are the works of the broad gauge system of the Eastern Bengal State railway. In other towns various manufactures are to be found, principally jute mills and jute presses, and also, at Dum-Dum, government factories for rifles

TWICKENHAM, a municipal borough mainly in the Twickenham parliamentary division of Middlesex, England, 12 mi. W.S.W. of St Paul's cathedral, London, on the river Thames, and with three stations on the Southern Region railway. Pop. (1938) 96,550 Area, 10.96 sq mi. It grew into an extensive residential district. The church of St. Mary has a Perpendicular tower. Among men of eminence buried here are Alexander Pope and Sir Godfrey Kneller The Thames in this neighbourhood forms a long deep reach in favour with fishermen, and Eel Pie Island is a resort of boating parties There are many fine houses in the vicinity, several possessing historical associations Strawberry Hill, the residence of Horace Walpole, was built to his taste in a medley of Gothic styles. Marble Hill was erected by George II for the countess of Suffolk, and Pope, Swift and Gay took part in its equipment. Orleans House was the residence in 1800 of Louis Philippe, then duke of Orleans, and this family again acquired it in 1852, when it was occupied by the duke of Aumale. York House was given to Lord Clarendon by Charles II, was probably the occasional residence of James II when duke of York, and in 1864 was occupied by the comte de Paris

Twickenham at the Domesday survey was included in Isleworth. Anciently it was called Twittenham or Twicanham, and the first form, or a variation of it, is used by both Pope and Walpole. The manor was early in the hands of the monks of Christ church, Canterbury, but in the reign of Henry VIII it came into the possession of the crown, and by Charles I was assigned to Henrietta Maria as part of her jointure In 1670 it was settled for life on Catherine of Braganza, queen of Charles II It remains in possession of the crown, but after the death of Catherine was let on leases The old manor house, now demolished, was Catherine's residence. It had been, according to tradition, the place of the retirement of Catherine of Aragon after her divorce from Henry VIII Twickenham was incorporated in 1926, and in 1937 the urban districts of Hampton, Hampton Wick and Teddington were added to the borough, which contains more than 2,000 ac. of open public spaces, including Hampton Court palace, the Home park and Bushey park.

TWILIGHT, the interval during which the atmosphere is illuminated after sunset; formerly known as *crepusculum*, Lat. for dusky or obscure. The analogous early morning phenomenon is known as the dawn (*q.v.*). These phenomena are caused by the intervention of the atmosphere between the sun and the earth's surface. An entire absence of atmosphere would cause darkness to set in sharply at sunset as on the moon; but under present conditions even when the sun is some distance below the horizon the upper layers of air are illuminated and are reflecting light. Even as early as the 11th century the duration of twilight was determined as ending when the sun had "travelled" 18° below the horizon and subsequent observations have not materially modified the figure.

This quantity, 18°, has been made the measure for the interval between sunset or sunrise and "complete" darkness, and is termed astronomical twilight; but during a large part of this interval the light is insufficient for ordinary employments, consequently a shorter period, civil twilight, is also recognized for which the quantity is about 6°, but it is conditioned by the amount of light still available.

The duration in each case is dependent on the latitude of the observer and the season of the year. The intensity of illumination depends to a considerable extent on the amount of atmospheric cloud and dust. Twilight after the sunsets of 1883–85 was frequently intense because of the reflection from the extra dust in the higher layers of the atmosphere as a result of the eruption of Krakatoa.

TWILIGHT SLEEP: *see* SCOPOLAMINE.

TWILL, a woven cloth in which the passage of the weft is arranged, not in regular succession as in plain weaving, but over one thread and under two or more according to the kind of twill This gives a succession of diagonal lines to the cloth, and though in the normal type of twill this diagonal traverses from selvage to selvage at an angle of 45°, considerable variations may be made.

TWIN FALLS, a city of southern Idaho, U.S.A., on the Snake river plateau, 40 mi from the Nevada state line; the county seat of Twin Falls county. It is on federal highways 30 and 93 and the Oregon short line of the Union Pacific railway system. Pop. (1950) 17,544 It is a trading and shipping point for a fertile irrigated region (706,000 ac. within 50 mi.), producing chiefly

livestock, dairy and agricultural products It has large wholesale and commission houses, bonded warehouses, several farmers' co-operative associations, flour mills, creameries, a fruit dehydrating plant and other manufacturing industries, converting farm products into less bulky form. There are many points of interest in the vicinity Shoshone falls (212 ft.) are 6 mi from Twin Falls The black lava canyon of the Snake river is spanned 2½ mi. N. of the city, by a bridge 476 ft above the water and 1,400 ft. long. The falls from which the city and county take their name are divided into two parts by a huge mass of black lava.

TWINS AND TWINNING. Human twins are of two kinds one-egg and two-egg twins. One-egg twins are variously known as identical, uniovular or monozygotic; two-egg twins, as fraternal, biovular or dizygotic. Most mammals regularly bear several young to a litter, each young derived from a separate egg Some of the larger mammals, however, habitually bear only one young at a time (as in the case of man, cattle, horses), but sometimes bear small litters of two, three or more. When such uniparous species bear plural young, the latter are known as plural-egg twins, triplets, etc. Some mammals, however, such as the nine-banded armadillo (*Dasypus novemcinctus*) and related South American species, have been shown to give rise to multiple offspring in an entirely different manner. A single early embryo divides and subdivides into four parts, which severally develop into four distinct offspring—one-egg quadruplets In addition to two-egg twins, the human race produces considerable numbers of one-egg twins, triplets, etc., in a manner probably similar to that known for the armadillos.

Supertwins.—Both one-egg and plural-egg twinning in man go beyond mere twinning proper to produce triplets, quadruplets, quintuplets and sextuplets (the highest number known to occur). Two, three, four or five offspring from a single egg are known (the Dionne quintuplets being surely monozygotic). Plural-egg triplets may come from two or three eggs; quadruplets from two, three or four eggs; and quintuplets from two, three, four or five eggs.

Frequencies of Twins, Triplets, etc.—In the United States, which has a mixed population of almost all races, one out of 44 babies born is a twin. For every 86 single births there is one twin birth, making a percentage of twin births of 1.15. Twin frequencies differ greatly among different races and countries, being highest among north Europeans and lowest among various Mongoloid peoples. Among countries keeping reliable vital statistics, Belgium claims 1.79% of twin births, Finland, 1.65%; while Japan has only 0.69%, due largely to relatively few two-egg twins. One-egg twins seem to have about the same incidence the world over. Triplets are about 86 times as rare as twins, and quadruplets about 86 times as rare as triplets. If then we speak of the frequency of twin births to singles as one to 86, that of triplets is about one in 86^2 and that of quadruplets about one to 86^3, a curious but unexplained set of ratios.

Diagnosis of One-egg Twins.—Two methods of distinguishing one-egg from two-egg twins are used: the foetal membrane method and the similarity method. According to the membrane method, one-egg twins should always be enclosed in a common birth robe (chorion) and two-egg twins in separate chorions, but some one-egg twins have separate chorions. Hence the membrane method is somewhat unreliable. According to the similarity method, twins that are so similar as to be easily confused are classed as one-egg twins and those that differ markedly, as two-egg twins. The few doubtful cases are resolved by meticulous comparisons of such details as blood groups, eye colour and finger-prints. In the hands of experts, few mistakes are likely to be made.

Hazards of Twinning.—The human species is highly specialized for single-offspring births, and plural-offspring births are less viable. The prenatal and infantile mortality rate of twins probably averages about 50%, or about five times that of singles Also, more than half of all twins are born prematurely and are thus more likely to be injured at birth. All of these hazards increase progressively for triplets, quadruplets and quintuplets.

Sex Distribution.—Twins are more frequently of like than of unlike sex. Extensive counts covering more than 700,000 cases show that twins are of unlike sex in only about three-eighths of them From such counts an estimate can be made of the frequency of one-egg twins, for these are never of unlike sex, while of the two-egg twins half are expected to be so Since, in fact, three-eighths are of unlike sex, it may be inferred that twice this number, or three-fourths, must be two-egg twins, and hence one-fourth, or the remainder, must be one-egg twins.

Joined-together Twins.—Occasionally twins are joined at birth, as in the famous Siamese twins. In most cases they are joined symmetrically, like part with like. Superficial unions are easily severed at birth. More deeply united pairs seldom survive, though a few have lived to become natural curiosities. Most joined twins exhibit abnormal disposition of blood vessels and viscera, known as *situs inversus*, in which the organs of one twin are more or less completely a mirror image of those of the other A few cases of separate one-egg twins show the same peculiarity. Joined twins are always same-sexed, and much evidence points to the conclusion that one-egg twins always result when the twinning division of the originally single embryo has been incomplete.

Heredity of Twinning.—The tendency to bear twins is regarded as slightly hereditary, though its exact mode and pattern of inheritance is far from clear. That relatives of twins have twins somewhat more frequently than the general population has been claimed by many writers, though satisfactory records are rare According to some investigators, the production of two-egg twins seems to be influenced only by the mother and depends greatly upon her age, for the frequency of twins increases at least three-fold from the age of 18 to that of 38. It is generally agreed that the tendency to bear two-egg twins is somehow hereditary, but opinions vary widely as to one-egg twinning. Some writers hold that the frequency of one-egg twinning depends on the inheritance of the father as well as that of the mother, but is uninfluenced by age or environmental factors. Others regard one-egg twinning as probably nonhereditary and due to an early arrest of development that disturbs the unity of the embryo and favours the development of two or more growth centres (organizers), each of which grows into a separate individual.

Twins and Human Genetics.—Twins have been extensively used in attempts to estimate the relative shares of hereditary and environmental factors in determining differences in physical, mental and temperamental traits. In character differences determined wholly by heredity, one-egg twins should be exactly alike, whereas two-egg twins should show degrees of resemblance no greater than brothers and sisters by different births. Most human differences, however, are determined partly by heredity and partly by environment. With respect to each trait we wish to know what relative shares hereditary and environmental factors have in determining differences. A comparison of large numbers of one-egg twin pairs reared together with an equal number of two-egg pairs reared together should give for each trait the percentage share of hereditary determination, for the two groups differ only with respect to heredity, the one-egg pairs being alike and the two-egg pairs different. A second comparison has been made between 50 pairs of one-egg twins reared together and 20 pairs of one-egg twins (all that could be found) reared apart under various degrees of environmental differences. This comparison should give us the effects of environmental differences, for the two groups are alike as far as heredity is concerned. From both comparisons it was evident that physical traits are least affected by environmental differences; that mental ability is affected more; educational achievement, still more; and personality or temperament, the most.

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(H. H. N.)

TWISS, SIR TRAVERS (1809–1897), English jurist, was born in London on March 19, 1809. He was educated at Univer-



BY COURTESY OF (1, 2, 3, 4) GUNNAR DAHLBERG FROM "TWIN BIRTHS AND TWINS FROM AN HEREDITARY POINT OF VIEW," (5) NEA SERVICE INC., (6) COPR. F. M. KEYES

FULL FACE AND PROFILE VIEWS OF TWINS

Twins are characterized as one-egg or two-egg twins One-egg twins are of the same sex and, generally speaking, nearly identical, but two-egg twins merely resemble each other as brothers and sisters do, and often are of opposite sex

1, 3 Full face and profile views believed to be two-egg twins
2, 4 Full face and profile views of twins believed to be one-egg twins. Likeness closer than in figs 1, 3
5. The Dionne quintuplets in their thirteenth month, diagnosed as one-egg quintuplets
6 Quadruplet daughters. In this case the father was one of 12 children, among whom was one pair of twins. There was no record of twins on the mother's side. If the explanation for the appearance of the quadruplets be sought in heredity, it is attributable most probably to the father rather than to the mother

sity college, Oxford, of which he was afterward successively bursar, dean and tutor. He published while at Oxford an epitome of Barthold Niebuhr's *History of Rome*, an annotated edition of Livy and other works, but his studies were mainly in political economy, international law, and international politics. In 1840 he was called to the bar, and became an advocate at Doctor's commons. In the ecclesiastical courts he enjoyed a large practice and filled many appointments such as commissary general of the city and diocese of Canterbury (1849), vicar general to the archbishop (1852) and chancellor of the diocese of London (1858). He was professor of international law at King's college, London (1852–55). His successful career continued in the civil courts, and in addition to his practice he was appointed in 1862 advocate general to the admiralty, and in 1867 queen's advocate general. He was knighted in 1867. His reputation abroad led to his being invited by the king of the Belgians in 1884 to draw up the constitution of the Congo Free State. Twiss lived in retirement in London after 1871 when he was involved in an unpleasant scandal. He died on Jan. 14, 1897. Among his important publications of this period were *The Law of Nations in Peace* and *The Law of Nations in War*.

TWO-NAME PAPER: *see* DOUBLE-NAME PAPER.

TWO RIVERS, a town in eastern Wisconsin, U S, in Manitowoc county. It is situated 85 mi. north of Milwaukee, on Lake Michigan at the point where the Neshoto and Mishicot rivers join to flow into the lake through a single channel The town is served by the Chicago and North Western railroad.

The altitude is 597 ft; the population was 10,243 in 1950, 10,302 in 1940 and 10,083 in 1930 by the federal census.

Manufactures include aluminum products, furniture, electrical toys and appliances, engines, castings, chemicals, yarn and knit goods, agricultural equipment and tile.

The town is in the centre of a diversified agricultural area, and dairying is important.

Two Rivers was first settled by fishermen who began commercial fishing there in 1836; the town was also a busy lake port until the 1870s Lumbering was an important activity of the early settlers and shipbuilding was an important industry between 1850 and 1875.

TWO-STEP, a modern round dance in which the partners perform a series of sliding steps in $\frac{2}{4}$ time. The first step of each measure, or the slide, is longer than the second.

(*See* also DANCE.)

TWYSDEN, SIR ROGER (1597–1672), English antiquary and royalist pamphleteer, was educated at St Paul's school, London, and then at Emmanuel college, Cambridge He entered Gray's Inn on Feb. 2, 1623. He succeeded to the baronetcy on his father's death in 1629. For some years he remained on his estate at Roydon, East Peckham, largely engaged in building and planting, but also in studying antiquities and the law of the Constitution.

Twysden took the most prominent part in preparing the Kentish petition of March 1642 and in subsequent demonstrations on behalf of Charles. He incurred the wrath of the parliament, was arrested on April 1, 1642, but was soon let out on bail, and on his promise to keep quiet. But his respect for legality would not let him rest, and he was repeatedly in trouble with the parliament until 1650, when he compounded and went home. He lived quietly there till the Restoration, when he resumed his position as magistrate. He died on June 27, 1672.

Twysden published *The Commons' Liberty* (1648), demonstrating that finings and imprisonings by parliament were illegal; *Historiae anglicanae scriptores decem* (1652), a work encouraged by Cromwell; and *Historical Vindication of the Church of England* (1657).

TYBURN, a left-bank tributary of the Thames, England, now having its course entirely within London and below ground. The name, which also occurs as Aye-bourne, is of obscure derivation, though sometimes stated to signify Twy-burn, *i.e.* (the junction of) two burns or streams. The Tyburn rose on the southern slope of the Hampstead heights in two streams, the more westerly of which rose in the spring known as the Shepherd's Well. It ran south, crossing Regent's Park, its course being marked by Regent's Park Water, and further south by the windings of Marylebone Lane and the dip in Piccadilly near the junction of Half Moon street. It then crossed the Green Park and entered the flood plain of the Thames near where Buckingham palace now stands. The exact point at which it entered the Thames is doubtful but its water is now drained off by sewer. After 1238 it supplied the city with water for a long time by means of nine conduits. The name is more famous in its application to the Middlesex gallows also called Tyburn Tree and Deadly Never Green, and also at an early period, the Elms, through confusion with the place of execution of that name at Smithfield.

The Tyburn gallows stood not far from the modern Marble arch. Connaught square is said by several authorities to have been the exact site, but it appears that so long as the gallows was a permanent structure it stood at the junction of the present Edgware and Bayswater roads. The site, however, may have varied, for Tyburn was a place of execution as early as the end of the 12th century. In 1759, moreover, a movable gallows superseded the permanent erection. On some occasions its two uprights and cross-beam are said to have actually spanned Edgware road. Round the gibbet were erected open galleries, the seats in which were let at high prices. Among those executed here were Perkin Warbeck (1499), the Holy Maid of Kent and confederates (1535), Haughton, last prior to the Charterhouse (1535), John Felton, murderer of Villiers, duke of Buckingham (1628), Jack Sheppard (1724), Earl Ferrers (1760).

In 1661 the skeletons of Cromwell, Ireton and other regicides were hung upon the gallows. The last execution took place in 1783, the scene being thereafter transferred to Newgate. The Tyburn Ticket was a certificate given to a prosecutor of a felon on conviction, the first assignee of which was exempted by a statute of William III from all parish and ward duties.

See A. Marks, *Tyburn Tree, its History and Annals* (London, 1908).

TYDEUS, in Greek legend, son of Oeneus, king of Calydon, and Periboea. Having slain his uncle (or other relatives) he fled for refuge to Argos, where Adrastus purified him and married him to his daughter Deipyle, who became the mother of Diomedes (*q v*). In the expedition of the Seven (*cf* OEDIPUS), Tydeus, who had fought valiantly, was mortally wounded by Melanippus. Having killed Melanippus, he proceeded to devour his head; this so disgusted Athena, who had meant to make him immortal, that she left him to die.

See Roscher's *Lexikon*, art. "Tydeus"

TYLDESLEY, an urban district of Lancashire, England, 10 mi. W.N.W. from Manchester. Pop. (1951) 18,096. Area, 8 1 sq. mi. The town, of modern growth, depends on cotton mills and collieries. The council maintains a library and technical school.

TYLER, JOHN (1790–1862), tenth President of the United States, was born at Greenway, Charles City county, Virginia, on March 29, 1790. He was the second son of John Tyler (1747–1813), of English descent, governor of Virginia in 1808–11 and U.S. district judge in 1812–13. John Tyler the younger entered the grammar school of the College of William and Mary, at Williamsburg, in 1802, and graduated at the college in 1807. Two years later he was admitted to the bar. His public life began in 1811, when he was elected a member of the Virginia house of delegates. Here he served for five years, being chosen also in 1815 a member of the council of State. In 1813 he raised a company for the defence of Richmond against the British, but his command was not called into action and his military service was concluded after a month. From Dec. 1816 to March 1821 he was a member of the National House of Representatives. Believing firmly in the republican principles of Jeffersonian democracy, he opposed the demand for internal improvements and increased tariff duties. He declined to follow Henry Clay in the proposed recognition of the independence of the Spanish colonies in South America and in the Missouri Compromise legislation, and he condemned Jackson for his execution of Arbuthnot and Ambrister in Florida. He declined re-election to the House in 1821 because of ill-health. In 1823–25 he was again a member of the Virginia house of delegates, and in 1825–27 was governor of the State. In 1827 he was sent

to the U S. senate to succeed John Randolph, after having been unanimously re-elected governor In 1829–30 he also served as a member of the Virginia Constitutional Convention. His career as senator was marked by great independence of party, for his political ideas continued to be those of a thoroughgoing "strict-constructionist." Believing protective tariff duties to be unconstitutional, he voted against the "tariff of abominations" in 1828, and also against the tariff of 1832; but the compromise tariff of 1833, made necessary by the hostile attitude of South Carolina, owed its inception largely to him. His hostility to a high tariff policy, however, did not prevent his condemning the South Carolina ordinance of nullification; and in the presidential election of 1832 he supported Andrew Jackson, to whose political principles and methods he was invincibly opposed, as the "least objectionable" of the various candidates. His opinions never changed, though he aligned himself with parties as they developed In this way he became a Whig (1833), but agreed with the Democrats on state's rights and differed from them on nationalism He sought to incorporate in a new code for the District of Columbia, in 1832, a prohibition of the slave trade in the district, at the same time opposing the abolition of slavery there without the consent of Maryland and Virginia, which had originally ceded the district to the United States In the controversy over the removal of the government deposits from the Bank of the United States he sided with the bank In 1833 he was again elected to the senate, notwithstanding the criticism of his independent attitude and the wide approval of Jackson's policy in regard to the bank. In the election of 1836 he was supported as a candidate for the vice-presidency by the friends of H. L White of Tennessee, the Democratic candidate opposed to M. Van Buren, and received 47 votes, none of them from Virginia When the legislature of Virginia instructed its senators to support Benton's expunging resolution, Tyler, admitting the right of instruction, could not conscientiously obey, and on Feb. 29, 1836, he resigned his seat. In 1838 he became once more a member of the Virginia house of delegates, and was chosen president of the Virginia colonization society, of which he had long been a vice-president. In 1839 he made an unsuccessful contest for the U S. senatorship. In December of that year the Whigs nominated W. H. Harrison for president and Tyler for vice-president without issuing a platform Tyler was nominated with the expectation that he would carry the south, and in the belief that his senatorial record was a declaration of principle Harrison and Tyler each received 234 electoral votes and were elected On April 4, 1841, one month after the inauguration, Harrison died, and Tyler became president. The detailed discussion of the events of his administration, 1841–45, belongs to the history of the United States (*see* UNITED STATES *History*).

He kept Harrison's cabinet until his veto of the bill for a "fiscal corporation," as being opposed to state's rights, led to the resignation of all the members except D Webster, who was bringing to a close the negotiations with Lord Ashburton for the settlement of the northeastern boundary dispute Tyler opposed the recognition of the spoils system and kept at their posts some of the ablest of the ministers abroad He stood, however, between the two great parties, without the support of either, Van Buren refused to recognize him as a Democrat, and the Whigs repudiated him, while, with Clay leading the majority in congress, harmony between that body and the executive was from the first impossible The annexation of Texas, achieved just before the close of his administration, seemed to commend him for a second term, and in May 1844 he was renominated by a convention of Democrats, irregularly chosen, at Baltimore The majority of the annexationists, however, would not support him, and he had further to meet the opposition of Van Buren, who had failed to secure the nomination in the regular Democratic convention, and of J. K. Polk, the regular Democratic nominee. Tyler accepted the Baltimore nomination, but on Aug 20 withdrew from the contest. From this time until the eve of the Civil War he held no public office, but his opinions on political questions continued to be sought, and he was much in demand as a speaker on public occasions. In Dec 1860 when South Carolina adopted its ordinance of secession, Tyler, though sympathizing with the state, took firm ground against disunion and exerted himself on behalf of peace. The legislature of Virginia appointed him a commissioner to confer with President Buchanan and arrange, if possible, for the maintenance of the *status quo* in the matter of Ft Sumter, in Charleston harbour; but his efforts were unavailing. He was largely responsible for, and presided over, the peace congress which assembled at Washington on Feb 4, 1861, pursuant to a resolution of the Virginia legislature. The constitutional amendment proposed by the conference did not meet with his approbation, and his action in signing and transmitting the resolution to congress was merely formal. On Feb 13, while in Washington on this mission, he was elected to the Virginia convention at Richmond, and took his seat on March 1. In the convention he advocated immediate secession as the only proper course under the circumstances He continued to serve as a member of the convention until it adjourned in December, in the meantime acting as one of the commissioners to negotiate a temporary union between Virginia and the Confederate States of America He was a member of the provisional Confederate congress in 1861 and was elected a member of the house of representatives of the permanent congress, but died on Jan 18, 1862, in Richmond, before that body assembled

Tyler was twice married; first in 1813 to Letitia Christian (1790–1842), and then in 1844 to Julia Gardiner (1820–89).

His son, LYON GARDINER TYLER (1853–1935), graduated at the University of Virginia in 1875 and practised law at Richmond, Va., from 1882 to 1888, when he became president of the College of William and Mary Among his publications, besides *Letters and Times of the Tylers*, are *Parties and Patronage in the United States* (1890); *Cradle of the Republic* (1900); *England in America* (1904–06), in the "American Nation" series and *Williamsburg, the Old Colonial Capital* (1908). He died Feb. 12, 1935.

The principal authority is Lyon G. Tyler, *Letters and Times of the Tylers*, Richmond, Va (1884–96). A good sketch of Tyler is in *Virginia Portraits* (1924), by Armistead Gordon

TYLER, MOSES COIT (1835–1900), American historian was born in Griswold (Conn.), on Aug. 2, 1835, but his boyhood was spent in Michigan. From his graduation at Yale in 1857 until his death in Ithaca (N.Y.), on Dec. 28, 1900, he alternated between a desire for a life of service in the ministry and a life of study Although he attended the Yale and Andover theological schools, held pastorates at Owego and Poughkeepsie (1859–62), and indulged in a couple of journalistic interludes, his reputation was won through his professorships at Michigan and Cornell universities and his publications, notably his *History of American Literature during the Colonial Time, 1607–1765* (1878, rev 1897); *Literary History of the American Revolution, 1763–1783* (1897); *Three Men of Letters* (1895); and *Patrick Henry* (1887), a sound and critical biography.

See tributes by W P. Trent in the *Forum* (Aug 1901) and by J W Jenks in the *Michigan Alumnus* (March 1901). *Moses Coit Tyler· Selections from His Letters and Diaries* (1911), by Jessica T. Austen, illuminates his personality and work.

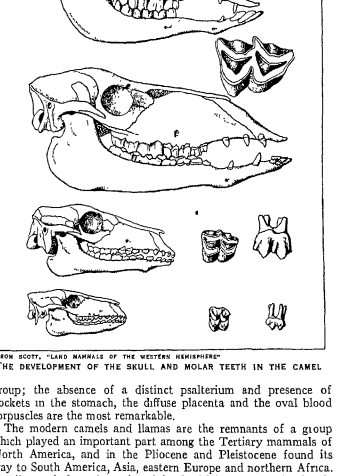
TYLER, WAT (or **WALTER**) (d. 1381), English rebel, was a native either of Kent or of Essex Nothing definite is known of him previous to the outbreak of the peasant revolt in 1381, but Froissart says he had served as a soldier in the French War. The name Tyler, or Teghler, is a trade designation and not a surname. The discontent of the rural labourers and of the poorer class of craftsmen in the towns, caused by the economic distress that followed the Black Death and the enactment of the Statute of Labourers in 1351, was brought to a head by the imposition of a poll tax in 1379 and again in 1381, and at the end of May in the latter year riots broke out at Brentwood in Essex on June 4, and at Dartford; on June 6 a mob several thousand strong seized the castle of Rochester and marched up the Medway to Maidstone. Here they chose Wat Tyler to be their leader, and the rising spread over Kent On the 10th Tyler seized Canterbury, sacked the palace of Archbishop Sudbury, the chancellor, and beheaded three citizens as "traitors" Next day he led his followers, strengthened by many Kentish recruits, on the road to London, being joined at Maidstone by John Ball

(*q.v.*), whom the mob had liberated from the archbishop's prison Reaching Blackheath on the 12th, the insurgents burnt the prisons in Southwark and pillaged the archbishop's palace at Lambeth, while another body of rebels from Essex encamped at Mile End. King Richard II was at the Tower, but neither the king's councillors nor the municipal authorities had taken any measures to cope with the rising The drawbridge of London Bridge having been lowered by treachery, Tyler and his followers crossed the Thames; and being joined by thousands of London apprentices, artisans and criminals, they sacked and burnt John of Gaunt's splendid palace of the Savoy, the official residence of the treasurer, Sir Robert Hales, and the prisons of Newgate and the Fleet On the 14th Richard II, a boy of fourteen, rode out to confer with the rebels beyond the city wall At Mile End the king met Wat Tyler; Tyler demanded the immediate abolition of serfdom and all feudal services, and the removal of all restrictions on freedom of labour and trade, as well as a general amnesty for the insurgents. Charters were immediately drawn up to give effect to these demands Meanwhile Tyler with a small band of followers returned to the Tower, and dragged forth Archbishop Sudbury and Sir Robert Hales from the chapel and murdered them on Tower Hill. During the following night and day London was given over to plunder and slaughter Meantime the people of property began to organize themselves for the restoration of order On June 15 Richard rode to Smithfield for a further conference with the rebels. Wat Tyler advanced from the ranks of the insurgents and shook the king's hand, bidding him be of good cheer Tyler then formulated a number of fresh demands, including the confiscation of ecclesiastical estates and the institution of social equality. Richard replied that the popular desire should be satisfied "saving the regalities of the Crown" Tyler thereupon grew insolent, and in the altercation that ensued was killed by the mayor, Sir William Walworth (*q.v.*), and John Standwick, one of the king's squires The enfranchisement of villeins granted by Richard at the Mile End conference was revoked by parliament in 1382, and no permanent results were obtained for the peasants by Wat Tyler's revolt.

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TYLER, a city of N.E Texas, county seat of Smith county The population was 38,864 in 1930 and 28,279 in 1940 by the federal census The city lies between the Sabine and Neches rivers, surrounded by farmlands, many lakes and masses of forests. Pecans, peaches, berries, vegetables, corn and cotton are the leading crops. Large nurseries specialize in roses; about two-thirds of the U.S. supply of rosebushes is grown within the immediate area There are abundant supplies of natural gas and oil; the latter was discovered 30 mi. S in March 1927 The educational system includes two commercial and two Negro colleges The city has a city-manager form of government The East Texas fair is held there in September, the Texas Rose festival in October Tyler was laid out for the county seat in 1846, and was named after Pres John Tyler. It was incorporated as a town in 1870; grew rapidly when the first railway reached it in 1871, and was chartered as a city in 1907.

TYLOPODA, a suborder of the paired-hoofed mammals (*see* ARTIODACTYLA) including the Xiphodontidae and Camelidae, of which the old world camels (*see* CAMEL) and the South American llamas and their allies (*see* LLAMA) are the only living representatives. The outstanding distinctions of the Tylopoda are. (1) the retention of the lateral incisors, canines and usually the first premolars as small recurved laniary tusks, (2) reduction of the remaining premolars and narrowness of the molars; (3) the peculiar form of tympanic bulla, folded in upon itself and filled with cancellous tissue; (4) elongate cervical vertebrae and peculiar course of the vertebral artery, perforating the inner side of the pedicle of the arch instead of the transverse process as in all other mammals (except *Macrauchenia*, *q.v.*); (5) carpal and tarsal bones remain separate, the trapezoid and magnum never co-ossified, nor the cuboid and navicular, while the trapezium is reduced to a small nodule in Miocene and disappears in later genera, only the ecto- and mesocuneiform are consolidated; (6) fore and hind feet completely didactyl, the lateral pair of digits absent except for small vestigial splints or nodules in the early forms, the median pair long, slender, appressed in early stages, consolidated into a cannon-bone in all later Tertiary and modern Tylopoda; (7) the distal ends of metapodials remain separate and slightly divergent, the keels of their distal facets confined to the palmar surface and not extending over the dorsal surface as in the pecora; (8) phalanges flattened and widened in varying degree and the hoof correspondingly reduced and limited to the upper surface of the terminal phalanx, conformant with the development of a heavy cutaneous pad on the palmar surface, and a digitigrade rather than ungulgrade gait. No horns or antlers are developed The femur and humerus are relatively elongate and the thigh and upper fore-limb are more free from the flank than in other ruminants. Many features of the soft anatomy are peculiar to the



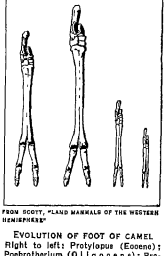
FROM SCOTT, "LAND MAMMALS OF THE WESTERN HEMISPHERE"
THE DEVELOPMENT OF THE SKULL AND MOLAR TEETH IN THE CAMEL

group; the absence of a distinct psalterium and presence of pockets in the stomach, the diffuse placenta and the oval blood corpuscles are the most remarkable.

The modern camels and llamas are the remnants of a group which played an important part among the Tertiary mammals of North America, and in the Pliocene and Pleistocene found its way to South America, Asia, eastern Europe and northern Africa. Fossil camels have been found in the Pleistocene of Alaska, in the Pliocene and Pleistocene of China, Siberia and Russia, the Pleistocene of Rumania and of Algeria, all of them related to the modern camels, but the Pliocene species from China and Russia are in a more primitive generic stage (*Paracamelus*). In South America the fossil Camelidae are related to the llama

group, the older forms of late Pliocene and early Pleistocene more primitive in dentition (*Palaeolama*)

The ancestry of the camels is shown in North America by a very complete fossil record from Oligocene to Pleistocene, with more doubtful predecessors in the Eocene The earliest stage is *Protylopus* of the Upper Eocene, about the size of a jack-rabbit It has none of the characteristics of the Tylopoda well developed but is said to show them in a rudimentary stage. *Xiphodon* and other genera from the Upper Eocene of Europe have some claim to be associated with the Tylopoda.



FROM SCOTT, "LAND MAMMALS OF THE WESTERN HEMISPHERE"

EVOLUTION OF FOOT OF CAMEL
Right to left: Protylopus (Eocene); Poabrotherium (Oligocene); Procamelus (Miocene); guanaco (living)

Poebrotherium of the American Oligocene is the first of the undoubted ancestral line of the camels It is about as large as a sheep and the long neck and limbs, peculiar course of the vertebral artery, the characteristic form of the tympanic bulla and the structure of teeth and feet are unmistakably camelid The dentition is complete, the anterior teeth are all incisiform in some species, in others the canines are small, recurved, spaced tusks. The feet are two-toed, the lateral digits reduced to nodules, the median pair elongate and appressed but not co-ossified into a cannon-bone, the distal facets like those of modern Camelidae.

Oxydactylus of the Lower Miocene has the anterior teeth small recurved tusks, the vestiges of the lateral digits have disappeared or co-ossified, the median pair is more closely appressed and the size has increased to that of a llama or larger.

In *Protolabis* of the Middle Miocene the first and second upper incisors are reduced in size, the molar crowns are higher, and the metapodials are co-ossified to a varying degree in different species and at different ages In *Procamelus* of the Upper Miocene the first and second upper incisors have disappeared, and the co-ossification of the metapodials is complete. Another side branch, *Alticamelus*, in the later Miocene and Pliocene differs from *Procamelus* in the long limbs and neck and relatively small head.

In the Pliocene follow a number of diverse genera incorrectly grouped under the name of *Pliauchenia*, and characterized by the loss of the second premolar in upper and lower jaw; but while they agree in this particular they differ widely in size, proportions, retention or loss of other teeth, height of molar crowns, etc. The best known is *Megatylopus*, probably identical with *Paracamelus* of the Chinese Pliocene, larger and more robust than the modern camel, with foot-pads less developed, but in most respects approximately ancestral. A group of smaller species, to which the name *Pliauchenia* may be found applicable, shows a similar approach to the llamas; a third group appears to be derived from *Alticamelus*, and a fourth parallels the Virginia deer in proportions (although not related).

In the Pleistocene the genus *Camelops* has lost the third lower premolar as well as $p\frac{2}{2}$, and $p\frac{2}{2}$ is much reduced; $p\frac{1}{1}$ is present or absent in different species. It is of about the size and proportions of the modern camels, but lacks the broadly flattened toes and probably had not much padding on the foot. Another genus, akin to the llamas but with longer cannon-bones, relatively smaller head and sometimes retaining $p\frac{1}{1}$, occurs in the Pleistocene of the southern and south-western United States.

It has been generally believed that the camels became extinct in North America in the older Pleistocene, but recent evidence shows that some at least survived in Nevada until almost recent times, and probably elsewhere in the south and south-west until late Pleistocene. The splitting up of the family into the camels proper and the llama group is clearly foreshadowed in the geographical distribution of the Pliocene and Pleistocene species, many of the south-western species showing more affinities to the llamas, while those of the north-west are nearer to the camels. The Alaskan species and the Chinese *Paracamelus* make a still closer approach to the camel, and the Siwalik species is a typical *Camelus*. The Rumanian "*Camelus*" *alutensis* is, however, a side branch with low-crowned molars, slender jaw and retaining $p\frac{1}{1}$, related to one of the North American Pliocene groups. In South America *Palaeolama* of the early Pleistocene, while retaining the second and third premolars like *Procamelus*, is quite a llama-like in details of molar construction, in characters and proportions of skull and skeleton.

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(W. D. M , X.)

TYLOR, SIR EDWARD BURNETT (1832–1917), English anthropologist, was born at Camberwell, London, on Oct. 2, 1832, the son of Joseph Tylor, a brassfounder. Alfred Tylor, the geologist, was an elder brother. His parents were members of the Society of Friends, at one of whose schools, at Grove House, Tottenham, he was educated. During 1855–1856 he travelled in the United States. Proceeding in 1856 to Cuba, he met Henry Christy the ethnologist. While on a visit to Cannes he wrote a record of his observations, entitled *Anahuac; or, Mexico and the Mexicans, Ancient and Modern*, which was published in 1861 In 1865 appeared *Researches into the Early History of Mankind*, which made Tylor's reputation. It showed great research, original insight and much constructive power in the formation of systematic views The chapters on early myths and their geographical distribution are especially valuable. In 1871 he published *Primitive Culture: Researches into the Development of Mythology, Philosophy, Religion, Language, Art and Custom*, which at once became the standard general treatise on anthropology. Tylor first determined the limits of animism, intending it to include "the general doctrine of souls, and other spiritual beings." In 1881 Tylor published a smaller handbook on *Anthropology*. In 1871 he was elected F R S , and in 1883 he became keeper of the University museum at Oxford, and reader in anthropology in 1884. In 1888 he was appointed first Gifford lecturer at Aberdeen university, and delivered a two years' course on "Natural Religion" In 1896 he became first professor of anthropology at Oxford. Knighted in 1912, he died on Jan. 2, 1917.

See *Anthropological Essays*, a volume dedicated and presented to Tylor, which includes a bibliography of his publications by Miss Freire-Marreco, and an appreciation of Tylor by Andrew Lang.

TYMPANON or **TYMPANUM,** a name applied by the Romans to both kettledrum and tambourine. Pliny described half pearls having one side round and the other flat as *tympania*. In architecture the tympanum is the triangular space enclosed between any horizontal feature and any form of gable above it Though sometimes left plain, in the most celebrated Greek temples it was filled with sculpture of the highest standard ever attained

TYNAN, KATHERINE (Hmkson) (1863–1931), English novelist and poet, was born in Ireland where she lived until her marriage in 1893 to H. A. Hinkson, author and barrister She published her first volume of verse, *Louise de la Vallière*, in 1885. She is a prolific and versatile novelist and the author of many admirable children's books; she has written miracle plays, and edited several anthologies. Her best work is in poetry, where she expresses religious feeling and love of Ireland with tenderness and charm. Her collected poems were published in 1930.

Her publications include: *The Land of Mist and Mountain* (1895); *Miracle Plays* (1896); *The Handsome Brandons* (1896); *A Book of Memory* (1906), *Irish Poems* (1913); *The Middle Years* (1917); *Wives* (1924); *The Infatuation of Peter* (1926).

TYNDALE (or TINDALE), **WILLIAM** (*c.* 1492–1536), translator of the New Testament and Pentateuch (*see* BIBLE, ENGLISH), was born on the Welsh border, probably in Gloucestershire, some time between 1490 and 1495. In Easter term 1510 he went to Oxford, where Foxe says he was entered at Magdalen

Hall. He took his M.A degree in 1515 and removed to Cambridge, where Erasmus had helped to establish a reputation for Greek and theology. Ordained to the priesthood, probably towards the close of 1521, he entered the household of Sir John Walsh, Old Sodbury, Gloucestershire, as chaplain and domestic tutor. Here he lived for two years, using his leisure in preaching in the villages and at Bristol, conduct which brought him into collision with the backward clergy of the district, and led to his being summoned before the chancellor of Worcester (William of Malvern) as a suspected heretic; but he was allowed to depart without receiving censure or being given any undertaking.

Translation of the Bible.—But the persecution of the clergy led him to seek an antidote for what he regarded as the corruption of the Church, and he resolved to translate the New Testament into the vernacular. In this he hoped to get help from Cuthbert Tunstall, bishop of London, and so "with the good will of his master" he left Gloucester in the summer of 1523. Tunstall disappointed him, so he got employment as a preacher at St. Dunstan's-in-the-West, and worked at his translation, living as chaplain in the house of Humphrey Monmouth, an alderman, and forming a firm friendship with John Frith; but finding publication impossible in England, he sailed for Hamburg in May 1524. After visiting Luther at Wittenberg, he settled with his amanuensis William Roy in Cologne, where he had made some progress in printing a 4to edition of his New Testament, when the work was discovered by John Cochlaus, dean at Frankfurt, who not only got the senate of Cologne to interdict further printing, but warned Henry VIII. and Wolsey to watch the English ports. Tyndale and Roy escaped with their sheets to Worms, where the 8vo edition was completed in 1526. Copies were smuggled into England but were suppressed by the bishops, and William Warham, archbishop of Canterbury, even bought up copies on the Continent to destroy them. Attempts were made to seize Tyndale at Worms, but he found refuge at Marburg with Philip, landgrave of Hesse.

Other Works.—About this time he changed his views on the Eucharist and swung clean over from transubstantiation to the advanced Zwinglian position. His *Parable of the Wicked Mammon* (1528), *Obedience of a Christen Man* (1528), in which the two great principles of the English Reformation are set out, viz. the authority of Scripture in the Church and the supremacy of the king in the state, and *Practyse of Prelates* (1530), a strong indictment of the Roman Church and also of Henry VIII.'s divorce proceedings, were all printed at Marburg. In 1529 on his way to Hamburg he was wrecked on the Dutch coast, and lost his newly completed translation of Deuteronomy. Later in the year he went to Antwerp where he conducted his share of the classic controversy with Sir Thomas More.

After Henry VIII.'s change of attitude towards Rome, Stephen Vaughan, the English envoy to the Netherlands, suggested Tyndale's return, but the reformer feared ecclesiastical hostility and declined. Henry then demanded his surrender from the emperor as one who was spreading sedition in England, and Tyndale left Antwerp for two years, returning in 1533 and busying himself with revising his translations. In May 1535 he was betrayed by Henry Phillips, to whom he had shown much kindness, as a professing student of the new faith. The imperial officers imprisoned him at Vilvorde Castle, the state prison, 6 m. from Brussels, where in spite of the great efforts of the English merchants and the appeal of Thomas Cromwell to Archbishop Carandolet, president of the council, and to the governor of the castle, he was tried for heresy and condemned. On Oct. 6, 1536 he was strangled at the stake and his body afterwards burnt.

Though long an exile from his native land, Tyndale was one of the greatest forces of the English Reformation. His writings show sound scholarship and high literary power, while they helped to shape the thought of the Puritan party in England. His translation of the Bible was so sure and happy that it formed the basis of subsequent renderings, especially that of the authorized version of 1611. Besides the New Testament, the Pentateuch and Jonah, it is believed that he finished in prison the section of the Old Testament extending from Joshua to Chronicles.

Beside the works already named Tyndale wrote *A Prologue on the Epistle to the Romans* (1526), *An Exposition of the 1st Epistle of John* (1531), *An Exposition of Matthew v.–vii.* (1532), a treatise on the sacraments (1533), and possibly another (no longer extant) on matrimony (1529).

The works of Tyndale were first published along with those of John Frith (*q.v.*) and Robert Barnes, "three worthy martyrs and principal teachers of the Church of England," by John Day, in 1573 (folio). A new edition of the works of Tyndale and Frith, by T. Russell, was published at London (1828–1831). *His Doctrinal Treatises and Introductions to Different Portions of the Holy Scripture* was published by the Parker Society in 1848. For biography, see Foxe's *Acts and Monuments;* R. Demaus, *William Tyndale* (1871); also the Introduction to Mombert's critical reprint of Tyndale's Pentateuch (1884), where a bibliography is given.

TYNDALL, JOHN (1820–1893), British natural philosopher, was born in Co. Carlow, Ireland, on Aug. 2, 1820. Tyndall was to a large extent a self-made man; he was stimulated to earnest study by the writings of Carlyle. He passed from a national school in Co. Carlow to a minor post (1839) in the Irish ordnance survey, thence (1842) to the English survey, attending mechanics' institute lectures at Preston in Lancashire. He then became for a time (1844) a railway engineer, and in 1847 a teacher at Queenwood College, Hants. Thence with much spirit, and in face of many difficulties, he betook himself, with his colleague Edward Frankland, to the university of Marburg (1848–1851), where, by intense application, he obtained his doctorate in two years. His dissertation was an essay on screw-surfaces.

Tyndall's contributions to science are due more to his personality and his gift for making difficult things clear rather than to his original researches. He became known through some early magnetic investigations and was elected F.R.S. in 1852. In May 1854 he was chosen professor of natural philosophy at the Royal Institution, a post which exactly suited his striking gifts and made him a colleague of Faraday, whom in 1866 he succeeded as scientific adviser to the Trinity House and Board of Trade, and in 1867 as superintendent of the Royal Institution. His reverent attachment to Faraday is beautifully manifested in his memorial volume called *Faraday as a Discoverer* (1868).

With his friend Huxley he went to Switzerland to study the motion of glaciers; his views brought him into conflict with Forbes and James Thomson.

Tyndall's investigations of the transparency and opacity of gases and vapours for radiant heat, which occupied him during many years (1859–1871), are frequently considered his chief scientific work. (*See* HEAT.) But his activities were essentially many-sided. He definitely established the absorptive power of clear aqueous vapour—a point of great meteorological significance. He made brilliant experiments elucidating the blue of the sky, and discovered the precipitation of organic vapours by means of light. He called attention to curious phenomena occurring in the track of a luminous beam. He examined the opacity of the air for sound in connection with lighthouse and siren work, and he finally verified what had been already substantially demonstrated, viz., that germ-free air did not initiate putrefaction.

Tyndall's devotion to science for its own sake may be seen in his treatment of the money which came to him in connection with his successful lecturing tour in America (1872–1873). He placed the money amounting to several thousand pounds in the hands of trustees for the benefit of American science—an act of lavishness which bespeaks a noble nature. He took some part in the controversy over theological problems which was going on at the time. He died at Hindhead on Dec. 4, 1893.

For the substantial publication of his researches reference must be made to the *Transactions of the Royal Society;* but an account of many of them was incorporated in his best-known books, namely, the famous *Heat as a Mode of Motion* (1863; and later editions to 1880), the first popular exposition of the mechanical theory of heat, which in 1862 had not reached the text-books; *The Forms of Water*, etc. (1872); *Lectures on Light* (1873); *Floating Matter in the Air* (1881); *On Sound* (1867; revised 1875, 1883, 1893). The original memoirs themselves on radiant heat and on magnetism were collected and issued as two large volumes under the following titles: *Diamagnetism and Magne-crystallic Action* (1870); *Contributions to Molecular Physics in the Domain of Radiant Heat* (1872).

TYNDARIS, an ancient city on the northern coast of Sicily, 5 m. east of Patti. It was founded (almost the last Greek city

in Sicily) by Dionysius the Elder in 395 B.C. It was one of the earliest allies of Timoleon. In the first Punic War it was dependent on Carthage, but expelled the Carthaginian garrison in 254 B.C. and joined the Romans. It was one of the points occupied by Sextus Pompeius, but was later used by Agrippa as a base. Pliny mentions that half of it (the north and north-east portion) was swallowed up by the sea (*Hist. nat.* ii. 206). The site is fine, an isolated hill (920 ft.) with spurs, rising abruptly seaward, and connected by a narrow isthmus with the lower ground inland. It has a magnificent view, including even the summit of Etna.

Remains of the city walls, built of rectangular blocks of stone, with several towers may be seen, and the main gate, on the land side, is traceable. Within are remains of a building incorrectly called the gymnasium, constructed of ashlar masonry, with three narrow halls, each about 90 ft. long; of a building with mosaic pavements, and a small theatre, the internal diameter of which is 212 ft., and the length of the stage 80 ft.

See R. V. Scaffidi, *Tyndaris* (Palermo, 1895). (T. A.)

TYNE, river in England, flowing into the North sea. The North Tyne rises, 80 m. from the mouth, at the south-west end of the Cheviot Hills, and has a wooded valley. At Bellingham it receives the Rede, whose valley, Redesdale, is the site of the battle of Otterburn (1388). The South Tyne rises below Cross Fell and flows north past Alston as far as Haltwhistle, where it turns east. The valley receives from the south the picturesque Allendale. The two branches join near Warden, above Hexham (30 m. from the sea) and the united stream continues past Corbridge, where a Roman road crossed it. In its last 15 m. the Tyne, here the boundary between Northumberland and Durham, is an important waterway, navigable up to Blaydon. Collieries and large towns line the banks—Newburn, Newcastle-upon-Tyne, Wallsend and North Shields on the north side, Gateshead, Jarrow and South Shields on the Durham side, with many lesser centres, forming continuous lines of factories and shipbuilding yards, necessitating the dredging of the river. At high-water spring tides there is 40 ft. of water at Shields Harbour at the river's mouth, and 29 ft. at Newcastle, 8 m. up the river.

TYNEMOUTH, municipal, county and parliamentary borough, Northumberland, England, including the townships of Chirton, Cullercoats, North Shields, Preston and Tynemouth. Pop. (1938) 66,510. Area, 7.3 sq. mi. North Shields, Tynemouth and Cullercoats are successive stations on a branch of the L.N.E.R. Tynemouth lies on the north bank of the Tyne, 8¼ mi. E. of Newcastle. Tynemouth is the principal watering place and residential district on this part of the coast.

On the point of the promontory on which it stands is a small battery called the Spanish battery. Within the grounds, to which the gateway of the old castle gives entrance, are the ruins of the ancient priory of St. Mary and St. Oswin—the principal remains being those of the church, which was a magnificent example of Early English work engrafted upon Norman. The municipal buildings are in North Shields, which is also an important seaport. (*See* NORTH SHIELDS.)

Although Roman remains have been discovered, the early history centres round the priory, founded (617–633) by Edwin, king of Northumbria. Earl Waltheof gave Tynemouth to the monks of Jarrow, and it became a cell to the church of Durham, but later, to the abbey of St. Albans in Hertfordshire. The priory was probably fortified in Saxon times, and was strengthened by Robert de Mowbray. After the Dissolution the fortifications were repaired by Henry VIII. In 1642 it was garrisoned for the king by the earl of Newcastle, but surrendered to parliament in 1644. It became barracks at the end of the 18th century.

Tynemouth and North Shields did not become important until the 19th century, the establishing of a port here and holding of fairs being prevented by the people of Newcastle. Before that time charters were granted in 1203 and 1204 to the prior and convent, and include freedom from toll, etc. In 1292 there were disputes between the citizens of Newcastle and the prior, who had built a quay at North Shields but was obliged by act of parliament to destroy it. After the Napoleonic wars the trade of North Shields rapidly increased. Fish quays were constructed and extended in the 20th century, and a considerable fishing trade is carried on. A 52-ac. trading estate was established at West Chirton. The depression of the 1930s was particularly felt here, and over 39% of the insured population was unemployed in Nov. 1934. The town was incorporated in 1849, became a county borough in 1901, and has returned one member to parliament since 1832.

TYPE, PRINTING: *see* PRINTING TYPE.

TYPE-CASTING MACHINES: *see* PRINTING TYPE; PRINTING.

TYPE METAL. An alloy containing antimony as the essential constituent; the other ingredient being lead, often with addition of tin and less frequently of copper. Metallic type containing antimony was used in the 17th century (Basil Valentine).

Antimony increases the fusibility and hardness of metals with which it is alloyed and imparts to these alloys its characteristic property of expansion on solidification. Typical alloys for printing type have the following proportions:—

	Lead	Anti-mony	Tin	Cop-per
Type metal	60	30	10	
"	70	18	10	2
"	77.5	16	6.5	
"	82	15	3	
Stereotype Metal	85.7	14.3	.	
" "	82.5	13	4.5	
Linotype Metal	84.5	13.5	2	
" "	82	13	5	
Cheap Linotype Metal	85.5	12	2.5	

The proportions given for linotype metals approximate fairly closely to the most fusible (eutectic) alloy of lead (85%), antimony (13%), with an addition of tin (2%). This alloy has the comparatively low melting point of 246°C., a degree of fusibility which renders it useful in the production of this form of type.

Type metal, being easily cast, is used for statuettes, metallic candlesticks and other decorative objects. A lead-antimony alloy (lead two parts to one of antimony) is used for the metallic keys of certain reed musical instruments.

So-called *hard lead* or *antimonial lead* containing antimony (15%) and lead (85%) is used for chemical stopcocks, *e.g.*, in the sulphuric acid industry. (G. T. M.)

TYPE SETTING: *see* PRINTING and TYPOGRAPHY.

TYPEWRITER, a machine which prints characters in sequence, performing the work of writing at a speed far greater than is possible with the pen. Formerly the term "typewriter" was also applied to the operator, but more recently the operator has become known as a "typist."

Early Machines.—The first recorded attempt to invent a typewriter is found in the records of the British Patent Office. These show that on Jan. 7, 1714, a patent was granted by Queen Anne to Henry Mill, an English engineer, for "an Artificial Machine or Method for the Impressing or Transcribing of Letters Singly or Progressively one after another, as in Writing, whereby all Writing whatever may be Engrossed in Paper or Parchment so Neat and Exact as not to be distinguished from Print." Mill's machine was never manufactured. Only one other attempt was recorded in the 18th century. This was a machine invented in 1784 for embossing characters for the blind. The first American patent on a typewriter was granted in 1829 to William Austin Burt of Detroit. The only model of this machine was destroyed by fire at the Washington Patent Office in 1836.

In 1833, a French patent was granted to Xavier Progin (or Projean), of Marseilles, for a device which he described as a "Krypographic" machine or pen. It consisted of an assembly of bars with type, each type striking downward upon a common centre. The Progin device was the prototype of all our present type-bar machines. The next important step was taken by Charles Thurber of Worcester, Mass., to whom an American patent was granted in 1843. In this machine the letter spacing was effected by the longitudinal movement of a cylinder or platen, a principle which is a feature of all present-day standard writing machines. A different model, brought out by Thurber in the year 1845, was designed to perform the motions of the hand in writing, and was intended for the blind. In the previous year a machine,



PHOTOGRAPH, (5) THE ROYAL TYPEWRITER COMPANY, INC., (7) THE REMINGTON RAND BUSINESS SERVICE, (8) THE UNDERWOOD TYPEWRITER COMPANY, (8) L. C. SMITH AND CORONA TYPEWRITERS, INC.

EVOLUTION OF THE TYPEWRITER

1. Thurber's Machine, 1843
2. Francis' Machine, 1857
3. Sholes, Glidden and Soule Machine, 1868
4. The first shift-key typewriter, 1878
5. Royal Standard Typewriter, 1914
6. The first practical typewriter, 1874
7. Remington Noiseless Typewriter, 1925
8. Bookkeeping Machine, 1928
9. Portable typewriter, 1938

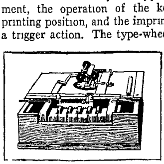
also intended for the blind, was shown by Littledale at the York meeting of the British Association. Pierre Foucault, a teacher in the Paris Institute for the Blind, patented a machine in 1849 that was shown at the great exhibition in London in 1851, and is said to have embossed characters for the blind admirably.

From 1850 the attempts became more numerous. Among those who took out patents in America during this period were Oliver T. Eddy of Baltimore, in 1850, J B Fairbanks, 1850, J. M Jones of Clyde, N Y, 1852, R. S Thomas of Wilmington, N C., 1854, Alfred Ely Beach of New York, 1856, J. H Cooper of Philadelphia, 1856, Dr. Samuel W. Francis of New York, 1857, Henry Harger, 1858, F. A. de May of New York, 1863, Benjamin Livermore of Hartland, Vt, 1863, Abner Peeler of Webster City, Ia, 1866, Thomas Hall, 1867, and John Pratt of Centre, Ala., who in 1866, while a resident in London, produced a device called the "Pterotype" (winged type), which operated on the type-wheel principle. Contemporary efforts by European inventors were those of Sir Charles Wheatstone in England, who constructed several experimental models between 1855–60; the Ravissa machine in Italy belongs to that period, and the models built by Peter Mitterhofer of the Tyrol, in 1864 and 1866 Among the most promising of these efforts were those of Beach and Francis Beach's machine operated in much the same manner as a modern typewriter, but it wrote only on a narrow ribbon of paper This machine, like so many others of this period, was designed for the blind, and printed raised letters which could be read by touch. The machine invented by Dr. Francis was a bulky affair, with keys like those of a piano. Type-bars were arranged in a circle, printing at a common centre

First Practical Typewriter.—The invention of three residents of Milwaukee, Wis., Christopher Latham Sholes, Carlos Glidden and Samuel W Soulé, in 1867, resulted in the first practical machine. Soulé soon retired from the undertaking, but Sholes, within five years, made nearly 30 experimental models. The first of these, showing the working principles only, was covered in patent of June 23, 1868. The second one, patent of July 14, 1868, was the first efficient typewriter model, in that it would write well, at a speed far exceeding the pen. It was still, however, a very crude machine, lacking the now familiar typewriter carriage, with its paper cylinder, and the keyboard in its present form. Many improvements followed and finally, on Mar. 1, 1873, a contract was made with E. Remington and Sons, gunmakers, of Ilion, N Y, for the development and manufacture of the Sholes and Glidden machine. The first completed typewriters were placed on the market early in 1874 and the machine was soon re-named the Remington Among its original features which remain standard in 1928 machines are the paper cylinder, with its line-spacing and carriage-return mechanism, the escapement which causes the letter spacing, the arrangement of the type-bars so as to strike the paper at a common centre, the actuation of the type-bars by means of key levers and connecting wires, printing through an inked ribbon, and the positions of the different characters on the keyboard, which conform almost exactly to the arrangement now known as "universal."

The first typewriter had no shift-key mechanism—it wrote capital letters only. The problem of printing both capitals and small letters without increasing the number of keys was solved by pl[illegible] two t[illegible] a capital and small face of the same letter [illegible] one for every character [illegible] practised only by operators of exceptional skill. In the latter decade, however, it rapidly gained acceptance and since 1900 it has been practically the universal method of instruction

Another early issue in the field of the typewriter concerned the relative merits of the type-bar and the type-wheel principles. The latter construction traces its descent through the Burt machine of 1829 and the Pratt machine of 1866. In modern machines of this variety the types are mounted on a circle or segment, the operation of the keys brings each type to correct printing position, and the imprint of type on paper is produced by a trigger action. The type-wheel machines offer an advantage in the ease with which the type segments may be changed, thus extending the range and versatility of the machine. However, machines of this construction have never been very serious competitors of the type-bar machines in the general commercial field. On nearly all typewriters the printing is done through an inked ribbon, which is fitted on spools, travels with the operation of the machine, and reverses automatically when one spool becomes completely unwound, the latter improvement dating from the year 1896.


BY COURTESY OF THE REMINGTON TYPEWRITER CO

SHOLES' FIRST MODEL OF THE TYPEWRITER

Following the first shift-key typewriter of 1878, the next great advance was the advent of visible writing. On all of the early type-bar machines the bars were arranged in a circular "basket," located underneath the carriage, and the type printed at a common point on the under side of the cylinder This construction compelled the operator to raise the carriage in order to see the writing line. The first visible writing machine appeared in 1883 The earlier visible machines employed the down-stroke principle, the type striking on top of the cylinder Later the front-stroke machines took the lead in the general business field, the first machine of this type to attain prominence dating from 1897. In front-stroke machines the type-bars are placed in a segment in front of the carriage, the type printing on the front of the cylinder. This solved the problem of visible writing and all writing machines of the leading standard makes are of this type.

Recent Developments.—Since the advent of visible writing there have been two other major developments in the general typewriter field, the development of the portable and the noiseless machine. The former—small, light, compact and easily carried—is especially designed for the owner's personal use. The earliest of these was a small machine of the type-wheel variety. The first type-bar portable to attain a considerable market appeared in 1912 Type-bar portable machines of all the leading makes are on the market, and their sale is extending the use of the typewriter to every kind of personal writing. The noiseless machine is a front-stroke machine of the type-bar variety, equipped with the usual standard keyboard. It differs, however, from other type-bar machines in that the printing is done not by percussion but by pressure, thus reverting to the principle of the printing press. This is accomplished by means of a little weight on the back of the type-bar As the type-bar starts, this weight gathers momentum and presses the type against the paper, swiftly and noiselessly. It is too early as yet to predict the future of the noiseless typewriter, but it is obviously growing in popularity.

Form and Tabular Work.—The extension of the uses of the typewriter to form and tabular work of every kind constitutes a distinct and separate development. During the first 25 years of its history, the time-saving service of the typewriter was confined almost entirely to straight, line-by-line writing, such as letter and manuscript writing, and the like This limitation was due to the lack of any mechanism for the instantaneous setting of the carriage at any desired writing point. This need, however, was supplied by the decimal tabulator, which appeared in 1898. This device permitted the writing of columns of figures, anywhere on the page and as many as the page would hold, with the same speed as ordinary work. From this improvement the advance to the machine which would add the columns as written was a natural transition. The first *adding typewriters* added in vertical columns only, but from these in turn have been evolved the complete bookkeeping or accounting machines, which write and add (or subtract)

simultaneously, both vertically and across the page, in any combination that the work requires. In this field the standard typebar machines, with tabulating and computing mechanisms, have a competitor in the so-called flat-platen machine, which is similar in its combined writing and adding performance, but prints on a flat bed instead of a travelling and revolving cylinder (*See* TABULATING MACHINES.)

The service rendered by the accounting or bookkeeping machine is broadly that of the ordinary typewriter, intensified The combination in one operation of two tasks, writing and adding, eliminates the separate adding cost. A further advantage is the error proofing of every task, the machine furnishing its own accounting controls.

The application of electricity to the operation of the machine has made its greatest advance in the accounting machine field. At least one operation, the return of the carriage, is usually performed by electric drive.

In the general typewriting field, several manufacturers brought out electrically operated machines

The typewriter has been one of the great transforming factors of modern business. One problem which confronted the writing machine in its early days was the securing of competent operators. Out of this need arose the modern commercial school, now a prominent feature in the educational system of every country. Socially the changes wrought by the typewriter have been even more noteworthy. Everywhere except in oriental countries the majority of stenographers and typists are women, and it is historically established that in all western countries, beginning with America, it was the typewriter that first opened to women the doors of business life (A. C RE.)

TYPHOID AND PARATYPHOID FEVERS. Typhoid fever is an acute infectious disease of man caused by a bacterium, *Salmonella typhosa* (*Bacillus typhosus*, *Eberthella typhi*) It is characterized by an insidious onset, high and continued fever, prostration, mental confusion and delirium, a specific skin rash on the trunk ("rose spots"), diarrhoea, specific lesions of the bowel and numerous complications.

This disease is ancient It can be recognized with reasonable certainty in clinical descriptions by medical writers dating back to the time of Hippocrates However, it was not until the first half of the 19th century (P. Bretonneau, 1820) that typhoid fever (enteric fever) was clearly distinguished from other continued fevers and termed "fièvre typhoïde" (P C. A Louis, 1829) by the French and "typhus abdominalis" (J. L. Schoenlein, 1839) by the German writers

Before the advent of bacteriology, the infective and contagious nature of the disease was recognized by William Budd in 1856, and the presence of the infective agent in the faeces of ill and convalescent patients and its spread through contaminated water and milk was postulated. The recognition of the typhoid bacillus by C. J. Eberth in 1880 and its isolation in pure culture by G. Gaffky in 1884 laid the foundation for the development of knowledge leading to accurate means of diagnosis, critically differentiating this disease from all others, and making possible studies to determine the means of spread and methods of prevention

The organism usually enters the body through the mouth, in contaminated food or water, penetrates the intestinal wall and multiplies in the lymph follicles (Peyer's patches and solitary lymph glands) near the lower end of the small intestine (ileum), particularly in the region of the ileocaecal valve, and possibly in other locations in the body, later entering the blood stream resulting in septicaemia and systemic infection. The incubation period averages 10–14 days but may be shorter or longer. There are few or no symptoms during this period. Early symptoms are headache, lassitude and generalized aching, feverish sensations and restlessness which may interfere with sleep. There may be loss of appetite, nose bleeds, cough, diarrhoea or constipation. Persistent fever develops and gradually rises, usually in a step-wise fashion, reaching a high of 103° or 104° F. after 7–10 days and continuing with only slight morning remissions for another 10–14 days In favourable cases, about the beginning of the fourth week the fever commences to decline, daily fluctuations in temperature readings become greater and there is a gradual return to normal.

In the first few days of the disease, the patient may remain ambulatory, but before the end of the first week he is seriously ill and confined to bed He is restless, hot and uncomfortable, and the cheeks are flushed, particularly in the latter part of the day. The pulse is slow, the abdomen is slightly distended and may be tender to pressure, especially over the right lower part, the region overlying that portion of the intestines where a specific ulceration is in progress Diarrhoea is frequent but by no means a constant symptom. When present, it may be slight or extremely profuse, the stools are light yellow in colour, resembling pea soup At the beginning or during the second week of fever at the height of the septicaemia when typhoid bacilli are present in great numbers in the blood stream, a skin rash usually appears. It consists of isolated round or oval spots of a pale pink or rose colour measuring from 2 mm to 4 mm. in diameter These "rose spots" are usually few in number and are found chiefly on the abdomen, chest and back. They appear in crops, last four or five days and then fade away, leaving a brownish stain at the site. Occasionally they may be very numerous and may continue to appear until near the end of the fever. Also during the second week of the fever, specific changes are occurring in the intestine The lymph follicles previously mentioned as the site of multiplication of the typhoid organisms during the incubation period have become swollen and enlarged, and portions have undergone necrosis (death of tissue) These areas of necrotic tissue extend through the mucous membrane to the lumen of the bowel. Necrotic fragments or entire glands slough off, leaving ulcers in the wall, which may be few or numerous, have thin ragged edges and are usually oval, extending in the direction of the long axis of the bowel. They may in their progress erode blood vessels, causing minor or massive haemorrhage into the bowel, or perforate the bowel wall, allowing the contents to enter the peritoneal cavity Ulceration exists from this time onward during the remainder of the fever and into the period of convalescence The ulcers heal by formation of scar tissue without contraction of the calibre of the bowel They do not all appear at once, so that ulcers in all stages of development and healing may be simultaneously present

With the continued high fever the symptoms usually increase in intensity Mental confusion and delirium appear; there may be tremors and jerking of the muscles and occasionally generalized convulsions. By the end of the third week the patient presents the so-called "typhoidal state"; he appears prostrated and emaciated, the tongue is dry and brown, abdominal symptoms are marked and mental disturbance is prominent

With cessation of fever, convalescence proceeds slowly. Relapses are common but usually of short duration

Typhoid fever is a disease of complications. By eroding blood vessels, the intestinal ulcers may cause massive and even fatal haemorrhage; haemorrhage occurs in from 5% to 10% of the cases. Perforation of the bowel (1% to 5%) results in peritonitis which prior to the advent of the sulfonamides and antibiotics was highly fatal. The patient experiences a sudden intense abdominal pain, vomits and shows signs of collapse. This development demands immediate surgical intervention for repair of the defect and the start of intensive antibiotic therapy. Osteomyelitis, chiefly of the long bones, may occur even some time after cessation of the fever. Localization and abscess formation may occur in any organ

Other complications include acute inflammation of the gall bladder, heart failure, pneumonia, encephalitis and meningitis. Death may result from toxaemia and general debilitation, or from one of the complications.

The mortality rate varies widely and is influenced by the quality of nursing and medical care. For the world at large in 1948, the average case mortality was about 9%.

Bacteriology.—*Salmonella typhosa* is an actively motile, short, rod-shaped, nonspore-forming Gram-negative bacillus. It grows readily on common culture media. Special complex differential media were developed for isolation from stools. It can be distinguished from other organisms of the *Salmonella* group by its biochemical reactions, particularly sugar fermentations, and by

serological reactions. The organism is destroyed by heat, drying or exposure to sunlight; under natural conditions, as in water, soil or faeces, it may remain alive for weeks or months. It is not destroyed by freezing.

In typhoid fever during the first week of the disease, the organism is almost invariably present in the blood stream and can be cultured from the blood with ease. From the second week onward the numbers in the blood progressively diminish Although positive stool cultures may be obtained early in the disease, the organism becomes present in large numbers in the faeces only during the second week It also usually appears in the urine at this time. With convalescence the urine and faeces gradually become free of the organism

Approximately 30% of cases become transient carriers excreting the organism in the stool or urine for several weeks or months About 5% remain long-term carriers, harbouring the organism and shedding it for several to many years In these carriers, who show no apparent ill effects, it is found mainly in the gall bladder and biliary passages. It may be excreted continuously or intermittently.

Diagnosis.—The clinical picture should suggest the diagnosis Leucopenia (lowered white blood cell count) is characteristic and eliminates many other diseases from consideration Final proof of the diagnosis depends on isolation and identification of the organism in culture from the blood, urine or faeces.

As with many infectious diseases, specific antibodies arise in the blood of the patient which will agglutinate (clump) suspensions of known typhoid organisms. This test, first applied in typhoid fever by F Widal in 1896 and named after him, is of presumptive value in diagnosis after the first week of the disease

Dissemination.—Every case of typhoid fever is due to ingestion of typhoid bacilli originating from a case of the disease or from a carrier The common means of communication are through water, milk, food, flies and direct contact. The organisms are excreted in the urine and faeces, with a case, these excreta and the patient's bedding and environs are a source of exposure to attendants and others in contact with him. Water contaminated by infective faecal material (sewage) provides a major means of spread.

Most major epidemics have been due to such pollution of public water supplies. Milk may be contaminated through a carrier (or a case) employed in the handling and processing, through flies or from polluted water used for cleaning purposes Food similarly becomes contaminated from the fingers of persons harbouring the organism, or through water or flies. Flies having access to infective faeces carry the organism to food. Fresh vegetables grown on soil fertilized or contaminated by untreated sewage and shellfish, particularly oysters, grown in polluted water are dangerous. Milk and other foods offer opportunity for the organism to multiply before ingestion, increasing the hazard.

Prevention and Treatment.—Prevention depends mainly on proper treatment of sewage, purification of water supplies by filtration and chlorination and the exclusion of carriers from employment in food industries In 1911 prophylactic vaccination using killed typhoid organisms was introduced, mainly in military forces and institutions, and contributed to lowering of the incidence of the disease.

The disease, a scourge of armies, was formerly extremely prevalent and remained so at mid-20th century in the less sanitized areas of the world. With improvement in sewage disposal and water purification, the incidence dropped to a very low figure. In the United States in 1900, the annual death rate was more than 30 per 100,000 population; by 1945, it was 0.25 per 100,000.

Treatment formerly was entirely symptomatic and supportive Specific treatment with chloramphenicol (chloromycetin) later proved to be of value.

PARATYPHOID FEVER

A group of organisms are responsible for paratyphoid fever, the commonest being *Salmonella paratyphi* (paratyphoid A), *S. schottmulleri* (paratyphoid B), and the paratyphoid C group (there are three varieties, *S. hirschfeldii*, *S. choleraesuis*, and the *kunzendorf* variety of the latter).

Paratyphoid fever due to paratyphoid A or B is similar to typhoid, usually milder, though occasionally simulating it in all respects. The means of infection, spread, clinical course, pathology, diagnosis, prevention, treatment and prophylaxis are similar to those for typhoid.

Whereas typhoid and paratyphoid A are diseases of man only, the paratyphoid B organism has been found in other animals and fowl, and accordingly these provide for additional means of contamination of food and water. *S. hirschfeldii* is mainly limited to man.

There are more than 200 recognized species of the *Salmonella* (named after D. E. Salmon who described the type species *S. choleraesuis*) group of organisms which are widely distributed over the world. In the man they are harboured by or cause disease of animals, though many may infect man.

Aside from the typhoid bacillus and paratyphoid A, B, and *S. hirschfeldii*, they usually cause in man a sharp, brief gastroenteritis (food infection) with fever, nausea, vomiting and diarrhoea of seven days' duration. In addition, a number of them may cause prolonged febrile illness similar to typhoid with all the complications.

Since *Salmonella* organisms may be found in practically all species of animals, food products derived from animals often contain them, particularly eggs, egg products and meat. Many species are harboured by rodents and fowl Food exposed to infected animals (mice, etc.) frequently becomes contaminated

The general prophylactic measures mentioned under typhoid apply to the entire group. Prophylactic immunization is available for paratyphoid A, B and C Protection of food from contamination and adequate heat treatment of foods liable to contain the organism should be practised

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TYPHON, in Greek mythology, youngest son of Gē and Tartarus; or of Hera without father (*Homeric Hymns*, iii. 349 *et seq.*). He is described as a grisly monster, with 100 dragon's heads, who was conquered and cast into Tartarus by Zeus. In other accounts, he was confined in the land of the Arimi in Cilicia (*Iliad*, ii. 783) or under Etna (Aeschylus, *P.V.* 370), or in other volcanic regions, where he was the cause of eruptions. He was probably a personification of volcanic forces. Amongst his offspring by Echidna were Cerberus, the Lernaean hydra, and the Chimaera. He was also the father of dangerous winds, and by later writers is identified with the Egyptian Set.

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TYPHOON. Regional name of tropical storms in the tropical part of the western North Pacific ocean. The term is of uncertain origin but is probably connected with the Chinese *t'ai fung*, great wind, or the Arabic and Hindustani *tufan*, a tempest. William Dampier entered in his logbook under July 4, 1687, the earliest known European description of a typhoon (tuffoon).

TYPHUS FEVER, a disease characterized by sudden onset with headache, chills, fever and general pains, a macular eruption appearing on the third to fifth day, toxaemia, and terminating in about two to three weeks. Originally considered a single clinical entity, it is now regarded as a group of closely related diseases caused by different species of rickettsia transmitted by arthropod vectors, under the following general classifications A–1, epidemic (louse-borne) typhus; A–2, murine (endemic; flea-borne) typhus; B, scrub (mite-borne) typhus or tsutsugamushi disease; C, tick-borne typhus (*see* ROCKY MOUNTAIN SPOTTED FEVER).

A–1. EPIDEMIC (LOUSE-BORNE) TYPHUS

History and Distribution.—This is the classic disease well

known in medical history and described under many names which usage gradually narrowed to typhus fever (English), *fleckfieber, typhus exanthematicus* (German), *typhus exanthématique* (French), *tabardillo, tifo exantemático* (Spanish), *typhus esantematico* (Italian) Up to the middle ages its existence was obscured in the undifferentiated pestilences, but it can be recognized with certainty in the writings of Spanish physicians toward the end of the 15th century styled as *el tabardgilo* from its spotted character According to Joaquim de Villalba, the first reference to an epidemic was one which began during the civil wars of Granada, 1489–90. During the 16th century it spread over the Spanish peninsula, causing great mortality It is possible that the infection was transported to the new world about this time by Hernan Cortes and his followers, although there is some evidence that the disease was known to the Aztecs and to certain Indian tribes in Mexico in pre-Columbian days During the 17th, 18th and 19th centuries, typhus prevailed intermittently in devastating epidemics throughout Europe and the British Isles. Its epidemiological characteristics became as well known as its clinical manifestations. It was associated with human misery—with people crowded together in filth, cold, poverty and hunger, with wars and famine, with refugees, prisons and jails and with ships. Beginning about 1846, and associated with the failure of the potato crop, an epidemic of unprecedented magnitude and severity centred in Ireland The disease was disseminated in the subsequent flood of emigration from that country. It was repeatedly introduced into Canada and the United States by the arrivals of immigrant ships For example, of 75,540 Irish persons emigrating to Canada in 1847, there were 30,265 who sickened with typhus, 5,203 died at sea, 8,012 at Quebec and 7,000 at Montreal, a total of 20,305 deaths In spite of repeated introductions from Europe and from Mexico, this form of typhus failed to establish a permanent foothold in either Canada or the United States The American Civil War of 1861–65 was one of the few wars of any magnitude in which typhus was not epidemic among military camps, prisons and refugee populations.

Clearly differentiated from typhoid fever and "relapsing fever," during the latter part of the 19th century and the first part of the 20th century typhus fever decreased and practically disappeared from the British Isles and western Europe with improvement in the hygiene of living conditions. It remained intermittently epidemic in Poland, the USSR, the Balkans, the highlands of Turkey, Iran, Iraq, North Africa and some parts of central and South Africa

At the close of World War I the disease was prevalent in Poland, Russia and Rumania, where the estimates of cases and deaths between 1919 and 1923 ran into millions In World War II from these areas it again spread into western Europe and caused devastating epidemics among refugees and displaced persons, particularly in the German concentration camps. For the first time military populations learned how to protect themselves

In Asia, the disease was still well known at mid-20th century in China, Korea, Afghanistan and northern India, outbreaks were reported among Communist troops in the Korean war. In the western world epidemics still occurred from time to time among the natives of the mountainous sections of Mexico and Central and South America

Epidemiology.—The epidemiological distributions of typhus are explained by its mode of transmission It is conveyed from person to person by the louse (*Pediculus humanus*). Lice are infected by feeding upon a person sick with the disease. The causative agent is a rickettsia (*Rickettsia prowazekii*) The microorganisms grow in the epithelial cells lining the gut wall and are excreted in the faeces of the louse. The infection kills the louse in from 12 to 18 days. There is no transovarial transmission of these rickettsiae from generation to generation in the developmental cycle of the louse It is probable that man is commonly infected from deposits of louse faeces on the skin through abrasions resulting from scratching. Rickettsiae may remain viable and retain their virulence for many days in dried louse faeces. There is evidence that inhalation or the deposition on mucous membranes of air-borne infected maternal of this kind may be responsible for some human cases Biological survival requires that a continuous chain of contacts be maintained The human host harbours the rickettsiae in the peripheral circulation only for a short time, 10 to 14 days, during the early part of the illness In order to maintain propagation of the disease in a population the supply of infected lice must be continuously replenished by feeding upon such sources and reach new and susceptible human beings before they perish

Clinical and Pathological Features.—The incubation period is about 8 to 12 days, but varies between 5 and 15 days. Onset is commonly abrupt, with headache, loss of appetite and malaise The fever rises rapidly with chills or chilly sensations Prostration becomes marked The patient is nauseated The temperature reaches a maximum range by the end of the first week and is sustained until about the 12th day, when, if the outcome is favourable, it falls rather rapidly, reaching normal in an uncomplicated course about the 14th to 16th day.

In cases proceeding to a fatal issue prostration is progressive and delirium and coma supervene. Cardiac failure may be the terminal event In recovery, depression and weakness may be protracted with slow convalescence.

The most characteristic symptom of the disease is the eruption which appears about the fourth to sixth day after onset It consists of dark reddish discrete spots two to five millimetres in diameter, some of which become slightly elevated, scattered over the body and limbs It may be accompanied by a general mottling These lesions at first are erythematous (abnormally red) and disappear on pressure, but rapidly become darker in colour and more petechial in character, leaving a brownish stain in the skin if the area is blanched. In the more severe and fatal cases the rash becomes almost confluent, involving the whole body surface, and subcutaneous haemorrhages occur. With recovery the rash fades slowly The case fatality varies somewhat in different epidemics, ranging from about 5% to 25%. The prognosis becomes more and more grave with advancing age While the proportion of deaths among children may be less than 5%, it may be ten times as great among the aged

The course and characteristics of the illness in man are manifestations of the underlying pathology. The rickettsiae localize and multiply in the endothelial cells lining the blood vascular system. The essential lesion is a focal injury to the capillary and precapillary vessel walls characterized by swelling and necrosis of the cells, infiltration of lymphocytes, plasma cells and monocytes, thrombosis and rupture with extravasation of red blood cells. Such lesions are significantly frequent in the skin, giving rise to the eruption, in the cerebral cortex they cause headache, irritability, confusion and delirium, in the heart muscle, weakness and sometimes circulatory failure, in the alveolar walls of the lung, an interstitial pneumonia, and they are widely scattered but less important in other organs and tissues. It has been demonstrated that suspensions of rickettsiae have an acute toxic effect when injected intravenously into mice To this toxic substance, which is neutralized by immune serums, may in part be attributed the host cell damage and interference with normal function

Diagnosis and Treatment.—The characteristics of the rash usually lead to the clinical diagnosis Laboratory confirmation is afforded by the Weil-Felix agglutination reaction, which becomes positive during the second week or later for Proteus OX_{19} and, usually in the lower titre, for Proteus OX_2. A more specific and delicate test is afforded by complement fixation using a suspension of the specific aetiologic rickettsia as an antigen. The causative agent can be recovered and identified by inoculating guinea pigs intraperitoneally with blood obtained from the patient in the early stages of the disease

The treatment of typhus is symptomatic and supportive. It is largely a matter of good nursing care, maintenance of nutrition and fluid balance. Parenteral administration of 5% glucose in normal saline is indicated by clinical evidence of dehydration. Analgesics and sedatives may be required to relieve pain and restlessness. On the basis of preliminary therapeutic trials, it appeared at mid-20th century that aureomycin exerted a definite effect on the course of the disease. In an adult, an oral dosage

regimen of 0 25 g., given every 3 hours, is continued until the patient has been afebrile for 24 hours Therapy usually lasts two to three days and is effective at any stage in the course of the disease.

Prevention.—*Delousing.*—The prevention of typhus depends upon protection from lice. Doctors, nurses and orderlies should be provided with louseproof clothing. The patient, his immediate environment and his contacts should be subjected to a thorough delousing procedure. Clothing may be disinfested by several methods using heat or pediculicide powders. The louse-infested patient should be bathed and the hair of the head and body clipped. Disinfestation can be accomplished most expeditiously and effectively by dusting with a 10% DDT louse powder It is blown from a hand-operated dust "gun" and can be applied without removal of the clothing. It does not kill nits but remains active and kills lice as they hatch for a considerable period. About one pound of powder is required for every 15 persons.

Vaccination.—Specific vaccines are produced by cultivation of rickettsiae in the yolk sacs of developing eggs or in the lungs of mice The resulting suspension is inactivated by adding 0 3% formal saline in appropriate quantity. The vaccine in a dosage of one millilitre is given in a series of three injections at approximately weekly intervals The protection afforded is not complete, however. If infection occurs in a recently vaccinated person, the disease usually runs an abortive course with little or no eruption. The risk of death is reduced A stimulating dose of one cubic centimetre of the vaccine should be administered every four to six months as long as danger of infection exists.

With proper public health organization, adequate resources and the discriminating use of methods available for vaccination and for delousing, epidemics of typhus fever need not be feared With a reasonable expenditure and effort they can be brought under control in a short period of time It is still an ever-present threat, however, to the primitive, impoverished and destitute peoples in many parts of the world.

A–2. MURINE (ENDEMIC; FLEA-BORNE) TYPHUS

History and Distribution.—Following the elucidation (1909–18) of the role of the common louse in the epidemiology of the classic typhus of the old world, it soon became apparent that in some parts of the world a disease was endemic which was clinically indistinguishable from it except for a relatively milder course and a lower fatality rate, and which was not associated with lousiness. It was described under such names as Brill's disease,[1] endemic typhus, mild typhus and tropical typhus. Studies conducted between 1922 and 1928 revealed widespread distribution of this form in the southeastern United States, in southern California and in Mexico. It was later found to exist in certain areas of Central and South America, the Mediterranean littoral, the Balkans, China, India, Malaya, Indonesia and Australia, and probably has a much wider distribution, overlapping to some extent the areas in which epidemics of louse-borne typhus occur.

Originally regarded as of minor importance in the United States, during the ten-year period 1932–41 more than 20,000 cases were reported.

Epidemiology.—The Norway rat is the principal reservoir of infection Occasionally, the common house mouse and other species of small rodents have been found to be infected. While several species of fleas and mites found upon rats are experimentally infectible, there is reason to believe that the tropical rat flea *Xenopsylla cheopis* is the principal vector. Transmission to man probably occurs through the medium of infected flea faeces. Inasmuch as this is an accident, the frequency of occurrence of human cases is determined by the character of man's association with his domestic rodents Passage from man to man by the flea is extremely unlikely, but it has been demonstrated that lice can be experimentally infected by feeding upon humans sick with the murine form of the disease. *It* is possible, thus, that the endemic flea-borne form may occasionally give rise to the epidemic louse-borne form where conditions are favourable

Clinical Course, Diagnosis and Treatment.—The course of the illness is essentially the same as for louse-borne typhus except with regard to severity. It is relatively milder, complications are less frequent and the over-all fatality rate is less than 5% The underlying pathology is similar. The Weil-Felix reaction becomes positive during the second week and the serum titre is usually higher with OX_{19} than OX_2, negative with OX_k. Complement fixation with properly prepared antigens affords a differentiation between the flea-borne and louse-borne forms. These forms can also be distinguished by the reaction of guinea pigs to experimental infection. With a murine strain the male guinea pig develops redness and swelling of the scrotum (Neill-Mooser reaction) which is absent or inconsistently present in animals inoculated with an epidemic strain Treatment of the patient follows the lines indicated for louse-borne typhus.

Prevention.—Prevention of murine typhus is dependent upon control of the rodent flea reservoir of infection. The number of rats, and consequently of rat fleas, must be reduced below the threshold of sanitary significance In an area of high prevalence the flea population may be rapidly but temporarily reduced by applying a residual spray of DDT along rat runs A vaccine made from a murine strain of typhus rickettsia should afford some degree of protection to persons especially exposed through occupation or living in buildings heavily infested with rats in an endemic focus.

B. SCRUB (MITE-BORNE) TYPHUS (TSUTSUGAMUSHI DISEASE)

History and Distribution.—A typhuslike fever ascribed to the bite of a minute insect was known to the natives of certain river valleys in Honshu, Jap , in the mid-19th century K Tanaka in 1899 presented a careful description of its clinical and epidemiological features and identified the vector as a mite found in large numbers in the affected valleys during the summer months, when most of the cases occurred From 1906 to 1932, tsutsugamushi disease was the subject of intensive investigation by Japanese scientists In the meantime, typhuslike fevers had been described under many names as endemic in localities scattered through southeastern Asia and the adjacent island archipelagoes As a result of the studies of Japanese, British, French, Dutch and Australian investigators, and of the U S Typhus commission during World War II, it became clear that these belong in two categories. (1) flea-borne murine typhus and (2) mite-borne typhus fever, scrub typhus, indistinguishable from tsutsugamushi disease. The latter was recognized as occurring in Formosa, the Pescadores Islands, the Philippines, Indochina, Malaya, Burma, India, Ceylon, Sumatra, Java, New Guinea and adjacent islands and northern Queensland, Austr. During World War II this form of typhus was far more important as a cause of morbidity and mortality to military forces operating in the southwest Pacific area and in the China-Burma-India theatre than was louse-borne typhus to the forces operating in the Mediterranean and European theatres.

Epidemiology.—The causative agent, *R tsutsugamushi*, is primarily a parasite of trombiculid mites of which two closely related species were identified as vectors—*Trombicula akamushi* and *T deliensis* During the larval stage these mites attach themselves to and feed upon various species of wild rodents, and are occasionally found upon other animals such as shrews and marsupials and upon birds Rodents were found to be infected in nature with *R. tsutsugamushi* (*Microtus montebelli* in Japan, *Rattus concolor browni* in New Guinea, *Rattus concolor concolor* in Burma) Infection contracted by the larvae while feeding is passed by stage to stage transfer through the lymph, free-living adult and egg to the next generation. Since the larvae feed but once upon a mammalian host, transmission from rat to rat and from rat to man requires this transovarial passage of the infection with *R. tsutsugamushi* in successive cycles of trombiculid with development It follows that the distribution of the human disease is determined

[1] In 1910 Nathan Brill called attention to a disease in New York city which resembled typhus but differed from it in its relatively mild course and epidemiological features It occurred sporadically among Jewish immigrants and showed no tendency to spread. In 1934 Hans Zinsser reviewed the distribution of this typhuslike disease in New York city and Boston, Mass On the basis of his observations, he advanced the hypothesis that these cases represented recrudescences of infections originally acquired many years previously, when the individual had been living in a European country where louse-borne typhus was epidemic. This hypothesis received support from later laboratory studies, which demonstrated conclusively that cases of Brill's disease were infected with typhus of the louse-borne type and not the murine type.

by the ecology of the affected localities, with regard to the number of rodents, numbers of the vector species of mites and the opportunities for the larval mites to make effective contact with human beings. The larvae live in the upper layers of the soil and the organic detritus which covers it and crawl short distances up on blades of grass and other vegetation. Accordingly, the disease shows an occupational selection for agricultural labourers, natives foraging in new or overgrown fields and abandoned plantations, explorers and prospectors, soldiers, etc.

Clinical Course, Diagnosis, Pathology and Treatment.—The distinguishing characteristic of this form of typhus is the occurrence of a primary lesion or eschar, usually single but sometimes multiple, at the site of the infective mite bite or bites. While not always present, an eschar can usually be found by careful examination somewhere on the patient. The eruption is more erythematous, macular and evanescent than in louse-borne typhus or flea-borne typhus. While the course of the fever may be terminated in two weeks, it is not unusual for it to last three or even four weeks A more or less extensive pneumonitis is common, and lesions in the myocardium may give rise to impairment of cardiac function and sometimes to circulatory failure. The case-fatality rate varies in different geographic areas from about 2% to 20%. The prognosis becomes increasingly grave with advancing age.

Diagnosis is usually made on the presence of fever, the primary eschar and characterstic eruption. Laboratory confirmation is afforded by the Weil-Felix reaction, which becomes positive during the second week of the disease with Proteus OX_{19} negative with OX_{19} and OX_2. About the same time, complement fixation becomes positive with an antigen made from a suspension of *R tsutsugamushi* The aetiologic agent can be easily recovered and demonstrated by intraperitoneal inoculation of white mice with a minute amount of clotted blood obtained from the patient early in the course of the disease. As with other typhuslike fevers treatment is symptomatic and supportive. J. E Smadel and his colleagues demonstrated that the clinical reaction can be completely suppressed by the administration of chloramphenicol (chloromycetin). In an adult, this requires that the drug be given in doses of three to four grams, at intervals of four to seven days, for four weeks or longer.

Prevention.—Prevention depends upon protection from mite bites in the endemic area. Camp sites should be cleared and the brush and grass burned before occupation. The individual may be protected by wearing clothing that has been treated with miticide chemicals. During World War II, methods were developed for treating uniforms with terminal laundry rnse and impregnation with a soap solution containing dimethyl phthalate or dibutyl phthalate and benzyl benzoate.

A satisfactory vaccine for this form of typhus had not been developed by mid-20th century. Attempts to protect man against scrub typhus by immunization with inactive vaccines had given uniformly discouraging results under the conditions of field exposure. It had become possible to provide immunity by inducing a subclinical infection with an attenuated strain of *R. tsutsugamushi* and suppressing the overt disease by chemoprophylaxis. This method, however, was cumbersome.

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(K. F. M.)

TYPOGRAPHER is a derivation of the word typography and means "a printer" The term has recently been revived and is used by those engaged in designing books of an exclusive character, such as those printed at private presses, where a specially designed type may be employed for some specific work. It is also sometimes adopted by "layout hands" employed in advertising departments where booklets and other advertisement matter is prepared and sent to the printer to produce.

TYPOGRAPHY is the art of printing (*See* also the articles PRINTING, PRINTING TYPE and CALLIGRAPHY) It has as its first object not ornament, but utility. The printer must never distract, even with beauty, the reader from his text. In the printing of books there is less room for individuality of style than in the typography of propaganda. The laws of typography in books intended for general circulation are based upon (a) the essential nature of alphabetical writing; (b) the force of tradition. But strict as the conventions are, there is not, and can never be, a rigid character of typography applicable to all books produced in a given geographic or ethnic area; or a universal formula acceptable to all books printed in Roman types. The strength of tradition expresses itself in the details of book arrangement and these vary widely. Certain laws of linear composition are, however, obeyed by all printers who use the Roman letter.

A fount of Roman type consists of (1) Roman: CAPITALS, SMALL CAPITALS, lower case, : . " ; 1 2 3 4 5 etc (), and (2) *Italic: CAPITALS, lower case.* In addition to these, as necessary adjuncts, the printer possesses (3) spaces; (4) leads, (5) straight lines of metal known as *rules,* and (6) a collection of mobile ornaments, head- and tail-pieces, flowers, decorated initial letters, vignettes and flourishes, wood blocks of borders, etc. Another decorative medium at his command lies in his use of (7) colour (red being the most widely used). For emphasis he possesses (8) special types of notably heavy face, and may use colour for the same purpose. (9) Space is another valuable element, margins, blanks, etc. being filled in with what are known as "quotations." Finally (10) there is the nature (colour, weight and texture) of the paper.

Composition is the selection and arrangement of all these elements; *Imposition* is the due placing of the composition upon the sheet; *Printing* comprises the press-work, securing a perfection of register (backing up), the quality and crispness of inking. Typography, therefore, controls composition, imposition and paper. The paper (*q.v.*) must be of a character capable of expressing the value of the composition. The margins must be proportionate to the area of the text, allowing convenient space for thumbs and fingers at the side and bottom of the page. The mediaeval margins as adopted by the Kelmscott Press, are handsome and agreeable in certain books, but, are neither agreeable nor convenient in other books, *e g.*, where the page dimension is necessarily small or narrow, and the book is to be carried in the pocket. For this and other books, the type may well be centered on the measure of the page, and slightly raised above ocular centre.

Composition.—The fundamental principles of page-composition are deducible from the ocular facts of alphabetical printing in the Roman letter. The eye cannot, with ease, read pages of words composed of letters designed with sharply contrasting thicks and thins. Nor can the eye agreeably read a mass of words composed even In a rightly constructed letter, unless the line is kept to a certain maximum length; that is to say, the reader's eye cannot comfortably seize more than a certain number of words in any given size except in a proportionate length of line. Nor can a reader comfortably seize a letter, a word or a line, unless the printer's setting is related to the reader's normal habit of vision when holding a book for reading. The typographer's respect for these principles will generally protect the reader from the risk of "doubling" (that is, reading the same line twice), or from being given a book in a large and "staring" type.

The average number of words which the reader's eye can conveniently seize is between 10 and 12 (some 48 characters). The typographer, while exerting himself to the utmost to respect this ocular limitation, may often be confronted with certain conditions

which make it impossible for him to secure a type of the right related size He is often forced to the use of a small type, and in order to obviate the risk of "doubling," he inserts leads between the lines of type and thus increases the space between them.

The practice of leading, denounced in certain quarters, is an essential necessity. The typographer, therefore, in making the best use of his material, must make legitimate use of leads It may be added, too, that in certain compositions, leads produce a happy effect; and in not a few cases, their absence may ruin a composition set even in a relatively large type.

The typographer should know how to extract the utmost from the use of a type which is narrow in relation to its height—leading and spacing play a decisive part here. A round, open, wide letter may, for certain purposes, be set "loose"; *i.e.*, the space between the letters will be greater (or appear greater by reason of the curves of the c, o, e, g, in the lower case), than in a relatively condensed letter. Consistency will here insert a satisfactory lead between the lines.

The space between words composed in a condensed letter is less than that between words in a round, wide form. A lead should always precede and follow quoted matter. Where there is no leading between the lines, and the composition is necessarily tight, it may be an advantage to set leads between the paragraphs.

Indention is a most important detail. The opening sentence of every work should automatically manifest itself as such. This may be contrived by using a large initial letter, by printing the first word in CAPITALS, or SMALL CAPITALS, or CAPITALS and SMALL CAPITALS. The first word may be set into the margin, but it should *not* be indented Indention marks paragraphs—the subsequent sections of the text. Where for any reason it may be necessary to avoid indention in paragraphs, a lead is plainly desirable. Absence of indention and of lead means the virtual extinction of the paragraph.

The depth of the page will be related to the length of line. The measure must be symmetrical, displaying a form pleasing to the eye. A rectangle is more pleasing than a square

A rectangular page composed of lines of 10–11–12 words long will generally be satisfactory. It remains to add the running page-heading, and the folio. The page-heading may either range to the left and right in the opening (fixing the two pages as a unity); or range to the right and left; or it may be centred. The folio may be centred at the foot, or range either way at the top or bottom; but it cannot be centred at the top without abolishing the running page headline. This may be done, but it is an undesirable practice. The running headlines may be set in capitals of the text, in upper- and lower-case of the text, or in any combination of capitals. The use of full-sized capitals renders over-conspicuous a repetitive feature inserted for extrinsic convenience—that is, the identification of loose leaves. By reason of its position, the headline looks ragged if set in upper- and lower-case. It seems best, therefore, to employ small capitals; all capitals are best separated by hair spaces as their rectangular structure and preponderance of perpendiculars tend to solidify the composition.

Full-sized capitals may well be used for chapter headings, the number of the chapter being kept in small capitals, and both indications being hair spaced. The practice of dropping the chapter opening is justified by the fact that the eye, in travelling from the generally occasional blank at the end of a chapter to the beginning of the next, finds a companion blank an agreeable consistency It has also the psychological advantage of saving the reader from feeling overpowered by the text. The rectangle of type is so imposed upon the edge as to allow centre, head, fore-edge and tail margins of a dimension proportionate, first, to the length of line and, secondly, to the disposition of space at points where the text is cut into chapters, and where the body joins the prefatory and other pages known as "preliminaries." These last, less strictly governed by convention than the text pages, offer the maximum opportunity of design to be found in the volume.

The history of printing is in large measure the history of the title-page. The title when fully developed occupied a recto page, either partially or wholly; and the title-phrase, or a catchword of it, has generally been set in a conspicuous size of type. Sixteenth century Italian printers generally used large capitals, copied from inscriptions, or more exceptionally, from caroline manuscripts; while English use followed the French in employing a leading line of large upper- and lower-case, followed by a few lines of pica capitals. Next came the printer's device, and at the foot of the page, his name and address. The large sizes of upper- and lower-case, being an inheritance from printers who were accustomed to black-letter (never set in solid capitals), have gone The device also has vanished, except from the University Presses.

The contemporary title-page is a bleak affair; in nine out of ten cases the blank between the title and the imprint of the printer-publisher tends to be the most outstanding feature. When the device was first abandoned, the author, printer or publisher took advantage of the leisure of the reader and the blank at their disposal to draft a tediously long title, sub-title and indications of the author's qualifications, designed to fill the entire page. The present day publisher goes to the other extreme, reducing the title to as few short words as possible, followed with "by" and the author's name. A professional writer may insert, *e.g.*, "Author of *The Deluge*" under his name, but three and sometimes four inches of space separate this from the first line of the imprint. Consequently unless the title be deliberately set in a size of type out of all relation to that of the remainder of the book, this space is over-conspicuous. It is clear that a volume in 12-point does not require a 48-point title unless it be a 300-page folio in double-column.

Care for the typography of a book means care for its unity. There is no reason for a title-page to bear any line in a type larger than twice the size of the text-letter. If the book be set in 12-point, the title need be no larger than 24-point—or even slightly smaller. It should be set in spaced capitals as a rule The author's name, like all displayed proper names, should also be in capitals The headings to the preface, table of contents, introduction, etc., should be in the same size and fount as the chapter heads; and should be dropped if they are dropped The order of these pages remains unsettled, except that all begin on a recto page. The logical order of the preliminary pages is half-title, title, dedication, contents, introduction, preface. This rule is applicable to most categories of books. Novels need neither table of contents nor list of chapters, though one or the other is generally printed. If it is decided to retain either, it would be reasonable to print it on the back of the half-title and facing the title page, so that the entire nature of the book will be indicated to the reader at a single opening. Where the volume is made up of a few short stories, their titles can be listed in the blank centre of the title-page

Book Sizes.—In addition to fiction, belles-lettres and educational books are habitually published in portable, if not in pocketable formats, crown octavo $7\frac{1}{2}''\times5''$ (in America known as 12 mo) being an invariable rule for English novels published as such. The novel in the form of biography will be published as a biography, $6''\times8\frac{1}{4}''$, the size also for history, archaeology, science, art and almost everything but fiction. Novels are only promoted to this format when they have become "standard." Size, therefore, is the most manifest difference between books.

Another obvious difference is bulk, calculated in accordance with the publisher's notion, first, of the general sense of trade expectation, and, secondly, of the purchasing psychology of a public habituated to certain selling prices vaguely related to number of pages and thickness of the proffered volume. Inconsistently enough, weight does not enter into these expectations. These habits of mind affect the choice of fount and size of type, and may necessitate the adoption of devices for "driving out," *i.e.*, making the setting take up as much room as possible. By putting the running headline between rules or rows of ornaments; introducing unnecessary blanks between chapters; contracting the measure; exaggerating the spaces between the words and the lines; excessively indenting paragraphs; isolating quoted matter with picas of white space; inserting wholly unnecessary sectional titles in the text and surrounding them with space; contriving to drive a chapter ending to the top of a recto page so that the rest of it and its verso may be blank; using thick but not heavy paper; in-

creasing the depth of chapter beginnings and inserting very large capitals thereto, the volume can be inflated to an extra 16 pages —a feat which the able typographer accomplishes without showing his hand to the reader.

Limited editions of standard authors, or of authors who desire to rank as such, are commonly given a rubricated title. Under no circumstances, however, should red appear anywhere else in the work. Hand-made paper is generally used for editions-de-luxe, and none but the brave among typographers will disregard the superstitious love of the book-buying classes for its untrimmed, ugly and dirt-gathering rough edges There is another category of limited edition produced by typographers working freely, without the handicap of trade conditions. These books are rapidly increasing in number, and use a wide variety of format, of type, of illustration and of binding.

Because, rather than in spite of, mechanical methods and standardization, printing is more various to-day than ever before Whereas English books of whatever category of 20 years ago were printed in only three designs of type, no fewer than eight founts are employed to-day It has been necessary that most of these are reproductions of classic old-faces, but it may well be that the near future will witness a real renaissance of type design based upon a sensitiveness to rightly-controlled type forms, and not animated by an uninformed curiosity for the original and the bizarre. (S Mo)

See bibliographies of PRINTING and PRINTING TYPE: also E. G Gress, *American Handbook of Printing* (N Y 1907), H Fournier, *Traité de la Typographie* (new ed., 1919), C. T. Jacobi, *Printing* (6th ed., 1919) F. Thibaudeau, *La Lettre d'imprimerie* (2 vols, 1921), and *Manuel français de typographie moderne* (1924); G Milchsack, *Gesammelte Aufsätze über Buchkunst und Buchdruck* (Wolfenbuttel, 1922); A. W Unger, *Die Herstellung von Buchern* (Halle, 1923); L E Brossard, *Le Correcteur typographe* (Tours, 1924); S Morison, *The Art of the Printer* (1925); F C. Collins, *Authors' and Printers' Dict.* (6th ed., 1928); J C Oswald, *Hist. of Printing* (1928).

TYPOLOGY. Typology results from a study of the various kinds of objects fashioned by man and the sorting of them into categories. The objects in each category can be often further classified, a geographical, chronological or evolutionary basis being taken. For example, in the case of artefacts made by primitive man in the Fiji Islands the typologist might begin by sorting out all the paddles These would then be further classified according to their locality and age On studying such a group of objects it is often possible to make out an evolutionary series in a tool family, a certain type being clearly derived from an earlier one and itself the parent of some further development

In prehistory, a typological study of the artefacts made by man is one of the four methods which yield information before written documents existed; the other three being stratigraphy (*q v*), a study of the state of preservation of the artefacts found, and of the objects associated with them The two latter methods are useful as checks on the information obtained from stratigraphy and typology.

Although as shown above typology sometimes enables us to determine a chronological sequence, this is primarily obtained by the stratigraphical method; typology enables us to study systematically the industries belonging to the various cultures By noting the peculiarities of the various tools which make up the industries we obtain type standards for each culture with which new finds, otherwise undatable, can be compared. Thus, it is found by experience that a particular implement, viz., the beaked burin, is almost exclusively confined to industries which on stratigraphical and other grounds, can be assigned to a Middle Aurignacian culture If then a new industry is discovered otherwise undatable, but including a large number of beaked burins, we can assume, with some probability, that the age is Middle Aurignacian Again, a certain type of celt, showing a rectangular cross-section and elaborate trimming, can at once be recognized not only as being of Scandinavian origin, but also as belonging to a definite period of late Neolithic date.

Typology can be applied to styles and techniques of painting. Thus, for example, in Southern Rhodesia palimpsests of Bushman paintings occur. The typologist can observe several different styles which are always found occurring in the same stratigraphical sequence, painted one over the other. In this way a succession of art styles has been determined (M. C. B)

TÝR, the Scandinavian god of battle, was not such a prominent figure in Northern mythology as among other Teutonic peoples. In Anglo-Saxon he was called Tī (*Tīw, Tiw*, gen *Tīwes*, whence "Tuesday") and equated with the Roman Mars. His Teutonic name is the same as the word for "god" in several Indo-European languages, *e g*, Lat. *dīuus*, Lith. *dēvas*, Skr. *devas;* even in Old Norse the plural (*Týar*) was still used in the same sense. (*See* TEUTONIC PEOPLES· RELIGION.)

TYRANNOSAURUS: *see* DINOSAURIA

TYRANT, a term applied in modern times to a ruler of a cruel and oppressive character (Gr. *τύραννος*). This use is based on a misapprehension of the Greek word, which implied nothing more than unconstitutional sovereignty. Such rulers are not confined to a single period, the 7th and 6th centuries B C. (the so-called "Age of the Tyrants" [*see* GREECE· *History*]), but appear sporadically at all times. The use of the term "tyrant" in the bad sense is due largely to the ultra-constitutionalists of the 4th century in Athens, to whom the democracy of Pericles was the ideal of government Thus the government which *Lysander* set up in Athens at the close of the Peloponnesian War is called that of the "Thirty Tyrants" (*see* CRITIAS).

TYRAS, a colony of Miletus, founded about 600 B C., some 10 m from the mouth of the Tyras (Dniester). The types of its coins suggest trade in wheat, wine and fish During the 2nd century B C. it fell under the dominion of native kings It was destroyed by the Getae about 50 B C. In A D 56 it seems to have been restored by the Romans and henceforth formed part of the province of Lower Moesia Its coins now display heads of emperors from Domitian to Alexander Severus. Soon after the time of the latter it was destroyed by the Goths. Its government was in the hands of five archons, a senate, a popular assembly and a registrar The few inscriptions are mostly concerned with trade. Its remains are scanty, as its site is covered by the mediaeval fortress of Monocastro or Akkerman (*see* CETATEA ALBA)

See E H Minns, *Scythians and Greeks* (Cambridge, 1909); **V. V.** Latyshev, *Inscriptiones Orae Septentrionalis Ponti Euxini*, vol. I.

TYRCONNEL, RICHARD TALBOT, EARL (TITULAR DUKE) OF (1630–1691), Irish Jacobite, son of Sir William Talbot (d 1633), a Roman Catholic lawyer and politician, served as a royalist in the Great Rebellion, and was present at the storming of Drogheda by Cromwell (Sept. 3, 1647), afterwards escaping to Spain He was arrested in London in Nov. 1655 for acting as agent in plots to upset the Commonwealth, but escaped once more After the Restoration he was employed in the household of the duke of York (James II) even after his participation in an intrigue to ruin the character of Anne Hyde, the duke's wife. In 1678 he was arrested in connection with the Popish plot agitation, and went into exile for a time During the reign of James he was appointed commander-in-chief in Ireland and created earl of Tyrconnel (1685); in Feb 1687 he was appointed lord deputy. Tyrconnel, who foresaw the revolution in England, intrigued for the handing over of Ireland to France, in the interests of the Roman Catholics, and in 1688, when James fled to France after the battle of the Boyne, Tyrconnel was left to carry on the struggle against William III. When the latter raised the siege of Limerick Tyrconnel fled to France for help On his return to Ireland, in Jan. 1691, he was of little use, and was compelled to retire to Limerick, where he died on Aug 14, 1691. In 1689 James created him duke of Tyrconnel, but the title was only recognized by the Jacobites

TYRCONNELL (*Tir-Conaill*), an ancient kingdom of Ireland. Conall Gulban, a son of Niall of the Nine Hostages, king of Ireland, acquired the wild territory in the north-west of Ulster (the modern Co. Donegal, etc.), and founded the kingdom about the middle of the 5th century. Of the several branches of his family, the O'Connells, O'Cannanans and O'Dohertys may be mentioned. The kings of Tyrconnell reigned until 1071.

TYRE, a famous seaport of Phoenicia, now in the State of Great Lebanon, in French mandated territory (mod. *Sur*); pop., 5,700. Tyre is built on a peninsula, formerly an island, has nar-

row streets and evident traces of antiquity in the material of its buildings. Of the two harbours which it formerly possessed, the northern, or Sidonian, still survives; the southern, or Egyptian, has disappeared. Once the great mart of the Mediterranean world, it has now an insignificant export trade in cotton and tobacco. It has a French garrison and a French adviser

History.—The name Usu (Ushu), the designation of the mainland town, appears in the Tell el Amarna letters (14th century B.C.), and in Papyrus Anastasi I (13th century). As it is not found in the list of Syrian cities tributary to Thutmoise III. (15th century B.C.), it is reasonable to conclude that it was founded before the beginning of the 14th century, but not before the beginning of the 15th. The earliest settlement, a colony of Sidon (*q.v.*), was in all probability divided between the mainland and the island. The building of a causeway connecting the island with the shore is attributed to Hiram, well known as the king of Tyre, who had commercial dealings with Solomon and supplied skilled labour and material for the erection of the temple at Jerusalem. Jezebel was a daughter of Ethbaal, a Tyrian king

From her island fortress, Tyre, the mistress of the seas, could defy her enemies and for the most part Assyrian and Babylonian might spent itself against her defences in vain Shalmaneser IV., after an unsuccessful attack by sea, maintained a blockade on the land side for five years until his death intervened. Ashurbanipal stormed the city in 664 B.C. In the 6th century B.C. it endured a 13 years siege from Nebuchadrezzar

However, Tyre, with the marvellous vitality of those early times, recovered in a comparatively short time. The city passed under the sway of the Seleucids (198 B.C.) and the Romans (68 B.C.). Herod the Great endowed it with a temple. St Paul spent a week there while the ship "unloaded her burden" on his journey from Ephesus to Jerusalem By the 2nd century it had become the see of a bishop. With the rest of Syria it passed into the hands of the Muslims in the 7th century The crusaders captured it (1124), and made it one of the chief cities of their kingdom of Jerusalem. After the fall of Acre, the Muslims destroyed it.

In Roman times Tyre, "seething with commerce" (*ebulliens negotiis*) was famous for the manufacture of silk and silken garments, as well as the famous Tyrian purple from the murex shell Lucan (*Phars* x. 41) tells how Cleopatra appeared at a banquet arrayed in thin-spun and clinging silk garments, made by the skilful Tyrians and then a new luxury

A French archaeological expedition visited Tyre in 1921 and explored the neighbourhood. *See* PHOENICIA.

See Mme D. le Lasseur, "Mission archéologique à Tyr" (1921); *Syria* 3 (1922); R. Dussand, *Topographie Historique de la Syrie Antique et Médiévale* (1927), 19 *seq.* (bibl). (E. R.O.)

The most important references to Tyre in the Bible are 1 Kings v., vii., ix., Is. xxiii; Am. i. 9 *seq.*; Ezek. xxvi–xxviii.; 2 Macc iv. 18 *sqq*: Mark iii 8, vii. 24 *sqq*; Matt. xi. 21 *seq.* (and parallels); Acts xii. 20 *Cf.* also Joshua xix. 29; 2 Sam. xxiv. 7; Ezra iii. 7; Neh. xiii. 16; Ps. xiv. 12, lxxxiii. 7, lxxxvii. 4.

Siege of, by Alexander the Great (332 B.C.).—After the battle of Issus, Alexander, as he marched southwards towards Egypt, called upon the Phoenician cities to open their gates, as it was part of his general plan to deny their use to the Persian fleet. The citizens of Tyre, who owed allegiance to the king of Persia, refused to do so, whereupon he laid siege to the city. New Tyre was built on a small island, about half a mile from the main land upon which the old city stood Possessing no fleet Alexander demolished old Tyre, and with the *débris* built a mole 200ft in breadth across the straits, and erected towers and war engines at its further end. Thereupon the Tyrians destroyed the towers by fire ships and damaged the mole. Many curious devices were made use of to defeat the Greeks, such as pots of burning naphtha and sulphur, and red-hot sand hurled from catapults. Alexander next widened the mole and rebuilt the towers, but he saw that without assistance of a fleet success could not be assured since the Tyrians had free access to the sea. From Sidon he obtained 80 Phoenician ships, and 24 from Rhodes, Mallus, Soli, Lycia and Macedonia Then the king of Cyprus, hearing of the defeat of Darius at Issus, joined Alexander with 220 warships. The reduction of Tyre was now but a matter of time, for if the assault from the mole proved unsuccessful, starvation must accomplish its work Alexander was, however, impatient to complete the siege before Darius could raise another army, so he constructed floating batteries upon which rams were mounted, and forced his way into the Egyptian and Sidonian harbours, and scaled the city walls. Thus after a siege of seven months the city was taken, 8,000 of the citizens were slaughtered, 2,000 later on executed, and 30,000 sold into slavery.

See Arrian, *Anabasis of Alexander*, Diodorus Siculus; G. Grote, *History of Greece* (1906), *The Cambridge Ancient History*, vol. VI. (1927). (J. F. C. F.)

TYRE. The tyre of a wheel is the outer circumference portion that rolls on the ground or on a track prepared for it. Railway vehicle wheels usually have hard steel tyres, which together with the hard steel rail give the maximum endurance and the minimum rolling resistance. The common tyre made for the exterior rim of non-motor road-vehicles serves to hold together the parts of the wheel and resists wear in travelling. It is ordinarily made of iron or steel, and consists of a flat hoop formed so as to fit tightly over the exterior of the wheel Its chief considerations are strength and durability. In bicycles, motor cars, and other road-vehicles in which freedom from vibration and shock is also desired, solid or pneumatic rubber tyres are employed.

The principle of the pneumatic tyre was patented by Robert William Thompson in England in 1845, in France the following year and in 1847 in the United States Thompson's patent substantially covers the tyre as it is known to-day. It showed a non-stretchable outer cover and an inner tube of rubber to hold air An early set of tyres made on this basis covered 1,200 miles when placed on an English brougham.

Almost half a century late, when the bicycle became popular, pneumatic tyres were revived by John Boyd Dunlop of Belfast, Ireland. He obtained certain patents in 1888 and 1889 on English bicycle tyres. A year after Dunlop's patents were issued, Charles K. Welch patented a tyre shoe of fabric having wire edges and a rim to clinch the shoe and hold it to the felloe of the wheel In 1892 a United States patent for a similar tyre was granted to A. T. Brown and G. F. Stillman. This was purchased by the Dunlop Company and these clincher tyres were manufactured in its American factory and, under licence, by the Diamond Rubber Company. In 1890, the first clincher tyre held in position by inwardly-curved flanges of the wheel rim was patented by William Erskine Bartlett, an American residing in England, and in 1892 another by Thomas B Jeffery in the United States Both of these were pronounced valid by the courts The thread or cord tyre was patented by John Fullerton Palmer in England and in the United States in 1893. Pneumatic tyres were first applied to motor-vehicles by a firm of French rubber manufacturers, Michelin and Company. After some improvements were made, rubber tyres were adopted by Panhard and Levassor and other French automobile manufacturers about 1895 The first tyres used in America on commercial motor-vehicles were made by the B. F. Goodrich Company in 1896 for Winton cars manufactured in Cleveland. These were single tube tyres.

RUBBER TYRE MANUFACTURE

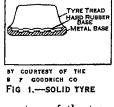
Rubber tyres may be considered in two classes—

(a) Solid or cushion tyres being those in which the rubber portion fulfils the combined functions of carrying the load, absorbing the shocks of meeting road surface irregularities, and resisting abrasion.

(b) Pneumatic tyres—in which the load is carried and the shocks absorbed mainly by compressed air. The structure of the pneumatic tyre is primarily designed to provide a non-extensible covering with impermeable lining to contain and restrain under compression the column of air. This covering is provided with a rubber tread portion which takes up the abrasive wear of road contact and protects the contained column of compressed air Such a structure has, as distinct from a solid rubber or cushion tyre, no capacity in itself either to carry load or to absorb shocks. It is entirely dependent on the contained compressed air

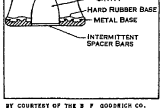
to enable it to function, and is therefore correctly named a "pneumatic" tyre

Solid Tyres, although at some time used for all types of road vehicles and for the earliest motor cars, have now practically disappeared from American highways because of legislation which discouraged their use. Large sizes have been supplanted by large pneumatic tyres, but small solid tyres are still used extensively on industrial trucks and tractors. Some of these are made with metal base bands to which the rubber is firmly attached. These bands are the full width of the base of the tyre and are dovetailed to secure firm anchorage of a hard rubber layer interposed between the metal and the soft rubber constituting the main portion of the tyre. This type of tyre is forced over the periphery of the wheel in an hydraulic press and remains fixed for the period of its life In other cases the tyre is vulcanized directly to the rim of a metal wheel instead of to a separate band.



BY COURTESY OF THE B F GOODRICH CO
FIG 1.—SOLID TYRE

Cushion Tyres.—This title is somewhat loosely applied to a number of variations of the solid tyre which are designed to provide greater deflection under load and increased cushioning against shocks. These objectives are attained by the use of softer rubber compounds and by insertion of cavities in the tyre. The cavities may be circumferential grooves in the centre of the tyre, indentations in the sides or holes extending through the rubber transversely. Such modifications reduce the volume of rubber and hence the load carrying capacity. Both solid and cushion tyres are still used on military vehicles.



BY COURTESY OF THE B F GOODRICH CO.
FIG. 2. — SEMI-CUSHION SOLID TYRE

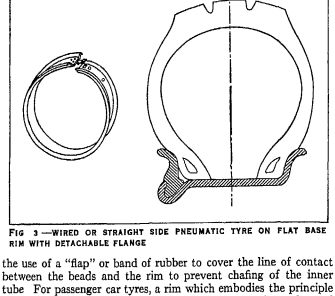
Pneumatic Tyres.—Whilst Thompson (Patent No. 10990 of 1845) was the first to conceive the possibility of supporting a road vehicle on a contained column of compressed air, and did in fact equip a horse-drawn brougham with 5-in. air-inflated tyres, it was to J. B. Dunlop (Patent No. 10607 of 1888) that the introduction of the pneumatic tyre must be credited; for from the production of his first crude inflated tyres at Belfast in 1888, the manufacture of pneumatic tyres has continued without break, with constant improvement in the product, until to-day it is essential to all high speed road motor transport, and has remained since its introduction the only equipment of cycles of all forms.

The simplest form of pneumatic tyre is that known as the single-tube tyre It consists of an endless tube of rubber-coated cotton fabric having on its inner face an impermeable rubber lining, and on its outer surface a covering of rubber to protect the fabric from wet or damage, with an additional thickness of rubber on the tread portion to resist road wear. Single-tube tyres were used on bicycles in America for many years; but because of the difficulty of repairing them they are no longer manufactured They never had any considerable use as equipment for motor cars.

The necessity for a ready means of repairing resulted in tyres taking the form of a separate inflatable inner tube, with a detachable outer cover. Out of a multitude of types of detachable covers introduced in the early '90s, two emerged—the *Wired On* or *Straight Side* type and the *Beaded Edge* or *Clincher* type.

The wired on type quickly secured a dominating position in respect to cycle tyres, but clincher tyres were used extensively for some years on motor cars. This beaded edge was entirely dropped for original equipment by American manufacturers of motor cars in 1923

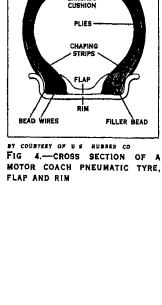
With the standardization of all tyres to one type, the design of rims has undergone some change. In America the straight side rim of the flat base type has been most commonly used for trucks and motor coaches. Its construction varies principally in the method of mounting the tyre and in attaching the rim to the wheel. Some of these rims are made with a loose flange of a self-locking type; some have two loose flanges with a separate locking ring; and there is also the transversely split type. They all require


FIG 3.—WIRED OR STRAIGHT SIDE PNEUMATIC TYRE ON FLAT BASE RIM WITH DETACHABLE FLANGE

the use of a "flap" or band of rubber to cover the line of contact between the beads and the rim to prevent chafing of the inner tube For passenger car tyres, a rim which embodies the principle of the Welch tyre of 1890, and which has been continuously used for cycle tyres and known as the well base or drop centre rim, has now been universally adopted for motor cars both in England and in America These drop centre rims enable the tyres to be very readily and easily mounted and dismounted The method is well known to all motorists and may be briefly described as depressing the endless wired edge of the tyre into the well of the rim at one point in its circumference thus allowing the wired edge of the tyre to be lifted over the edge of the rim at the opposite point of its circumference.

Cord and Canvas Tyres.—The bodies of pneumatic tyres are now made universally of parallel, cabled cords without cross-threads or with only enough light filler yarns to hold the cords in the form of a sheet to facilitate shipment to the manufacturer and handling during application of the rubber. This form of fabric reinforcement has replaced the square woven fabrics of earlier days in which warp and filling were substantially equal in size and strength. The cords are usually made of cotton, although other materials, notably rayon and steel, have recently been adopted for certain kinds of service.

High Pressure and Low Pressure (or Balloon) Tyres—When motor tyres were being almost exclusively made of square woven cotton fabric, the dimensions of the various sizes of tyres required for carrying certain loads had become fairly well stabilized, and equally the inflation pressures necessary for each size of tyre had also been uniformly accepted.



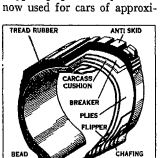
BY COURTESY OF U S RUBBER CO
FIG 4.—CROSS SECTION OF A MOTOR COACH PNEUMATIC TYRE, FLAP AND RIM

The superiority of the cord type, due partly to the cord construction and partly to its increased sectional dimensions led to further developments in which the sectional sizes of tyres were still further increased; and, since the larger the section of the tyre employed to carry a given load the lower the inflation pressure necessary to support the load,

these larger tyres could be made with considerably thinner retaining casings because of the lower inflation pressure which they had to withstand.

Such larger tyres quickly received the name of *balloon* tyres—a title naturally suggesting itself to an observer struck by the enlarged dimensions The name *balloon* quickly became very generally applied to all tyres of larger sectional dimensions, employing lower pressures.

The balloon motor tyre has demonstrated its superior cushioning properties to motorists generally, and to-day low pressure tyres are the standard equipment of all passenger cars With larger sectional dimensions, smaller rim diameters have been required Changes in dimensions and air pressures may be illustrated by comparing the data for 30″x3½″ high pressure tyres with those for 6 00″x16″ balloon tyres, now used for cars of approximately the same weight. Instead of 23″ diameter rims and 50lb pressure the newer type calls for 16″ rims and about 28lb. pressure



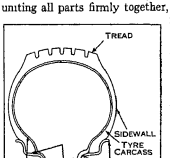
BY COURTESY OF U S RUBBER CO
FIG. 5.—STEP-DOWN SECTION OF A BALLOON PASSENGER CAR TYRE

The designation of tyre size indicates the type of tyre. For example, 32″x6″ refers to a high pressure tyre of section 6″ in diameter and of 32″ maximum *tyre* diameter (*i.e.* 20″ rim), whereas 6 00″x16″ indicates a balloon tyre of approximately 6″ cross section width and of 16″ *rim* diameter (*i.e.* 28″ maximum tyre diameter).

In order to increase stability against side sway the width of rims has been increased. To-day 6-00″x16″ tyres are mounted on rims measuring 4″ between flanges instead of 2⅝″, the width of the rims for the high pressure tyres which they superseded As already stated, all passenger car tyres are now mounted on drop-centre rims. In order to facilitate mounting and demounting of the tyres and to obtain snug fit to the rims the shape of rims and beads has been changed from a horizontal seat to a bevel as shown in fig. 6

All rims and tyre dimensions and their designations are regulated in the United States by the Tire and Rim Association, an organization composed of representatives of tyre and rim manufacturers. This body co-operates with similar groups in other countries with a view to establishing international standards for tyre and rim dimensions.

Briefly, the construction of a pneumatic tyre can be summarized as consisting in—first, the preparation of the cord material, which is now a specialized operation on which many of the largest cotton mills in the world are exclusively employed The cord, after passing from the cotton mills, is first treated in the tyre factory by a coating of rubber applied on a calendering machine to both sides of the sheets of cord fabric. These rubberized sheets are then cut into bias strips of suitable widths and brought to building machines on which the casing is built up, and the wire rings which retain the finished tyre upon the rim are enclosed within the edges of the casing. Various parts of fabric and rubber are added in the form of chafing strips, filler strips, rubber insulation plies, and cotton breaker strips, and finally the tread and sidewall coverings are added. Early practice of building this structure over a core of approximately the finished shape of the tyre has been generally discontinued Tyres are now built in the form of wide, flat endless bands which, before vulcanization, are subjected to a shaping process either by producing a vacuum outside the band in a forming box or by applying pressure against the inner surface of the band. The tyres thus formed are mounted on expansible rubber bags and placed in steel moulds for vulcanization. For many years it was common practice to stack the moulds containing the tyres one above another on an hydraulic ram inside a vertical cylindrical steam pressure vessel After the cover of the vessel was closed the ram was raised, forcing the halves of the moulds tightly together around the tyres, and heat was supplied by steam outside the moulds while the bags inside the tyres were expanded with air, steam, or hot water or combinations of them. Hot water or steam furnished heat from the inside in addition to that supplied by the steam surrounding the moulds. When air was used all heating was from the outside, and if there was any leakage of air to the outside of the moulds through the connections to the bags the rate of heat transfer was greatly reduced The use of steam or water avoided the dangers of variability in vulcanization inherent to the use of air. In modern practice the tyres and their enclosed bags are each placed in individual, hinged steam-jacketed moulds (watch-case heaters) With these heaters air from inside the bags cannot, of course, leak into the steam cavity. This process of vulcanization under pressure results in the moulding of the tyre into its finished form, uniting all parts firmly together, and produces within the rubber mass certain reactions between the rubber and the sulphur and other ingredients which have been previously incorporated in the rubber, resulting in a tough and durable product.



BY COURTESY OF THE B F GOODRICH CO
FIG. 6.—PNEUMATIC TYRE ON WELL BASE RIM

Inner Tubes are designed to hold the air inside the tyre casings. The early practice of vulcanizing straight tubes on cylindrical mandrels and afterward splicing their ends together, has now been abandoned in favour of vulcanization in circular, steam-jacketed moulds while the rubber is expanded by air against the mould surface. All tubes are, of course, fitted with non-return valves. Metal valve stems, once universally used, have been largely supplanted by flexible rubber stems with metal inserts Inner tubes are made 15% to 20% smaller in volume than the casings into which they fit. When inflated they expand to fill the inside of the casings.

Self puncture-sealing tubes are now common. One type consists of a structure in which the portion of the tube liable to puncture is under compression so that the rubber presses tightly against the puncturing object. Another type contains inside the rubber wall a layer of plastic material which flows under the internal pressure to surround the penetrating object and to plug the hole if it is withdrawn Neither type is intended to offer permanent sealing but to prevent rapid deflation of the tyre on the highway Another device consists of a double-chambered structure, the two parts connected and inflated to the same pressure. If the outer chamber is punctured the inner one will carry the load safely until the car can be stopped.

FUNCTIONS OF TYRES

Cushioning.—Road impacts are of two kinds, shock and drop. When a tyre strikes an obstacle protruding above the road surface the road and the tyre both experience shocks, designated respectively as shock impact to the road and shock reaction to the vehicle. Studies by the U S. Bureau of Public Roads indicate that shock reactions increase progressively with the speed of the vehicle up to 40 m.p.h. and assume constant value at further increased speeds. If travel over the obstacle raises the axle of the vehicle the tyre, after passing it, drops back into contact with the road, producing what are termed drop impact and reaction. These reach maximum value between 20 and 40 miles per hour Above these speeds the tyre envelops obstacles more completely and drop reactions decrease in magnitude. The fact that pneumatic tyres, especially the low pressure type, are far superior to others in reducing shocks to the road has prompted legislation favouring the use of pneumatic tyres.

Avoidance of Slipping.—Depending on the material and smoothness of road surfaces and on conditions of the weather, the coefficient of friction between tyres and road may range widely,

—from 0·02 to 0·70. Dry surfaces offer high resistance to slippage; whereas wet surfaces, especially immediately after rain begins, are extremely slippery. Non-skid designs are formed on treads during the vulcanization process when the rubber bags inside the tyres expand them against an engraved mould presenting the desired design in reverse. The designs most effective in preventing slipping and skidding on wet, hard surfaces are those which remove water from the highway under the tyre through channels in the tread, permitting the rubber to grip a nearly dry surface. On dirt roads traction and steadiness are enhanced by deformation of the road material as it sinks into depressions in the tyre tread This condition is encountered with farm tractors which are used over ploughed ground Tyres for such equipment are consequently made with sturdy, thick crossbars of rubber To improve traction still further, farm vehicle tyres are weighted either with iron weights applied to the wheels or by almost filling the tyres with a non-freezing water solution of a suitable salt

Reduction of Noise.—Even over smooth pavements some non-skid designs produce objectionable noise and vibration especially if, after some thousands of miles of travel, the tyres are unevenly worn. Intensity of sound caused by tyres has been measured by microphone and radio-receiving instruments and great improvement has been made in eliminating noise from this source Elimination of isolated knobs or buttons, and the use of continuous ribs or of unevenly spaced rectangular blocks to avoid regular vibrations, has been effective in accomplishing this change

Ease of Steering.—Proper design of the cross-sectional contour of tyres, the manner in which the cords are arranged, and the width of rims all affect steering of the vehicle. Properly designed and properly inflated tyres run true without weaving Dynamic balance of tyre and tube assembly must be maintained within certain limits specified by car manufacturers This requirement is designed to prevent uneven tread wear and "shimmy" or "tramp," which were frequently encountered when balloon tyres first came into use.

Long Service.—Aside from the expense of replacement, long uninterrupted service is demanded of tyres to-day for other reasons, particularly when the vehicle is used for commercial purposes Failure to meet appointments or to maintain a bus schedule, and delay in transportation of goods, must be avoided. The quality of modern tyres is remarkably high and failure of tyres properly used is extremely rare

The following figures indicate the economic importance of the rubber tyre industry in the United States

TABLE I

Motor vehicles registered in 1938:	
Passenger Cars	25,261,649
Motor Trucks	4,224,031
Total	29,485,680
Motor Vehicles on Farms in 1938	
Passenger Cars	4,516,508
Trucks	997,127
Total	5,513,635
Rubber Tyre Shipments in 1938:	
High Pressure Casings	2,539,804
Balloon Casings	39,709,268
Solid and Cushion Tyres	373,815
Inner Tubes	40,292,614
Number of Manufacturing Establishments in 1935	42
Number of wage earners in 1935	57,128
Wages in 1935	$ 78,853,000
Value of tyres and tubes produced in 1935	$446,029,000

At one time the useful life of tyres was ordinarily terminated by failure of the fabric in the carcass. To-day, however, carcasses of tyres almost invariably outwear the tread, even though tread life has been improved greatly during the past decade Consequently the practice of retreading or of recapping treads is now economical and many tyres will last until a second tread has been worn through The development of retreading compositions which vulcanize around 260° F has made possible application of new treads on worn tyres without deterioration of the carcass, which would occur at somewhat higher temperatures.

Wheels for many purposes are now fitted with rubber tyres. Not only bicycles and motor road vehicles but railroad cars, industrial trucks and tractors, farm tractors and farm machinery, wheelbarrows, lawn mowers, juvenile vehicles (notably coasters), roller skates, bullock carts, and rickshas are now equipped with rubber tyres Aeroplanes, also, are now normally equipped with low pressure tyres. The cost of pneumatic tyres is low to-day compared with 20 years ago and the quality vastly higher. Consequently, the average number of tyres required per car each year has decreased from about five to less than one and a half. Lower costs of tyres and increased safety and freedom from delays resulting from tyre failure have been important factors in promoting the extensive use of motor cars for pleasure and business purposes.

(W H P., J W. Sc)

TYREE, island of the Inner Hebrides, Argyllshire, Scotland. Pop. (1931) 1,448. It is situated fully 2 mi S W. of Coll, the isle of Gunna lying in the channel between the two islands, and has an extreme length from north-east to south-west of nearly 12 mi. and a breadth varying from ¾ mi. to 4½ mi. Carnan Mor (460 ft) is the highest point; there are several lakes. On the south-western point of Balephuil bay are ruins of St. Patrick's temple, besides duns and chapels; an ancient underground dwelling was found in 1916. Steamers call from Oban regularly at the small harbour of Scarnish. Horses are bred on the island. Marble has been worked. Skerryvore, a lonely rock in the Atlantic, with a lighthouse, 14 mi. south-west, belongs to the parish of Tyree.

TYROL: *see* TIROL.

TYRONE, EARLS OF: *see* O'NEILL (Irish Family).

TYRONE, a county of Northern Ireland, bounded north and west by Donegal, northeast by Londonderry, east by Lough Neagh and Armagh and south by Monaghan and Fermanagh. Its greatest length is 46 mi. and greatest breadth 60 mi. The land area is 1,218 square miles. The population in 1937 was 127,586. Running along the northeastern boundary with Londonderry are the schist ridges of the Sperrin Mountains (Sawel, 2,240 ft., and Meenard, 2,061 ft.). Most of the south of the county is occupied by sandstone formations. Mullaghearn, north-east of Omagh, reaches 1,778 ft. South of Clogher a range of hills, reaching 1,255 ft. in Slieve Beagh (Upper Carboniferous sandstones and shales), forms the boundary between Tyrone and Monaghan.

From Coalisland to Dungannon true Coal Measures appear. This coalfield includes one seam 9 ft. thick at Coalisland; less important coals occur in the Millstone Grit series at Dungannon. The field doubtless continues eastward under the Triassic sandstone that stretches towards Lough Neagh. The pale clays, probably Pliocene, of the southern shore of the lake cover the flat land east of Coalisland, and are several hundred feet thick. North of Stewartstown, near Tullaghoge, a very small patch of Magnesian limestone contains Permian marine fossils; and, farther north, the county includes part of the basaltic plateaus, protecting Chalk, which extend into Co. Londonderry.

The Foyle forms a small portion of the western boundary of the county, and receives the Mourne, which flows northward by Newton Stewart. The principal tributaries of the Mourne are the Strule (constituting its upper waters), the Derg from Lough Derg, and the Owenkillew, flowing westward from Fir Mountain. The Blackwater rises near Fivemiletown and forms part of the south-eastern boundary of the county with Monaghan and Armagh. Lough Neagh bounds the county on the east. Lough Fea is situated in the north-west, and there are several small lakes near Newtown Stewart.

Tyrone became a principality of one of the sons of Niall of the Nine Hostages in the 5th century, and from his name—Eoghan—was called Tir Eoghan, gradually altered to Tyrone. From Eoghan were descended the O'Neals or O'Neills and their numerous septs. The family had their chief seat at Dungannon until the reign of Elizabeth, when it was burned by Hugh O'Neill to prevent it falling into the hands of Lord Mountjoy. The earldom of Tyrone had been conferred by Henry VIII. on Conn O'Neill, but on his death, when the earldom should have descended to his heir Matthew, baron of Dungannon, another son, Shane, was pro-

claimed chief with the consent of the people. Shane defied English authority, but his forces were defeated near the river Foyle in 1567, and shortly afterwards he was himself killed Tyrone was one of the counties formed at Sir John Perrot's shiring of the unreformed parts of Ulster; but his work was interrupted by the rising of Hugh O'Neill in 1596 During the insurrection of 1641 Charlemont Fort and Dungannon were captured by Sir Phelim O'Neill, and in 1645 the parliamentary forces under General Munro were defeated by Owen Roe O'Neill at Benburb. At the Revolution the county was for a long time in the possession of the forces of James II.

Raths are numerous in the county. There is a large cromlech near Newtown Stewart and a horned cairn of three chambers at Clady Halliday. The county contains numerous stone circles averaging 30 to 50 ft. in diameter, being the focus of those of the second class. There are some ruins of the ancient castle of the O'Neills, near Benburb; mention may also be made of the ruins of the castles of Newtown Stewart, Dungannon, Strabane and Ballygawley. The hill pastures support a large number of young cattle. Oats, potatoes and turnips are the principal crops. The cultivation of flax, formerly an important industry, has greatly deteriorated Poultry-keeping is a growing industry. There are manufactures of linens and coarse woollens (including blankets); brown earthenware, chemicals, whiskey, soap and candles are also made. There are a few breweries and distilleries.

Branches of the Great Northern railway from Portadown (Co. Armagh) and Dungannon in the south-east, and from Enniskillen (Co. Fermanagh) and Fintona, unite at Omagh, whence a line proceeds north by Newtown Stewart and Strabane to Londonderry. From Dungannon a branch runs north to Cookstown, where it joins a branch of the Northern Counties (L.M.S) railway.

Water communication includes Lough Neagh, and the Blackwater entering it, and navigable to Moy, whence the Ulster canal skirts the boundary of the county with Co. Armagh to Caledon. Tyrone contains four urban and six rural districts, and there are seven Poor Law unions. The county returns five members to the parliament of Northern Ireland and, along with County Fermanagh, two members to the United Kingdom parliament.

TYRONE, a borough of Blair county, Pennsylvania, U.S A., 15 mi N.E. of Altoona, on the Little Juniata river and Federal highways 220 and 322; served by the Pennsylvania railroad. Pop. (1950) 8,214, 1940 federal census 8,845. The borough is 910 ft above sea level, in an agricultural district, with deposits of limestone, iron and zinc. It is a distributing point for coal from the Clearfield region and manufactures rivets, chemicals, clothing and paper. The village was incorporated in 1857.

TYRRELL, GEORGE (1861–1909), Irish divine, was born in Dublin on Feb. 6, 1861. He was educated under Dr. Benson at Rathmines School and entered Trinity College in 1878. He was greatly influenced by the writings of Cardinal Newman, and early in 1879 entered the Roman Catholic Church. In 1880 he joined the Society of Jesus and became teacher of philosophy at Stonyhurst. He had a keen sympathy with the difficulties experienced by the ordinary lay mind in trying to reconcile the conservative element in Catholicism with the principle of development and growth, and in *The Faith of the Millions, Hard Sayings* and *Nova et vetera* he attempted to clear them away. Tyrrell privately circulated among his friends writings in which he drew a clear line of distinction between religion as a life and theology as the incomplete interpretation of that life. One of these, the *Letter to a Professor of Anthropology*, was translated without his knowledge into Italian, and extracts from it were published in the *Corriere della Sera* of Milan in Jan. 1906. For at least eight years before this he had been more or less in conflict with the authorities of his order, through his sympathy with "modernist" views, but the publication of this letter (afterwards issued by Tyrrell as *A Much Abused Letter*) brought about his expulsion from the order in Feb. 1906. "The conflict," he wrote, "such as it is, is one of opinion and tendencies, not of persons; it is the result of mental and moral necessities created by the antitheses with which the Church is wrestling in this period of transition." Tyrrell found no bishop to give him an ecclesiastical status and a *celebret*, and he never regained these privileges In July 1907 the Holy Office published its decree condemning certain modernist propositions, and in September the pope issued his encyclical *Pascendi Gregis*. Tyrrell's criticism of this document appeared in *The Times* on Sept 30 and Oct. 1, and led to his virtual excommunication from the Church. On July 6, 1909, he was suddenly taken ill, on the 10th he received conditional absolution from a priest of the diocese of Southwark, and on the 12th extreme unction from the prior of Storrington. His intimate friend, the Abbé Brémond, gave him absolution, being with him at his death on July 15, 1909.

His works include: *Lex Orandi* (1903); *Lex Credendis* (1906); *Through Scylla and Charybdis* (1907); *Mediaevalism* (1908); and *Christianity at the Cross Roads* (1909).

See the estimates by Baron F. von Hügel and Rev. C. E. Osborne in *The Hibbert Journal* for Jan 1910; also the obituary in *The Times* (July 16, 1909), and the *Life*, by M. D Petre.

TYRRELL, SIR JAMES (d. 1502), the supposed murderer of the English king Edward V., and of his brother Richard, duke of York, was a son of William Tyrrell and a grandson of Sir John Tyrrell (*d. c.* 1437), who was treasurer of the royal household and was on three occasions Speaker of the House of Commons. The family is said to descend from Walter Tirel, the murderer of William Rufus During the Wars of the Roses James Tyrrell fought for the Yorkists; in 1471 he was knighted; and in 1477 he was member of parliament for Cornwall. With regard to his share in the murder of the prince in 1483 he appears to have been selected by Richard III. and sent to the Tower of London, where he supervised the crime which was carried out by his subordinates. Afterwards he received several appointments from Richard and was sent to Flanders. He was also employed by Henry VII and was made governor of Guisnes, but he seems to have incurred the king's displeasure through his friendship with Edmund de la Pole, earl of Suffolk. Having been treacherously seized he was conveyed to England and was executed on the 6th of May 1502 Just before his death he made a confession about the murder of the princes.

TYRTAEUS, Greek elegiac poet, lived at Sparta about the middle of the 7th century B C According to the older tradition he was a native of the Attic deme of Aphidnae, and was invited to Sparta at the suggestion of the Delphic oracle to assist the Spartans in the second Messenian war. Later accounts reject his Athenian origin but it is admitted that Tyrtaeus flourished during the second Messenian war (*c.* 650 B.C)—a period of musical and poetical activity at Sparta, when poets like Terpander and Thaletas were welcomed—that he not only wrote poetry but served in the field, and that he endeavoured to compose the internal dissensions of Sparta (Aristotle, *Politica*, v 6). About 12 fragments (three of them complete poems) are preserved. They are mainly elegiac and in the Ionic dialect, written partly in praise of the Spartan constitution and King Theopompus (Εὐνομία), partly to stimulate the Spartan soldiers to deeds of heroism in the field ('Υποθῆκαι—the title is, however, later than Tyrtaeus). The interest of the fragments preserved from the Εὐνομία is mainly historical, and connected with the first Messenian war. The 'Υποθῆκαι were very popular in the army (Athen xiv. 630 F) Of the marching songs ('Εμβατηρια), written in the anapaestic measure and the Doric dialect, only scanty fragments remain. Verrall (*Classical Review*, July 1896, May 1897) definitely places the lifetime of Tyrtaeus in the middle of the 5th century B.C, while Schwartz (*Hermes*, 1889, xxxiv.) disputes the existence of the poet altogether, *see* also Macan in *Classical Review* (Feb. 1897); H. Weil, *Études sur l'antiquité grecque* (1900), and C. Giarratani, *Tirteo e i suoi carmi* (1905). There are English verse translations by R. Polwhele (1792) and imitations by H. J. Pye, poet laureate (1795), and an Italian version by F. Cavallotti, with text introduction and notes (1898). The fragment beginning Τεθνάμεναι γὰρ καλὸν has been translated by Thomas Campbell, the poet.

TYRWHITT (tĭr'ĭt), **THOMAS** (1730–1786), English classical scholar and critic, born March 27, 1730, in London, where he died Aug 15, 1786. He was educated at Eton and Queen's college, Oxford. In 1756 he was appointed under-secretary for war, in 1762 clerk of the House of Commons. His principal classical works are: *Fragmenta Plutarchi II. medita* (1773), from a Harleian ms.; *Dissertatio de Babrio* (1776), containing

some fables of Aesop, hitherto unedited, from a Bodleian ms.; the pseudo-Orphic *De lapidibus* (1781), which he assigned to the age of Constantius; *Conjecturae in Strabonem* (1783); Isaeus *De Menecliis hereditate*, editio princeps (1785); Aristotle's *Poetica*, his most important work, published after his death (1794). Special mention is due of his editions of Chaucer's *Canterbury Tales* (1775–78); and of *Poems, supposed to have been written at Bristol by Thomas Rowley and others in the Fifteenth Century* (1777–78), with an appendix to prove that the poems were all the work of Chatterton. In 1782 he published a *Vindication of the Appendix*. While clerk of the House of Commons he edited *Proceedings and Debates of the House of Commons*, 1620–21 from the original ms. in the library of Queens' college, Oxford, and Henry Elsynge's (1598–1654) *The Manner of holding Parliaments in England*

TYTLER, ALEXANDER FRASER, LORD WOODHOUSELEE (1747–1813), Scottish judge, was born at Edinburgh on Oct. 15, 1747, the son of William Tytler. He was called to the Edinburgh bar in 1770. His first work, a supplement to Lord Kames's *Dictionary of Decisions*, entitled *The Decisions of the Court of Session*, was published in 1778, and a continuation appeared in 1796 In 1780 he was appointed a professor of universal history at Edinburgh. His lectures appeared finally in 1801 as *Elements of General History*. In 1790 he was appointed judge-advocate of Scotland, and wrote a *Treatise on the Law of Courts-Martial*. In 1801 he was raised to the bench as Lord Woodhouselee.

He died at Edinburgh on Jan. 5, 1813.

Besides the works already mentioned, he wrote *Life and Writings of Dr. John Gregory* (1788); *Essay on the Principles of Translation* (1790); a dissertation on *Final Causes*, prefixed to his edition of Derham's *Physico-Theology* (1799); a political pamphlet entitled *Ireland profiting by Example* (1799); an *Essay* on Laura and Petrarch (1801); and *Memoirs of the Life and Writings of Henry Home of Kames* (1807).

TYUMEN, a town in the Omsk region of the Russian S.F.S.R., in 57° 15′ N., 65° 18′ E., on the Tura river, which is difficult for navigation owing to its shallowness. though dredging has somewhat improved it; it is usually ice-free from May 8 to Nov. 15. Pop (1939) 75,537. The highway across the Urals passes through the town, and the railway links it with Sverdlovsk and Omsk. In 1580, Vermak wintered on the site and in the following year captured Isker or Sibir, the fort from which Siberia took its name; the fort of Tyumen was established in 1585. Later it became the centre for the colonization of the Tura, Tavda, Tobol and Ob rivers, but was superseded by Chelyabinsk (1939) 273,127, which had a railway link earlier than Tyumen. In 1893 the first dairy farm was begun near Tyumen by the English wife of a Russian, and this led to the immediate and rapid development of that industry in western Siberia It has the largest tanning and leather industry in Siberia, and has smelting works, saw-mills, match factories and steamer and boat building yards. Wool is dressed, and there are potteries. The koustar (peasant) industries include cooperage, the making of carts, furniture, sledges, horse-collars and wooden household utensils. The Tyumen carpets, with bright floral and animal designs are famous; the former Samoyede vegetable dyes are being replaced by aniline. The ploughs of the Kamen volost are also noted.

TZETZES, JOHN, Byzantine poet and grammarian, flourished at Constantinople during the 12th century A.D. Tzetzes has been described as a perfect specimen of the Byzantine pedant. Excessively vain, he resented any attempt at rivalry, and violently attacked his fellow grammarians. Owing to want of books, he was obliged to trust to his memory; hence he is to be used with caution But he was a learned man, and deserves gratitude for his efforts to keep up the study of ancient Greek literature. Of his numerous works the most important is the *Book of Histories*, usually called *Chiliades* ("thousands") from the arbitrary division by its first editor (N. Gerbel, 1546) into books each containing 1,000 lines (it actually consists of 12,674 lines in "political" verse). It is a collection of literary, historical, theological and antiquarian miscellanies, subsequently re-edited by the author with marginal notes. The *Chiliades* is based upon a collection of letters (107 in number) which are addressed partly to fictitious personages, and partly to the great men and women of the writer's time. They contain a considerable amount of biographical details. He is the author of the *Ilíaca*, an abridgment of and supplement to the *Iliad* in 1676 hexameters, and the Homeric *Allegories*, dedicated to the empress Irene, two didactic poems in which Homer and the Homeric theology are explained on euphemistic principles. Tzetzes also wrote commentaries on Greek authors, for instance, on the *Cassandra* or *Alexandra* of Lycophron (ed. C. G. Müller, 1811), in which his brother Isaac probably helped him. He is our earliest authority (*Chil* 3, 88, 339–48) for the story of the beggary of Belisarius. Mention may also be made of a dramatic sketch in iambic verse in which he describes the wretched lot of the learned.

Editions:—*Chiliades· Corp Poet Graec.* (Lyons, 1612); ed. Kiessling (1826). *Ilíaca:* ed Lehrs & Dübner (Paris, 1868). *Allegories* in Matranga, *Anecdota Graeca*, vol. i. (1850); *Scholia to Lycophron*, ed. Müller (1811).

For the other works of Tzetzes *see* J. A. Fabricius, *Bibliotheca graeca* (ed. Harles), xi 228, and C. Krumbacher, *Geschichte der byz. Lit.* (2nd ed., 1897); monograph by G Hart, "De Tzetzarum nomine, vitis, scriptis," in Jahn's *Jahrbücher für classische Philologie*, Supplementband xii. (Leipzig, 1881).

U

IN the Semitic alphabet the letter 𐤅 (*vau*) was sixth in order, and represented a labial spirant (equivalent to English *v* or *w*) The Greeks used the letter to represent a vowel and placed it last in their alphabet following Τ (*tau*). In the place occupied by 𐤅 (*vau*) in the Semitic alphabet the western Greek alphabets had the letter digamma Ϝ, which they used to represent the bilabial spirant (modern English *w*), a sound that had fallen out of use in the eastern dialects. Greek forms of the letter were Υ, ϒ or ⋁ and the last of these passed from the Chalcidic alphabet into Latin. The form ϒ was identical in both the Etruscan and Lydian alphabets.

The Latins, who at first used the combination FH to express the unvoiced labial spirant (English *f*), came under Etruscan influence to represent this sound by F alone. Thus, this letter, which in Greek had represented the bilabial spirant (English *w*), was no longer available, and *v* had to do duty for both the vowel (English *u*) and the bilabial spirant (English *w*). In later Latin before the separation of the Romance languages the bilabial passed into the voiced spirant equivalent to English *v*. Meanwhile, while the majuscule letter retained its form V, the minuscule and uncial had a rounded form, e.g., 𝔲 (uncial), 𝓊 (cursive of the 6th century) and, later, Carolingian 𝔘. Thus the letter passed into the mediaeval hands having the majuscule pointed form V and the minuscule rounded form *u* and representing two sounds, the vowel (*u*) and the spirant (*v*). In the later middle ages a differentiation took place similar to that between the letters *i* and *j*. The majuscule form, being generally used initially, came to represent the consonant, which usually occurred initially, in all positions; while the rounded form was used exclusively for the vowel. As a result a minuscule *v* and a majuscule *U* were adapted for use when required. The differentiation was wise and useful, and reversed the process by which in the Latin alphabet the single symbol had done duty for both consonant and vowel.

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	B.C. 1,200	?
CRETAN	1,100-900	⋁
THERAEAN	700-600	⋁
ARCHAIC LATIN	700-300	V
ATTIC	600	V
CORINTHIAN	600	Υ V
CHALCIDIAN	600	Υ
IONIC	403	V Υ
ROMAN COLONIAL	PRE-CLASSICAL AND CLASSICAL TIMES	V
URBAN ROMAN		V V
FALISCAN		V
OSCAN		Υ V
UMBRIAN		V
CLASSICAL LATIN AND ONWARDS		U

THE DEVELOPMENT OF THE LETTER "U" FROM THE EARLIEST TIMES TO THE PRESENT DAY

In Attic Greek the sound represented by the letter was a high front rounded vowel (similar to French *u*, German *ü*). In Latin the vowel was a middle high rounded one (similar to the sound of *oo* in *shoot*). In modern English short *ŭ* has become in most positions a low middle vowel closely resembling the original sound of short *ă* (*e.g.*, in the words *but*, *dumb*). There are certain exceptions, however (*cf. bull*, *bush*, *put*). The long vowel has within the last 200 years developed a palatal spirant (the sound of *y*) before it, except when it follows a liquid (*r* or *l*). Contrast the sound of the pure vowel in the word *brute* with that in the words *huge*, *rebuke*. This change is sufficiently recent for such words as begin with long *ū* (*e.g.*, *University*) to be preceded, when the indefinite article is required, by the form *an*, not *a*, showing that the sound was a pure vowel sound. It is still so pronounced in certain cases in the United States of America It is an interesting fact that this change was exactly paralleled in the Boeotian dialect of Greek. (B. F. C. A.)

UAKARI, the name of certain tropical American monkeys, distinguished by their short tails. They constitute an aberrant group of the genus *Pithecia* confined to the forests of Amazonia, and frequently distinguished as the genus *Cacajao*. (*See* PRIMATES.)

UBANGI, a river of equatorial Africa (extreme length 1,400 mi.), the chief northern affluent of the Congo (*q.v.*). The Ubangi (otherwise Mubangi or Mobangi) enters the Congo by various mouths between 0° 22′ and 0° 37′ S. and 17° 40′ and 17° 50′ E. The Ubangi is formed by the junction of the Bomu and the Uele (Welle), the latter rising a few miles from the western edge of the western rift-valley, north of Lake Albert and after a course of 700 mi. it joins the Bomu at Yakoma. Both streams, which have hitherto received numerous affluents, flow westward as a wide river. A short distance below the junction of the Bomu and Uele, the Kota, coming from the borders of Darfur and forming the most northerly extension of the Congo basin, enters the united stream (right). The remaining tributaries, mostly on the right bank, are smaller. Below the confluence with the Kouma, which river offers water communication to within easy reach of the Shari basin, the Ubangi makes a great bend south and immediately it flows between hills and passes the Zongo or Grenfell rapids, which are a barrier to navigation save for small boats in flood season. Above Zongo rapids the river is navigable up to the confluence of the Uele and Bomu, and the former is navigable at high flood up to the Bomokandi confluence in 26° 8′.

The Uele was discovered from the north by G. A. Schweinfurth in 1870, who believed it to belong to the Chad system, but W. Junker, who (1882–83) followed the river to near its confluence with the Bomu, showed that it belonged to the Congo system. In 1885 George Grenfell ascended the Ubangi as far as the Zongo rapids. He was followed in 1886–89 by the Belgian, A. van Gèle, who established the identity of the Ubangi with Schweinfurth's Uele. The Bomu was discovered from the north in 1877 by a Greek, P. Potagos, and its upper course was followed for some distance by Junker. The Ubangi and the Bomu form the frontier between Belgian Congo and French Equatorial Africa, the northern banks of both streams belonging to France.

ÜBERWEG, FRIEDRICH (1826–1871), German historian of philosophy, was born on Jan. 22, 1826 at Leichlingen, in Rhenish Prussia, where his father was Lutheran pastor. Educated at Göttingen and Berlin, he qualified himself at Bonn as *Privatdozent* in philosophy (1852). In 1862 he was called to Königs-

berg as extraordinary professor, and in 1868 was advanced to the ordinary grade He died on June 9, 1871. His compendious, accurate and impartial *History of Philosophy* has been repeatedly re-edited. At first he followed Beneke's empiricism, and opposed the subjectivistic tendency of the Kantian system, maintaining in particular the objectivity of space and time, which involved him in a somewhat violent controversy. His own system he preferred later to describe as an ideal realism, which refused to reduce reality to thought, but asserted a parallelism between the forms of existence and the forms of knowledge.

Uberweg's works include *System der Logik* (1857; 5th ed., 1882; Eng trans. of 3rd ed. by T. M. Lindsay, 1871); *Grundriss der Gesch. der Phil.* (1865–66, 12th ed. 1923–28); an essay (1861) on the authenticity and order of Plato's writings; *Schiller als. Hist. und Phil.* (published by Brasch from his papers, Leipzig, 1884). *See* F. A Lange, *F. Ueberweg* (1871); M. Brasch, *Die Well- und Lebensanschauung F. Ueberwegs* (Leipzig, 1889).

U-BOAT: *see* SUBMARINE CAMPAIGN, 1914–18.

UCCELLO, PAOLO (1397–1475), Florentine painter. His name was Paolo di Dono, but he was commonly called Uccello from his love of painting birds. He was born in Florence, the son of a surgeon barber. When about ten years of age he was apprenticed to Lorenzo Ghiberti, who was then engaged on his first doors of the Florentine Baptistery. It is not known who was Paolo's master in painting, and only a small number of his works have survived. He went to Venice in 1425 and designed a mosaic of St. Peter for the façade of St. Mark's. On his return to Florence in 1433 he was employed in the cathedral; he painted the equestrian figure of Sir John Hawkwood, an English adventurer and soldier of reputation, who had died in the service of Florence in 1394. The painting, now hanging over the door of one of the aisles, was transferred from wall to canvas in 1842. It is a chiaroscuro in terra verde, the first equestrian picture of the Renaissance. In 1443 Paolo designed cartoons for the circular windows of the cupola A year later he probably went to Padua, perhaps in the company of his friend Donatello. His paintings there of giants, in chiaroscuro, at the entrance of the Casa Vitaliani, were much admired by Mantegna. They are, unfortunately, no longer extant. Of the frescoes in the cloisters of S. Maria Novella, Florence, showing the stories of the Creation and the Deluge, only fragments remain. The series of three battlepieces, representing the Rout of San Romano, dispersed in the galleries of Florence, Paris and London, once formed part of the decoration of a large ground floor room, the bedchamber of Lorenzo the Magnificent, in the Medici (Riccardi) palace. The Louvre has a panel, much repainted, of the portraits of Giotto, Brunellesco, Donatello, Antonio Manetti and himself. Paolo's last work is said to have been a fresco painted over the door of the church of S. Tommaso in the Mercato Vecchio. This work apparently met with the disapproval of his friend, Donatello, and Paolo thereupon gave up painting and devoted himself to the study of perspective. He died on Dec. 10, 1475. He had a fine feeling for the decorative value of shapes and colour. He excelled in the representation of the picturesque armour and costumes of his time, and introduced birds, horses and animals of all kinds. He contributed much towards the development of the art of representing natural objects in three dimensional space.

See Vasari, *Vite* (edit Milanesi); Herbert Horne, *Monthly Review* (Oct, 1901), Kern, "Der Mazzocchio des P. Uccello" (*J preuss. K.*, xxvii, 1915); Sir Dominic Colnaghi, *A Dictionary of Florentine Painters* (1928). (I. A. R.)

UDAD, AOUDAD or **AUDAD,** the Barbary sheep, *Ammotragus lervia*, the only wild sheep found in Africa, where it inhabits all the mountain ranges of the north, descending eastward far into the Sudan. It is distinguished by the abundant hair on the throat and fore-quarters of the rams, the length of the tail, the absence of face-glands, and the goat-like structure of the horns

UDAIPUR or **MEWAR,** an Indian state in the Rajputana agency. Area, 13,170 sq.mi. Pop. (1941), 1,926,698. The greater part of the country is level plain. A section of the Aravalli mountains extends over the southwestern and southern portions, and is rich in minerals, but the mines have been long closed. The general inclination of the country is from southwest to northeast, the Banas and its numerous feeders flowing from the base of the Aravalli range. There are many lakes and tanks in the state, the finest of which is the Debar or Jalsamand, with an area of nearly 21 sq mi The ancient coinage is of the Sassanian or Persian type.

The chief, whose title is maharana with a salute of 19 guns, is the head of the Sisodia clan of Rajputs, and claims to be the direct representative of Rama, the mythical king of Ayodhya He is universally recognized as the highest in rank of all the Rajput princes. The dynasty offered a heroic resistance to the Mohammedans, and boast that they never gave a daughter to a Mogul emperor. They are said to have come from Gujarat and settled at Chitor in the 8th century After the capture of Chitor by Akbar in 1568 the capital was removed to Udaipur by Maharana Udai Singh During the 18th century the state suffered greatly from internal dissension and from the inroads of the Mahrattas. It came under British protection in 1817.

The name of *Mewar* is derived from the Meos, or Minas, a tribe of mixed Rajput origin, who have likewise given their name to a different tract in northern Rajputana, called Mewat, where they are now all Mohammedans. The Mewar Bhil corps, raised as a local battalion in 1840, which was conspicuously loyal during the Mutiny, was in 1897 attached to the Indian army.

The picturesque city of UDAIPUR is 2,469 ft. above sea-level. Pop. (1941), 59,648. It is situated in a valley amid wooded hills, on the bank of a large lake (Pichola), with palaces built of granite and marble. The maharana's palace, which crowns the ridge on which the city stands, dates originally from about 1570, but has had additions made to it till it has become a conglomeration of various architectural styles. On Lake Pichola are two islands, on which are palaces dating respectively from the middle of the 17th and of the 18th centuries. In the neighbourhood are Eklingji (with a magnificent temple of the 15th century), and Nagda, the seat of the ancestors of the chiefs of Udaipur.

There is another UDAIPUR STATE in the Central Provinces (till 1905 one of the Chota Nagpur states of Bengal). The capital is Dharmjaygarh.

UDAL, NICHOLAS (1504–1556), English schoolmaster, translator and playwright, author of the earliest extant English comedy, *Roister Doister*, came of the family of Uvedale, who in the 14th century became lords of Wykeham, Hants, by marriage with the heiress of the Scures. He latinized the name of Udallus, and thence anglicized it as Udal. He is described as Owdall of the "parish of St. Cross, Southampton, 12 years old at Christmas 1516, when admitted a scholar of Winchester college in 1517 (*Win. Schol. Reg.*) He was therefore 164 years of age when admitted a scholar of Corpus Christi college, Oxford, in June 1520; he is called Wodall as a lecturer at that college in 1526 to 1528 (T. Fowler, *Hist. C. C. C.*).

With John Leland he produced "dites" (ditties) "and interludes" (B.M. MS. 18A lxiv) at Anne Boleyn's coronation on May 31, 1533. Leland's contributions are all in Latin; those of "Vidallus" the Welsh form the chief part, are mostly in English, the speeches being each spoken by a "child," at Cornhill beside Leadenhall "at the Conducte in Cornhill" and "at the litle Conducte in Chepe." From the dedication to his *Flowres for Latine Spekynge, selected and gathered out of Terence and the same translated into Englysshe*, published by Bartlet (*in aedibus Berthelett*) (1534), it is inferred that Udal was usher at St. Anthony's school next door to Austin Friars, London. At midsummer 1534 he became head master of Eton. At Eton Udal's salary was £10 and £1 for livery, with "petty receipts" of 8*s.* 4*d.* for *obits*, 2*s* 8*d.* for laundress, 2*s.* for candles for his chamber, and 23*s.* 4*d.* "for ink, candles and other things given to the grammar school by Dr. Lupton, provost."

There was a yearly play, 3*s.* being paid for the repair of the dresses of the players at Christmas, and 2*s.* 4*d.* to a servant of the dean of Windsor for bringing his master's clothes for the players. A payment for repair of the players' dresses recurs every year. Udal has been credited (E. K. Chambers, *Mediaeval Stage*, ii, 244, 192) with producing a play at Braintree while vicar there, recorded in the churchwardens' accounts for 1534 as "Placidas *alias* Sir Eustace." The play is actually cited in the accounts (only extant in 17th-century extracts) "Placy Dacy *alias* Sir Ewestacy," and is the old play of Placidas, mentioned in the 9th century. Udal only became vicar of Braintree in 1537 but did not reside there at that time He held the benefice until 1554. The accounts of Cromwell for 1538 include "Woodall, the scholemaster of Eton, to playing before my lord, £5." Presumably he brought a troupe of Eton boys with him In that year he published a second edition of his *Flowres of Terence* for the benefit of Eton boys. The oftenquestioned account of Thomas Tusser (*Five Hundred Points of Good Husbandrie*) is typical of Eton at the time, as Udal's predecessor Cox is said in Ascham's *Scholemaster* to have been "the best scholemaster and greatest beater of our time":—

> From Fowles[1] I went to Aeton sent,
> To learn straightwales the Latin phrase;
> Where fifty-three stripes given to me at once I had;
> For fault but small or none at all
> It came to pass thus beat I was;
> See, Udall, see, the mercte of thee to mee, poor lad.

Udal's rule of the rod at Eton was short. He was brought up before the privy council on March 14, 1541 for being "counsail" with two of the boys, Thomas Cheney and Thomas Hoorde, for stealing silver images and chapel ornaments. He denied the theft, but confessed to a much more scandalous offense with Cheney, and was sent to the Marshalsea prison. He tried, but failed, to get restored to Eton.

He seems to have maintained himself by translating into English,

[1]Tusser was a chorister of St. Paul's.

in 1542, Erasmus's *Apophthegms* and other works In 1544 he published a new edition of the *Flowres of Terence*. He seems to have taken a schoolmastership in Northumberland or Durham, as Leland in one of his *Encomia* speaks of him, probably at this time, as translated to the Brigantes He purged himself, however, by composing the *Answer to the Articles of the Commoners of Devonshire and Cornwall* (Pocock, *Troubles of the Prayer Book of 1549*, Camd. Soc, new series, 37, 141, 193), when they rose in rebellion in the summer of 1549 against the First Prayer Book of Edward VI. In 1551 he received a patent for printing his translation of Peter Martyr's two works on the Eucharist and the Great Bible in English (Pat 4 Edw VI, pt. 5, m 5; Shakespeare Soc. iii, xxx). He was rewarded by being made a canon of Windsor on Dec. 14, 1551 On Jan 5, 1552 he edited a translation of Erasmus's *Paraphrases* of the Gospels, himself translating the first three, while that on St John was being translated by the princess Mary, till she fell sick and handed her work over to Dr Malet. The work was done at the suggestion and expense of the dowager queen Katharine, in whose charge Mary was. A translation by Udal of Geminus's *Anatomie* or *Compendiosa totius anatomiae delineatio*, was published in 1553; Udal's preface is dated July 20, 1552, "at Windesore." In June and September 1553 (*Trevelyan Pap* Camd. Soc. 84, ii, 31, 33) "Mr. Nicholas Uvedale" was paid at the rate of £13 6*s.* 8*d* a year as "scholemaster to Mr Edward Courtney, beinge within the Tower of London, by virtue of the King's Majesty's Warrant"—the young earl of Devon, who had been in prison ever since he was 12 years old.

Queen Mary on Dec 3. 1554, issued a warrant on Udal's behalf directing "the master and yeomen of the office of the Revells" to deliver whatever Udal should think necessary for setting forth dialogues and interludes, while the exchequer was ordered to provide the money to buy them (Loseley mss Kempe 63, and *Hist mss Com. Rep.* vii, 612) One of these interludes was probably *Roister Doister*; for it was in January 1553/*4*, 1554, that Thomas Wilson, master of St Katharine's hospital by the Tower, produced the third edition of *The Rule of Reason*, the first textbook on logic written in English, which contains, while the two earlier editions, published in 1551 and 1552 respectively, do not contain, a long quotation from *Roister Doister* "taken out of an interlude made by Nicholas Udal." The play was entered at Stationers' Hall, when printed in 1566. Only one copy is known, which was given to Eton by an old Etonian, the Rev Th Briggs, in 1818, who privately printed 30 copies of it. There are strong reasons for believing that *Roister Doister* first appeared in 1553, and therefore could not have been written at Eton or for Eton boys

Nor could it have been written at Westminster school or for Westminster boys, as argued by Professor Hales in *Eng. Studien* (1893) viii, 408 For though Udal did become head master of Westminster, he only became so on Dec 16, 1555, nearly two years after Wilson's quotation from *Roister Doister* appeared He was at Winchester in the interval, perhaps as master of the old City Grammar or High school When the monks re-entered Westminster, on Mary's restoration of the abbey (Nov 21, 1556), the school did not, as commonly alleged, cease, nor had Udal ceased to be master (Shakespeare Soc. iii, xxxiv) when he died a month later. He was buried on Dec. 23, 1556.

Roister Doister well deserves its fame as the first English comedy. It is infinitely superior to any of its predecessors in form and substance It has sometimes been described as a mere adaptation of Plautus's *Miles Gloriosus*. Though the central idea of the play—that of a braggart soldier (with an impecunious parasite to flatter him) who thinks every woman he sees falls in love with him and is finally shown to be an arrant coward—is undoubtedly taken from Plautus, yet the plot and incidents, and above all the dialogue, are absolutely original, and infinitely superior to those of Plautus

The play was printed by F. Marshall in 1821, in Thomas White's *Old English Dramas* (3 vols, 1830) by the Shakespeare Society, vol iii, the introduction to which contains the fullest and most accurate account of his life; in Edward Arber's reprints in 1869; and Dodsley's *Old Plays* (1894), vol iii A. W. Moon (Times Lit Supp Ap. 19, 1928) suggests the ascription to Udal of a lost play *Eaechiac* acted at King's College, Cambridge, before Queen Elizabeth, on Aug. 8, 1564, eight years after Udal's death He identifies this piece with the *Tragoedia de papatu* referred to by Gale (*Scriptores Britanniae*) as Udal's work

UDAL, a kind of right still existing in Orkney and Shetland, and supposed to be a relic of the old allodial mode of landholding existing antecedently to the growth of feudalism in Scotland (*see* ALLODIUM). The udal tenant holds without charter by uninterrupted possession on payment to the crown, the kirk, or a grantee from the crown of a tribute called scat, or without such payment, the latter right being more strictly the udal right. Udal lands are convertible into feus at the option of the udallers.

UDINE, a town and archiepiscopal see of Venetia, Italy capital of the province of Udine, situated between the Gulf of Venice and the Alps, 84 mi. by rail N.E. of Venice, 450 ft. above sea level. Pop. (1936) 54,638 (town); 63,098 (commune). The interesting Porta Aquileia (14th cent.) is almost all that is left of the old city walls. Some of the streets are arcaded and there are some fine palaces. The old castle on a hillock in the centre of the town, at one time the residence of the patriarchs of Aquileia, and now used as a museum and picture gallery, was erected by Giovanni Fontana

(G H Q) during World War I from 1915 to 1917.

UDMURTSK, formerly called the Votyak republic, an autonomous republic, within the Russian S.F S R., originally part of the former Vyatka province. Area 15,019 sq mi Pop. (1939) 1,220,007 (rural 899,287, urban 320,720). It is surrounded by the Tatar A S.S.R , and by the provinces of Sverdlovsk and Kirov, and lies between 56° and 58° 30' N. and 51° 30' and 54° 15' E. Geographically it includes a part of the Ural foothills forming the watershed between the Vyatka and Kama and the tributaries of the Chepsa The soils are not very productive, consisting mainly of sands and clays and gray forest soils, and 43% of the area is forest covered, while there are vast swamps and marshes. The prevailing trees are the fir (76%) and the pine (12%), birch, ash, elm, maple and oak occur in small areas in the south. The climate is extreme, winter is long and severe and summer brief and hot; the rainfall is adequate in the north, but diminishes markedly in the south

Agriculture is the chief occupation, but is of an extensive character; the three-field and even earlier systems are still in use. Rye and oats are the chief crops raised, flax and potato cultivation have increased markedly. The famine and epidemics of 1921–22 diminished the population and lessened the stamina of the survivors.

In spite of the abundance and good quality of the timber, it is not yet satisfactorily exploited, partly because of deficient transport and distance from markets and partly because of lack of skilled workers The rivers are unfavourable for navigation and there is no steamer communication, but on many streams it is possible to float timber after the spring thaws; in summer they become very shallow Mineral wealth includes the iron of the northeast region, slate, copper, quartz sand, chalk and red clay. Peat is abundant and has great future importance in view of the development of peat fuel as a source of electrical energy. The Varzinchsk district has been a health resort since 1888; its curative mud and sulphur springs are noted. Agriculture is insufficient to support the peasants, who supplement their income by a variety of petty trades. Many products of these home industries are used locally, but others are sent to the fair at Gorki, where they form about 9 8% of the turnover of peasant traders.

Factory industry is little developed except at Izhevsk (*q.v.*), the administrative centre, where there are steel works and ammunition factories and where other metal goods, including hunting guns, are produced. In the northeast there is much iron-smelting, and glass, pottery and vegetable oils are produced in the province. There are six saw-mills and a rosin-turpentine factory.

The Moscow-Kirov railway goes through the north of the area and the Kazan-Sverdlovsk, with a branch from Izhevsk to Votkinsk (Udmurtsk), through the south Roads are poor and are not being constructed, owing to lack of capital. The literacy rate was formerly very low, 18% for the whole province and 14% among the Votyaks. The terrible famine conditions of 1921–22 resulted in the closing of schools. They were reopened later and during the Second Five Year Plan new schools were built for the local population. Education on elementary level became compulsory.

The region was inhabited by Finnish tribes when Slav penetration and colonization began in the 12th century. For some time it was under the overlordship of Novgorod, but in the 15th century passed under that of Moscow. Though colonization went on continuously, the forest and marsh and the poor soil conditions did not prove attractive to Russian settlers and the Finnish tribes preserved their language and customs The Votyaks (Otyaks), who call themselves Ot, Ut or Ud, and who are called Ar by the Tatars, may possibly be akin to the Ars of the Yenisei They form 52.3% of the population and are of middle stature, with light-coloured eyes and fair, often red, hair, and Finnish skull and facial characters. Their dialect is akin to that of the Permyaks. They are mainly agricultural, factory

and town populations being Russian, the latter forming 43·3% of the population

UFA, the chief town of the Bashkir A S S R., situated at the confluence of the Ufa river and the Byelaya, in 54° 44′ N., 56° E., at the western edge of the Ural forests Pop (1939) 245,863 Its industries include copper-smelting, sawmilling, flourmilling, rope-making, brewing and fruit-liqueur distilling After the fall of Kazan, which destroyed the centre of unity of the non-Russian elements in the district, the Russians advanced through the Finnic-Bashkirian state and founded Ufa in 1574

UGANDA, a British protectorate in Eastern Equatorial Africa, lying between Lake Victoria and Lakes Albert and Edward, and between the Mountain Nile and Lake Rudolf Lacking a sea coast, it is bounded on the north by the Anglo-Egyptian Sudan, on the east by Kenya, on the south by Lake Victoria, Tanganyika Territory and Ruanda-Urundi, and on the west by the Belgian Congo. The same name was originally applied to the Bantu kingdom of Buganda, which is one of the provinces of the protectorate, and is now styled officially by the correct native name of "Buganda " The Swahili followers of the first explorers always pronounced the territorial prefix, Bu, as a simple vowel, U; hence the incorrect rendering "Uganda." It was first applied to the kingdom on the northwest shores of Lake Victoria discovered by J H Speke in 1862, and in time came to include the large protectorate which grew out of the extension of British influence over Buganda

Frontiers and Area.—The area of the protectorate varied considerably after Buganda was placed under British protection in 1894. From that date up to 1901 various regions were added. Its then Eastern province, which included the northern half of the eastern shores of Lake Victoria, was transferred in 1903 to the East Africa Protectorate (now Kenya Colony) The northern frontier is, roughly, about the line of 4° N and is conterminous with the Anglo-Egyptian Sudan On the Nile itself the frontier was at Lado (a little north of 5° N). By agreement, made in 1914, the frontier on the river was drawn back to Nimule, while the Sudan surrendered to Uganda approximately 4,000 sq mi. W of the Nile which had been part of the Lado enclave. On the south the protectorate includes part of Lake Victoria, and west of the lake the frontier, for the most part, is the 1st degree of S lat. This frontier coincided with the northern frontier of German East Africa On the west, where German, British and Congo Free State territories met, the Uganda frontier was to begin along the 30th meridian of east longitude In 1904 it was found, however, that the 30th meridian had been placed about 25 mi. W of its true position on the maps used when the frontier was agreed upon, and the adjustment of claims caused by this "wandering meridian" gave much trouble As finally settled in 1912 the Uganda-Belgian Congo frontier is drawn so as to include Kizegi, a highland region containing some of the peaks of the Mfumbiro volcanoes, in Uganda, and to put most of Lake Edward in Belgian territory From that lake the frontier goes across the Ruwenzori range and along the Semliki river to Lake Albert, the western half of which, nearly to the north end, fell to the Belgian Congo. Thence the frontier follows the Congo-Nile watershed. In 1922 further frontier changes were made. The Didinga district east of the Nile was taken over by the Sudan, while in 1926 Kenya Colony took over administration of the Rudolf province. These arrangements relieved Uganda of responsibility for remote, unsettled, semi-arid regions where Abyssinians, Somali and Turkana carried on gun-running and raided peaceful tribes The area of Uganda protectorate, allowing for the changes stated, is 93,981 sq.mi. (including 13,680 sq.mi of water). The division into provinces is (1) Buganda, (2) Eastern (originally Central), (3) Western, which after 1939 also included the former Northern province (originally Nile). The following description includes in part the former Rudolf province.

Physical Features.—The protectorate, with a singularly diversified surface of lofty plateaus, snow-capped mountains, vast swamps, dense forests and regions of desolate aridity (valley of Lake Rudolf) offers a remarkable variety of climates. The Eastern province is abundantly watered near Victoria Nyanza and around Mt. Elgon and the noble Debasien mountain (about 50 in. to 100 in. annually); elsewhere in Karamojo and the northern regions, the rainfall lessens to about 20 inches. Busoga and the western part of the Elgon district have a regular West African climate—hot, moist and not over-healthy. These are the conditions of Buganda, a country with an annual rainfall of from 60 to 80 in., a regular West African climate, and severe and frequent thunderstorms. Much the same may be said about the Western province, except for the cooling influence of the Ruwenzori snow range, which pleasantly affects Toro and northern Ankole. The rainfall on Ruwenzori and the central Semliki valley is about 100 in per annum. Along the Ruwenzori range are glaciers and snowfields nearly 15 mi. in continuous length and some 5 mi. in breadth. The area formerly known as Northern province is, perhaps, the hottest part of Uganda. Like the districts round Lake Rudolf, the average altitude (near the Nile) is not more than 2,000 ft., but the rainfall is more abundant, being an average of 30 in per annum.

Mt Elgon (*q.v.*), a vast crater, the rim of which rises to more than 14,000 ft., and its surrounding heights form a mountain country notable for innumerable cascades and dense forests. Elgon dominates a large area and can be seen from the northeast coast of Victoria Nyanza, from near the main Nile stream, from the heights overlooking Lake Rudolf and from Kikuyu escarpment The Eastern province consists of well-forested, undulating land (Busoga) on the coast of the lake, a vast extent of marsh round the lakelike backwaters of the Victoria Nile (Lakes Kioga or Ibrahim, Kwania, etc.), and a more stony, open, grain growing country (Bukedi, Lobor, Karamojo). The Turkana country west of Lake Rudolf is now arid, and most of the rivers have ceased to show running water in their lower courses. A good deal of high land—rising in some peaks to near 10,000 ft.—is found in the eastern part of the former Northern province, and these heights attract moisture and nourish permanent streams flowing Nilewards. But much of the lower ground is stony and poor in vegetation, while the lowland near the main Nile is exceedingly marshy.

The Ripon falls in the centre of the northern coast of the Victoria Nyanza, at the head of the exquisitely beautiful Napoleon gulf, mark the exit of the fully born Nile from the great lake. The Victoria Nile tumbles over 30 mi. of cascades and rapids (descending about 700 ft. in that distance) between Ripon falls and Kakoge. Here it broadens into Lake Kioga (Ibrahim), in reality a vast backwater of the Nile, and continues navigable (save for sudd obstacles at times) through Lake Kioga and thence northward for 100 mi. to Foweira and Karuma falls Between Karuma and Murchison falls the Victoria Nile is unnavigable. At Fajao the navigation can be resumed into Lake Albert. The main Nile stream, when it quits Lake Albert, continues navigable as far north as Nimule (3° 40′ N.). Navigability begins again 100 mi. lower down at Rejaf, from which point steamers ply to Khartoum (*see* NILE)

The topography of the Western province includes the eastern part of Lake Edward, Lake George, the eastern and northern shores of Lake Albert (*q.v.*), part of the great snowy range of Ruwenzori (*q v*), the dense Semliki, Budonga, Mpanga and Bunyaraguru forests, the salt lakes and salt springs of Bunyoro and western Toro, the innumerable and singularly beautiful crater lakes of Toro and Ankole, part of the volcanic region of Mfumbiro (*q v.*) and the healthy plateaus of Ankole The water of Lake Victoria is perfectly fresh. In Lakes Albert and Edward the water ranges from salt to slightly brackish.

Geology.—Although a good deal of geological work has been done, much more remains to be done. What may be called the foundation formation, consisting of Archaean rocks—gneiss, schist and granite—covers large areas through which the Nile cuts its way in alternate narrow gorges and open reaches. In Ankole and Koki, rocks consisting of granular quartzite, schistose sandstone, red and brown sandstone, and shales with cleaved killas rest on the Archaean platform Clay rocks of very varying texture and appearance occur over a wide area in Buganda, the Western province, and the south part of the former Northern province. The Nile, at the Ripon falls, leaps over a basalt dike. The rocks on the

verge of the Kisumu province of Kenya Colony are mainly volcanic (basalt, tuff, lava, kenyte) Thick beds of crystalline limestone occur in the Eastern province, with sandstone in Musoga, basalt round Mt Elgon, slate (Busoga) and iron stone (Busoga and Bukedi). In the former Rudolf province there are the basalt, lava, tuff and kenyte of the volcanic Rift valley, overlying a formation of granite, gneiss and quartz. Gneiss, granite and quartz—the decomposed granite giving the red "African" clay—are the leading features in the formation of the Northern province, of Buganda, and of the Western province, with some sandstone in the littoral districts of Buganda and in Ankole, and eruptive rocks and lava in southwestern Ankole and on the eastern flanks of Ruwenzori. Laterite is a surface deposit of wide occurrence, and iron ore (haematite) is abundant Deposits of Karroo age have been found at Entebbe and elsewhere. It may be added that there is abundant evidence of man's presence in Uganda in the Palaeolithic and Neolithic ages.

Flora.—The vegetation is luxuriant, except in the Rudolf region, which has the sparse flora of Somaliland. In the Western province, Busoga and the Elgon district, the flora is very West African in character. The swampy regions of the Nile and of the Eastern province are characterized by an extravagant growth of papyrus and other rushes, of reeds and coarse grass There are luxuriant tropical forests in the coast region of Buganda, in Busoga, west Elgon, western Bunyoro, eastern Toro, the central Semliki valley and northwest Ankole. The upper regions of Mt. Elgon, Mt. Debasien and Mt. Agoro are clothed with forests of conifers—juniper and yew—and witch hazels (*Trichocladus*). There are also giant yew trees (*Podocarpus*) on the flanks of Ruwenzori and the Mfumbiro volcanoes between 7,000 and 9,000 ft., but no junipers. The alpine vegetation on all these lofty mountains is of a mixed Cape and Abyssinian character—witch hazels, senecios, lobelias, kniphofias, everlasting flowers, tree heaths and hypericums. The really tropical vegetation of Buganda is nearly identical with that of West Africa.

Fauna.—The fauna also has many West African affinities in the hot, forested regions. In the adjoining Kisumu province of Kenya Colony there are several West African mammals, such as the broad-horned tragelaph and the forest pig. These are also found in part of the Semliki forests. As a rule, however, the fauna of the Upper Semliki valley, of parts of Ankole, Buganda and Bunyoro, of the former Northern, Rudolf and Eastern provinces, is of that "East African," "Ethiopic" character which is specially the feature of South and East Africa and of the Sudan right across from Abyssinia to the river Senegal. Among notable mammals the chimpanzee is found in Bunyoro, Toro and northwest Ankole, and has only recently become extinct in Buganda; the gorilla is found in the Mfumbiro region; the okapi inhabits the Semliki forests on the Congo frontier, the giraffe (the male sometimes developing five horn cores) is common in the former Northern, Eastern and Rudolf provinces; there are three types of buffalo—the Cape, the Congo and the Abyssinian; two species of zebra—one of them Grévy's—the African wild ass, the square-lipped ("white") and pointed-lipped ("black") rhinoceroses; the elephant—in 1928 it was estimated that there were 20,000 elephants in the protectorate—hippopotamus, water tragelaph ("Speke's antelope"), Cape ant-bear, aard-wolf (*Proteles*), hunting-dog, and nearly every genus and most of the species of African antelopes. The birds are more West African than the mammals, and include the gray parrot, all the genera of the splendidly coloured turacoes, the unique "whaleheaded stork" and the ostrich.

Inhabitants.—Europeans in 1944 (official estimate) numbered 2,553, of whom about one-third were females. The whites are chiefly missionaries, government officials and traders (the white population in 1909 was 507). The approximately 3,000 Asiatics of 1909, mainly British Indians, had increased to 27,573 (official estimate) in 1944. The African population in 1944 was officially estimated at 3,926,528. These may be broadly divided into three ethnic groups—Bantu, Nilotic and Hamitic, of which the Bantu tribes (including the powerful Baganda) are the most numerous. These indigenous peoples are mainly Negroid with some Caucasian admixture. The so-called Congo pygmies (*Pygmy prognathous*), a pygmylike people of little importance, inhabit the Semliki forest, Kiagwe in Buganda and the western flanks of Mt. Elgon. The Bantu tribes, including the Baganda, Banyoro, Bairu, Basese, Basoga, Bakonjo, Masaba and Kavirondo, are largely concentrated in the areas south and west of the Victoria Nile. The Nilotic tribes, including the Alur, Bari, Madi, Acholi, Gang, Lango, Latuka, Tesi, Sabei (Nandi), Turkana and Karamojo, inhabit the northern regions of the protectorate for the most part The Hamitic groups, which make up the remarkable "Hima" or "Huma" aristocracy in Bunyoro, Buganda, Toro and Ankole, are found mainly in the Eastern province. The pygmies are generally known as Bambute or Bakwa in the Semliki forests. They are reddish-yellow and brownish-black (according to individual variation) in skin colour, with head hair often tending to russet, and body hair of two kinds—black and bristly on the upper lip, chin, chest, axillae and pubes; and yellowish and fleecy on the cheeks, back and limbs. Their faces are remarkable for the long upper lip and the depressed broad nose with enormous alae. Associated with these pygmies is the "Forest Negro" type (Lendu, Lega, Baamba, Banande), of normal human stature, but short-legged and unusually prognathous. The Bantu Negroes include the remarkable Baganda people These last, before the arrival of Arabs and Europeans, displayed a nearer approach to civilization than has as yet been attained by an unaided Negro people. Their dynasty of monarchs can be traced back with tolerable certainty to a period coincident with the reign of Henry IV of England (A.D. 1400). The first Buganda king was probably a Hamite of the Hima stock (from Bunyoro). Until the coming of the white man the Baganda and most of the other Bantu peoples of the protectorate worshipped ancestral and nature spirits, who had become elevated to the rank of gods and goddesses. The influence of Christianity is great among the Baganda A "totem" system is still in vogue. All the Baganda belong to one or other of 29 clans, or "Bika," which are named after and have as totem familiar beasts, birds, fish or vegetables. The Baganda are not sexually a very moral people, but they have an extreme regard for decency, and are always scrupulously clothed (formerly in bark cloth, now in calico). As a general rule all the Bantu tribes in the western half of the protectorate, including the Basoga, are careful to consider decency in their clothing, while the Nilotic tribes are, or until recently were, often completely nude in both sexes More or less nudity among men is characteristic even of the Bahima (Hamites). But in this caste the women are scrupulously clothed.

The Nilotic tribes and Hima are tall people The Bahima are often markedly handsome, even to European eyes. In the Bahima the proportion of Caucasian blood is about one-fourth; in the Nilotic tribes and Bantu from one-sixteenth to none at all The aboriginal stock of the Uganda Protectorate is undoubtedly the pygmy-prognathous, which has gradually been absorbed, overlaid or exterminated by better developed specimens of the Negro subspecies, or by Negro-Caucasian hybrids from the north and northeast.

The languages spoken in the Uganda Protectorate belong to the following stocks: (1) *Hamitic* (Murle and Rendile of Lake Rudolf); (2) *Masai* (Bari, Elgumi, Turkana, Sūk, etc); (2a) Sabei on the northern slopes of Elgon and on Mt. Debasien; (2b) *Nilotic* (Acholi, Alur, Gang, etc.); (3) *Madi* (spoken on the Nile between Alur and Bari, really of West African affinities); (4) Bantu (Lu-ganda, Runyoro, Lu-konjo, Kuamba, Lihuku, the Masaba languages of west Elgon and Kavirondo, etc.); and lastly, the unclassified, isolated Lendu and Mbuba spoken by some of the pygmy-prognathous peoples. Among the Baganda a knowledge of English is common, and Kiswahili is the *lingua franca* of the protectorate, especially in trade.

Agriculture and Trade.—Agriculture, including livestock, is the basis of the protectorate's economy. At the end of Dec. 1937, only 6,565,456 ac. had been alienated, which included 6,232,320 ac. in free grants to natives. There are no native reserves, but natives occupying cultivated land are not disturbed. At the same date, only 267,566 ac., in freehold and leasehold, had been alienated to non-natives. Native crop cultivation (1937) covered

approximately 5,624,189 ac., of which about 3,750,000 ac. were devoted to food crops for domestic consumption exclusively, 1,736,900 ac were under cotton, and the remainder under coffee, tobacco, maize, rice, sugar cane, etc. In Buganda plantains are the staple food: sweet potatoes are grown all over the protectorate; millet is of chief importance to the Nilotic tribes, cassava, peas and beans are other common food crops. The natives also possess large herds of cattle—mostly humped, short-horned breeds—and flocks of sheep, all of the flat-tailed species, and goats Thus livestock gives rise to a large trade in hides and skins Of crops for export cotton holds a pre-eminent place; it is an industry entirely in the hands of the natives Next in importance comes coffee, grown mostly on European-owned plantations European planters have concentrated chiefly on coffee, rubber, and more recently, tea Formerly there was a fair trade in "wild" rubber; that died out about 1912, but plantation (Para) rubber exports began to be of value by 1918. Maize, groundnuts, sesame (simsim), chillies, tea and tobacco are among the minor crops. Cotton is grown by a multitude of small cultivators from seed supplied by the government, experiments favouring a "Nyasaland upland" variety The quality of the product is protected by careful control of the seed supply. The swampy lands of the Eastern province are particularly suitable for the crop The cotton is ginned at a large number of small ginneries instead of, as in the Sudan and elsewhere, by a few large ginneries. Cotton exports began modestly in 1904–05 with the despatch of 180 cwt. cotton lint worth £236. By 1910 value of cotton exported had grown to £60,000; in 1918–19 £965,000 A "boom" followed; in 1924 the cotton exported was 196,000 bales and brought £3,486,000. Thereafter there was some decline, due mainly to adverse weather conditions and the fall in world prices, and aggravated probably by the system of small and expensive ginneries. Exports of cotton fell in value to £3,051,000 in 1926, and in 1927, when a larger area suffered from drought and the crop failed, to £1,690,000. In 1936–37, 1,484,829 ac. were under cotton, yielding 338,391 bales (400 lb.) for export, to the value of £4,269,283.

In 1901–02, when trade returns were first compiled, the value of exports was about £50,000—the chief articles being rubber, ivory, skins and hides These, with some transit trade from Belgian Congo, continued the chief commodities up to 1908–09, when the exports were valued at more than £150,000. From 1910–11 cotton became the leading export, while coffee first figured to a noticeable extent during World War I Imports are of a very miscellaneous character, cotton goods being the largest single item Inevitably, during the process of development, imports exceeded exports in value. Between 1904 and 1917 imports increased from £190,000 to £1,296,000. In the same period exports increased from £60,000 to £1,076,000. In 1917 a customs union was entered into with the East Africa Protectorate (Kenya Colony). Separate statistics for imports have not since been available, but it was soon obvious that exports exceeded imports in value. Exports had risen to £2,393,000 in 1923, and were valued at £5,096,000 in 1925. The great effect of decreased cotton output and lower prices was seen in the export figures for 1926 (£3,597,000), and 1927 (£2,310,000) But the industry was too firmly established to be more than temporarily shaken. The cotton was sent mainly to Great Britain, India and Japan Domestic exports in 1937 totalled £5,702,736, while the principal imports for home consumption in the same year totalled £2,823,754.

The mineral resources of the protectorate are but little known or developed. Since 1926 tin has been mined in the Kagera area, and it is also worked in Ankole, copper has been found in the Ruwenzori region, and mineral oils in the neighbourhood of Lake Albert. Tin first figured in the exports in 1927, when the ore exported was worth £20,000 Gold, tantalite and wolfram have also been exploited for export.

Towns and Communications.—The administrative capital is Entebbe (*a throne*) on a peninsula projecting into Victoria Nyanza in 0° 4′ N., 32° 27′ E. About 20 mi. N by E of Entebbe is Kampala (or Mengo), the capital of Buganda Strictly, Kampala is the name of one of seven steep hills on which the town (pop about 60,000) is built. The European quarters, fort, government offices and Indian bazaar are on Nakasero hill, on Namirembe hill is the Anglican cathedral of St. Paul, replacing the church destroyed by lightning in 1910; on another hill (Rubaga) are the mission and cathedral of the Roman Catholics; on Mengo hill are the town residence of the kabaka of Buganda and the buildings of the *lukiko* (the Baganda parliament) On Kampala hill is the museum, and on Kasubi hill the tomb of Mtesa The port of Kampala is Port Bell, 7 mi. distant, a railway joining the two places. Of other towns the chief is Jinja, by the Ripon falls, a busy cotton and transport centre.

The protectorate is well provided with 2,075 mi of roads (1937), which have the deserved reputation of being the best in East Africa. Access to the outer world was provided, in 1902, on the completion of the railway from Mombasa to Kisumu, on the Victoria Nyanza, and by the provision of steamers on the lake This sufficed until the great development of the cotton trade after World War I. To avoid the need to transport goods across Victoria Nyanza a railway (320 mi. long, begun in 1921 and completed in 1928) was built from Nakuru, on the Mombasa-Kisumu line to a point on the Busoga railway This new railway—165 mi of which are in Uganda—became the main line. It passes through a great cotton belt, and its usefulness was increased in 1929 by the building of a railway from Jinja to Kampala (about 60 mi). By this route Uganda is in direct railway communication with the Indian ocean. The distance between Kampala and Mombasa is 896 mi. Altogether, 322 mi. of the Kenya and Uganda Railway system lie within Uganda, comprising 208 mi of the main line to Kampala, 100 mi from Tororo to Soroti (Eastern province), 17 mi from Mbulamuti to Namasagali on Lake Kioga, and 7 mi. between Kampala and Port Bell on Lake Victoria There are steamer services (besides the boats on Lake Victoria) on the Victoria Nile, Lake Kioga, and Lake Albert and on the Mountain Nile to Nimule. From 1920 onward efforts were made to connect the Sudan and Uganda by air routes, and there are aerodromes at Nimule and Jinja. Motor traffic was first introduced in 1908.

Administration and Revenue.—The protectorate is administered on crown colony lines The governor is assisted by an executive council and (after 1921) by a legislative council, composed of six official and four unofficial appointed members The right of franchise is not enjoyed by any group At the head of each province is a resident. The native states have a large measure of home rule Of these Buganda is the chief and relations with it were settled by treaty in 1900. The *kabaka* (king) is assisted by a ministry and by a *lukiko* or parliament. Similar arrangements have been made with the states of Bunyoro, Ankole and Toro, while in regions where no well-defined native state existed, administrations under recognized chiefs have been built up wherever possible. Revenue is derived from poll taxes, customs duties, an export-cotton tax, trading licences and land rents. The chief items are import duties and the poll taxes After 1915–16 the protectorate was self-supporting. The figures for 1926 were: revenue, £1,389,000, expenditure, £1,295,000 In 1937 revenue totalled £1,959,534, and expenditures were £1,740,887. With growing revenue the administration devoted large sums to education, which up to 1925 had been mainly in the hands of the missionaries, and to public health For the education of the natives a system was developed from village school to public school

HISTORY

The countries grouped under this protectorate were invaded at some relatively remote period—say, 3,000 to 4,000 years ago—by Hamitic races from the northeast, who mingled extensively with the Nile Negroes first, and then with the aboriginal inhabitants of Buganda, Bunyoro and Nandi. These Hamites brought with them a measure of Egyptian civilization, cattle and the arts of metallurgy, pottery and other adjuncts to neolithic civilization There was probably no direct intercourse with Egypt by way of the Nile, owing to the lakelike marshes between Bôr and Fashoda, but instead an overland traffic with Ethiopia (the land of Punt) via Mt. Elgon and the Rudolf regions. In time even this intercourse with the non-Negro world died away, and

powerful kingdoms with an aristocracy of Galla descent grew up in Buganda, Bunyoro, Busoga and Ankole

The kingdom of Buganda especially dominated the lands of Victoria Nyanza in the 19th century King Suna of Buganda first heard of the outer world of white men in 1850 from a runaway Baluch soldier of Zanzibar. Speke in 1862 reached Buganda, the first of all Europeans to enter that country In the early '70s Sir Samuel Baker extended the rule of the Egyptian Sudan as far south as the Victoria Nile. General Gordon, who succeeded Baker, attempted through Colonel Charles Chaillé Long, in 1874, not only to annex Bunyoro but also Buganda to the Egyptian dominions But owing to the indirect influence of the British government, exercised through Sir John Kirk at Zanzibar, the Egyptian dominions were prevented from coming south of the Victoria Nile.

First Christian Missions.—Suna, the powerful king or emperor of Buganda, who was the first to hear of a world beyond Negroland, had been succeeded in 1857 by his still more celebrated son, Mtesa or Mutesa (*Mutesa* means the measurer). Mutesa had received Speke in a most friendly manner. In 1875 he received an epoch-making visit from H. M. Stanley. Stanley, in response to Mutesa's questions about religion, obtained from that king an invitation to Anglican missionaries, which he transmitted to London through the *Daily Telegraph* The letter was entrusted to Linant de Bellefonds, a Frenchman in the Egyptian service, who had been sent to Buganda by Gordon. On his return Bellefonds was murdered by the Bari When his body was recovered Stanley's letter was found concealed in one of his boots and was forwarded to England.

Meanwhile the Zanzibar Arabs had reached Buganda in ever-increasing numbers as traders; but many of them were earnest propagandists of Islam, and strove hard (with some success) to convert to that religion the king and chiefs of Buganda and adjoining countries. In 1877 the Rev C. T. Wilson, one of a party of missionaries sent in answer to Stanley's appeal, arrived in Uganda, and towards the end of 1878 was joined by Alexander Mackay. In 1879 another party arrived by the Nile route In the same year the French Roman Catholic mission of the White Fathers of Algeria was inaugurated, and thus from 1879 dates the triangular rivalry of the creeds of Anglican and Roman Christianity and of Islam.

In 1882 Islam gained an ascendancy, and the French withdrew for a time. In the autumn of 1884 Mutesa died. A great change had been wrought in Uganda during the latter years of his reign. Calico, firearms and swords had replaced the primitive bark cloth and spear, while under the teaching of the missionary-engineer Mackay the native artisans had learned to repair arms and use European tools. Mutesa was a clever man of restless energy, but regardless of human life and suffering, and consumed by vanity. He was succeeded by his son, Mwanga, a cruel, weak and vicious youth then about 18. The intrigues of the Arabs led him to suspect the designs of the missionaries. He became alarmed at their influence over numbers of his people and resolved to stamp out Christianity. The identification of the missionaries with political embassies and their letters of introduction from secular authorities, added to Mwanga's fears and early in 1885 he determined to crush Christianity and Moslems alike. Mackay and the Rev. R. P Ashe were seized and their followers persecuted Then in the autumn of that year Bishop Hannington, unwisely, approached Buganda by Busoga, *i.e*, from the east—the route by which native tradition held that the conquerors of Buganda would come By Mwanga's orders Hannington was murdered (Oct. 1885) In May 1886 there began a renewed and more terrible persecution of Christians. Converts were butchered wholesale; on one occasion 32 were burned at the stake together. The Baganda Christians showed great heroism and the persecution but increased the number of converts. In 1888 a scheme of Mwanga's to entice all the Christian and Moslem converts on to an island in the lake and leave them there to starve miscarried Mwanga then fled and after a time made his way to a French mission station at the south end of Victoria Nyanza. In his absence his eldest brother Kikewa was made king and the principal offices were divided among the three parties—the Ba-Ingleza ("English" Protestants), the Ba-Fransa ("French" Roman Catholics) and the Ba-Islamu (Moslems). But the Moslems, under Arab instigation, treacherously attacked and murdered many of the Christian chiefs and the Christians fled to Ankole. For a time the Arabs were in the ascendant and as Kikewa refused to be circumcised he was dethroned. His brother Karema was made king and large numbers of the peasantry were forced to submit to the hated circumcision.

The "French" and "English" factions even in these straits could not avoid quarrelling. They asked Mwanga to come back on conditions which he accepted, and he was brought across the lake by a trader named Stokes (formerly a mission-agent) whose main aim seems to have been to secure ivory Mwanga's attempt to recapture Mengo was unsuccessful and he took refuge in an island on the lake. The Christians now asked the missionaries to return to keep the peace between them and among those who came was Père Lourdel, who gained much ascendency over Mwanga. The Christians defeated the Moslems in Oct. 1889, most of the Arabs with the Baganda being killed. The Moslems, however, rallied, gained a victory in November, but were finally beaten in Feb. 1890. Before this decisive victory Mwanga had appealed for help to a caravan then near the lake, led by Frederick John Jackson, who had been sent by the newly formed Imperial British East Africa company (the I.B.E.A.) to extend British influence (*see* KENYA COLONY). Jackson had instructions not to go to Uganda. While he was absent from his camp Karl Peters, at the head of a so-called German Emin Pasha Relief Expedition, arrived. He read Jackson's correspondence and hastened on to Buganda. There with the help of Père Lourdel—who in Dec. 1889 in Mwanga's name had offered to accept the British flag—Peters concluded a treaty with Mwanga Jackson hearing of Peters's doings followed him up to Mengo—but Peters had hurriedly departed to the south end of the lake. Jackson was in a difficulty; finally he decided to take back to the coast an envoy from each faction The day before he left Père Lourdel died.

Lugard's Work.—All these local intrigues were rendered useless by the Anglo-German agreement of July 1890 which placed Uganda in the British sphere of influence. Thereupon the I.B.E.A. company, in Oct. 1890, instructed Capt. F. D. Lugard (afterwards Lord Lugard), then at Kikuya, halfway between the coast and the lake, to go to Uganda. Marching with unprecedented rapidity, Lugard entered Mengo on Dec. 18 with a force of 50 Sudanese soldiers and about 250 armed carriers. Lugard, by introducing the names "Protestant" and "Catholic"—till then unknown—and by insisting that all religion was free, endeavoured to dissociate it from politics. This attitude was welcome to neither faction, and for some days the position of the new arrivals on the little knoll of Kampala was very precarious. Lugard's first object was to obtain a treaty which would give him a right to intervene in the internal affairs of the country and after some critical episodes such a treaty was signed on Dec 26. Lugard's position was strengthened by the arrival in Jan. 1891 of Captain W. H. Williams, R.A., with a small force of Sudanese and a maxim gun. Seeing, however, that the situation in Buganda was impossible unless they had a strong central force, which the I.B.E.A. company could not provide, Lugard and Williams formed the idea of enlisting the Sudanese who had been left by Emin and Stanley at the south end of Lake Albert Passing through Ankole and Bunyoro, along the northern slopes of Ruwenzori, Lugard reached Kavali at the south end of Lake Albert He brought away with him 8,000 Sudanese men, women, children and slaves, under Selim Bey (an Egyptian officer). Some of these he left at posts he established along the southern border of Bunyoro. After an absence of six months from Buganda, Lugard reached the capital at the end of the year (1891) with 200 or 300 Sudanese soldiers and two or three times that number of followers. Meanwhile Williams, amid endless difficulties, with a mere handful of men, had managed to keep the two factions from civil war

Not long after Lugard's return lawlessness again broke out and several murders were committed. In spite of strenuous efforts on Lugard's part to avert war the French party early in 1892 attacked the English, who had assembled round Kampala. The

king and French party were defeated and fled to the Sese Islands. The king and chiefs (except two ringleaders) being offered reinstatement, they appeared anxious to accept Lugard's terms, but the French bishop joined them in the islands, and from that day all hopes of peace vanished. Fighting was recommenced by a "French" attack on "English" canoes, and Williams thereupon attacked the island and routed the hostile faction. After this the "French" slowly concentrated in Buddu in the south, the Protestants migrating thence. Mwanga who was eager to accept Lugard's offers of reinstatement, succeeded in escaping from the custody of his own party and arrived in Mengo on March 30, 1892. A new treaty was made, and the British flag flew over the capital, while the French party was given a proportion of chiefships and assigned the province of Buddu. These were liberal conditions, while later, to close a controversy with France, the British government paid £10,000 to the French priests for damage.

The Mohammedans now clamoured for recognition. Lugard went to meet them, and succeeded in bringing back Mbogo, a half brother of Mtesa—Karema had died—to Kampala, and in assigning them three minor divisions of Uganda (afterward reduced to one).

A British Protectorate.—Lugard on his return to Uganda at the end of 1891 had received orders to evacuate the country with his whole force, as the I B.E A. company could no longer maintain their position. A reprieve till the end of 1892 followed, funds having been raised by the Church Missionary Society and friends The lives of many Europeans were at stake, since anarchy must follow withdrawal, and the repudiation of British pledges to the natives. Moreover, abandonment would have left the headwaters of the Nile to fall into the hands of some other—possibly hostile—European power. In June 1892, therefore, Lugard determined to leave for England to appeal against the decision for abandonment Williams remained in Uganda, where the outlook was now fairly promising, and every effort was made to reduce expenses On arrival in England Lugard found that the British government had decided not to give the company any help to maintain its hold upon Uganda A strong section of the Liberal party, headed by Sir William Harcourt, demanded the abandonment of Uganda; an equally strong agitation was set on foot for its retention, with the result that Lord Rosebery (then prime minister) despatched Sir Gerald Portal to report on the best means of dealing with the country. Portal and his staff reached Uganda in March 1893, the country at the time showing every mark of returning prosperity. Portal was not long in making up his mind; he recommended to the imperial government the retention of Uganda (*i.e.*, Buganda), the abandonment of Unyoro (Bunyoro) and Toro, and the construction of a railway halfway only to the lake. He departed after two and a half months' residence, leaving Capt. J. R. L. Macdonald in charge.

In Nov. 1893 Colonel (Sir Henry) Colvile arrived to take charge, and at once led the Baganda army against King Kabarega of Bunyoro. That country was completely overrun and Colvile built a line of forts from Buganda to Lake Albert, of which he left Major A. B. Thruston in command. In June 1894 Uganda (*i e.*, the kingdom of Buganda) was declared a protectorate, and at the end of the year Sir Henry Colvile was invalided Peace seemed assured in Uganda, territorial limits to religious teaching were abolished, English Roman Catholic priests were added to the French Fathers, and the material progress of the country was marked. A few European traders settled in the country, good permanent houses were built, roads were made and kept in repair, and many new industries introduced, chief among which were the expression of oil from various oilseeds and the cultivation of coffee. Trees were imported and land set aside for planting forests In 1896 the building of a railway from the coast to Uganda was begun In the same year the protectorate was extended over Bunyoro and Busoga.

The Sudanese Mutiny.—In the middle of 1897 this era of peace was rudely interrupted. Macdonald had returned to East Africa in command of an exploring expedition, for which Colonel Trevor Ternan, the acting commissioner, had been ordered to supply 300 Sudanese In June George Wilson, subcommissioner at Kampala, discovered a plot to revolt and in July Mwanga fled to the south of Buddu and raised the standard of rebellion. The rebels were defeated, while Mwanga was made a prisoner by the Germans Ternan, unaware of the disaffection of his men, now sent three companies to Macdonald, selecting those who had been continuously fighting in Bunyoro, Nandi and Buddu This caused great discontent, which was increased by the fact that their pay was six months in arrears and their clothing long overdue The men, too, had other grievances, they were especially sore at again being sent on service without their wives.

After Colonel Ternan's departure on leave the three companies who had joined Macdonald broke out into revolt in the Nandi district (East Africa Protectorate) and set off to Uganda, looting the countries they passed through Macdonald and F J. Jackson followed with a force of Zanzibaris. Meanwhile Major Thruston—a man justly loved by his soldiers, in whom he had complete confidence—hurried to the garrison at Luba's near the Ripon Falls, relying on his personal influence to control the men He and two other Europeans were seized and made prisoners On Oct 19 the mutineers were defeated by Macdonald's force The same night the Sudanese leaders, fearful lest their men might submit, murdered Thruston and his companions and sent [illegible] gambi and carried it with great gallantry A large number of Indian troops arrived early in 1899 and in May Colonel C G Martyr inflicted another heavy defeat on the mutineers at Mruli. Mwanga, however, managed to get through and join Kabarega and the rebels in the north In June 1899 Colonel J T. Evatt had the good fortune to capture both Mwanga and Kabarega, who were subsequently removed to the Seychelles, where Mwanga died in 1903 (For Kabarega *see* UNYORO) Colonel C. Delmé-Radcliffe subdued the last of the Sudanese mutineers in 1900–1901

In the autumn of 1899 Sir Harry Johnston was sent out to Uganda as special commissioner and he remained there till 1902. During that period he settled many disputes, included Toro, Ankole, Bukedi and other regions in the protectorate, reduced expenditure and increased revenue. He gave the kingdom of Buganda a definite constitution, settled the land question in that kingdom and in other regions and also the question of native taxation. The land settlement had very important, if undesigned, results for its effect was to do away with tribal tenure and substitute the freehold and leasehold system, with certain undesirable results. By the treaty of Mengo, signed in March 1900, the young king of Buganda, Daudi Chwa, a son of Mwanga, born in 1896, was accorded the title of his highness the Kabaka. During his minority the kingdom of Buganda was governed by regents. Of these the most notable was Sir Apolo Kagwa (d. 1927), a true statesman An epidemic of sleeping sickness, which between 1901 and 1909 caused more than 250,000 deaths, did not prevent the country making progress, the material development being accompanied by the conversion of most of the Buganda to Christianity. The completion in 1902 of the railway from the Indian ocean to Lake Victoria did much to facilitate trade. With settled conditions the administration was transferred, 1906, from the foreign to the colonial office, Sir Hesketh Bell being the first governor

Social Conditions.—Christianity and western civilization increasingly made their influence manifest, while material prosperity brought new problems. Uganda being, however, a "black man's country," there was no clash between European and African interests. Officials and missionaries continued to play a leading part in the evolution of the people, and they were backed up by the native administration of the various states included in the protectorate, which have a large degree of autonomy. Daudi Chwa, who attained his majority on Aug 8, 1914, and was created a K C M G. in 1925, and Sir Apolo Kagwa, who on ceasing to be regent became prime minister, were foremost in giving aid to the British in World War I. Other rulers and tribes were equally willing, and by supplying 10,000 soldiers, a native medical corps and more than 160,000 carriers Uganda helped substantially to defeat the Germans in East Africa.

The country suffered from a severe famine in 1919 and from the general trade depression in 1921–22. But it quickly recovered In cultivating cotton, an industry which started on a small scale in 1904 and 20 years later had attained great proportions, the natives found an easy method of acquiring wealth; a fact not without danger and adversely affecting the labour supply for other work. However, there was steady growth in education and a power of adaptability to new conditions was clearly noticeable. At a critical period of development Uganda owed much to the wise guidance of Sir R. T. Coryndon, governor from Feb 1918 to Sept. 1922. It was during this period, in 1921, that a (nominated) legislative council was created.

Being dependent upon the railway through Kenya Colony for its outlet to the sea Uganda had with that colony a customs and railway

union. The question of political federation, which was raised after World War I, presented, however, difficulties, arising chiefly from the presence of a large white population in Kenya, whereas Uganda depended upon the African for prosperity. It was chiefly to meet the demands of the native cotton growers in Uganda that the railway extension was undertaken which on its completion in 1928 enabled the crop to be sent direct to Mombasa. In Jan 1929, a commission, with Sir E Hilton Young as chairman, recommended the appointment of a high commissioner for Kenya, Uganda and Tanganyika, with executive powers This was to be "a preliminary step" to a governor-generalship for "Eastern Africa." The recommendation, however, was not acted upon

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(H. H. J.; F. R. C.; X)

UGRO-FINNISH LANGUAGES: *see* FINNO-UGRIAN LANGUAGES.

UHLAND, JOHANN LUDWIG (1787–1862), German poet, was born at Tübingen on April 26, 1787. He studied jurisprudence at the university of his native place, but also devoted much time to mediaeval literature. Having graduated as a doctor of laws in 1810, he went for some months to Paris; and from 1812 to 1814 he worked at his profession in Stuttgart, in the bureau of the minister of justice. He had begun his career as a poet in 1807 and 1808 by contributing ballads and lyrics to L. von Seckendorff's *Musenalmanach;* and in 1812 and 1813 he wrote poems for J. Kerner's *Poetischer Almanach* and *Deutscher Dichterwald.* Uhland's ballads follow the form of the masterpieces of Goethe and Schiller, but they have some of the spirit of naive wonder of the mediaeval poet, *i.e.,* they belong definitely to the Romantic school. But his style has a precision and grace which distinguish his best work from that of most of the contemporary Romantic poets. His work strengthened the national spirit, and he himself did good practical work as a liberal member of the Wurttemberg assembly, and, later, as a member of the Frankfurt parliament In 1815 he collected his poems in a volume entitled *Gedichte* To almost every new edition he added some fresh poems He wrote two dramatic works—*Ernst, Herzog von Schwaben* and *Ludwig der Baier*—the former published in 1818, the latter in 1819

Uhland was not only a poet and politician; he was also an ardent student of the history of literature. In this field he published *Das altfranzosische Epos* (1812); *Der Mythus von Thôr nach nordischen Quellen* (1836), and *Alte hoch- und niederdeutsche Volkslieder* (1844–45). He died at Tübingen on Nov. 13, 1862.

Uhland's *Gesammelte Werke,* edit by H. Fischer, were published in 1892 in 6 vols; also by L. Frankel (2 vols., 1893) and L. Holthof (1901). His *Gedichte* passed through nearly 50 editions in the poet's lifetime; jubilee ed. of the *Gedichte und Dramen* (1886) A critical ed by E Schmidt and J Hartmann appeared in 1898 (2 vols.) Uhland's *Schriften zur Geschichte der Dichtung und Sage* were published in 8 vols. (1865–73), his *Tagebuch von 1810–1820* by J. Hartmann (1893). *See* H. Mayne, *Uhlands Jugenddichtung* (1899); H. Schneider, *Uhland. Leben, Dichtung, Forschung* (1920)

UHRICHSVILLE, a city of Tuscarawas county, Ohio, U.S.A., 85 mi. S. by E. of Cleveland, on Stillwater creek and federal highways 36 and 250; it is served by the Baltimore and Ohio and the Pennsylvania railways. Pop. (1930) 6,614; in 1940, 6,435; in 1930, 6,437. Coal is mined in this region, and the city is one of the principal centres in the country for the manufacture of sewer pipe and other clay products. It was settled about 1803 and incorporated in 1832.

UIGHUR, the name of a Turkish tribe and dynasty who came from the east and ruled in Kashgaria from the 10th to the 12th century. They used a variety of the Syriac alphabet. (*See* TURKS)

UIST (oist), **NORTH AND SOUTH,** islands, outer Hebrides, Inverness-shire, Scotland. North Uist lies southwest of Harris (Long Island), from which it is separated about 8 mi. by the Sound of Harris. The island is 13 mi. long by 17 mi wide. Population (1931) 2,349. The highest point is Mt. Eaval (1,138 ft.). The principal sea-lochs are Loch Maddy and Loch Eport, both on the east. On the east coast the surface is mostly swampy moorland, but on the west there is some fertile soil. The inhabitants are chiefly engaged in crofting, fishing and cattle rearing. The principal village, Lochmaddy, is a trade centre, and a favourite resort of anglers, being a regular calling station for the steamers from Glasgow and Kyle of Lochalsh. The islands of the parish of North Uist (pop. 1931, 2,827) comprise—to the southwest Baleshare (pop 1931, 136), Kirkibost (6), Heisker (33), the Monach group, with a lighthouse on Shillay (3); to south, Grimsay (259) and Ronay (6); to northeast, Leiravay (8); to the north, Boreray (8) and Vallay (19).

South Uist had a population in the island (1931) of 2,810 and in the parish of 4,236, an extreme length of 27 mi., an extreme width of 7 mi. Towards the northeast it is mountainous. The chief sea-lochs are Loch Boisdale, frequented by anglers, Loch Eynort and Loch Skiport on the east coast. On the east side the surface is mainly alluvial peat, broken by hills, but on the west there is a belt of productive land. Besides crofting, the inhabitants are engaged in the fisheries and cattle raising. Steamers from Glasgow, Portree, Oban, etc., call regularly at the village of Lochboisdale, where there is a wireless station. The islands attached to the parish of South Uist include, to the south, Eriskay (pop 420), where Prince Charles landed on Aug 2, 1745; to the northeast, Wiay; to the north, Grimsay (19); Flodday (26), just off the northeast shore of Benbecula; and Benbecula (961), with an area of 40 sq.mi., from which there are low-tide fords to North Uist and South Uist.

UITENHAGE, 33° 46′ S. 25° 27′ E.; altitude 169 ft; 21 mi. by rail from Port Elizabeth, South Africa. Pop. (1946) 26,520 including 11,090 whites, 10,016 natives, 287 Asiatics and 5,127 coloured. The town was founded by De Mist in 1804, on the Zwartkops river. Water courses flow along the sides of the streets, which are lined with trees. On the banks of the river are two large wool-washing establishments. In the town are railway workshops, the main industry of the place.

UITOTOAN (WITOTOAN), a group of tribes of South American Indians, forming an independent linguistic stock. The Uitotos (Witotos), from whom the stock takes its name, and the tribes related to them live in the region of the Peruvian-Colombian border, between the Yapura and Putumayo rivers, especially on the Caraparana and Igaraparana, northern tributaries of the latter. The Witotos are a short, dark-skinned folk, with almost Negroid faces. They are on a lower level of culture than their neighbours in many respects. On the other hand they have developed the drum language to a surprisingly high point. Their religious beliefs and mythology are of great interest.

See T. Koch-Grünberg, *Zwei Jahre unter den Indianern* (Berlin, 1909); K. Th. Preuss, *Religion und Mythologie der Uitoto* (Leipzig, 1921).

UJIJI, a town of East Africa, on the east side of Lake Tanganyika, in 4° 55′ S. and 29° 40′ E. Pop. (1936) about 10,000, largely Swahili. Ujiji was the meeting point of merchants from all parts of the lake and the terminus of a caravan route from Dar-es-Salaam. The Zanzibar Arabs made it their headquarters in the first half of the 19th century and it became a great slave and ivory mart. In 1858 Richard Burton and J. H. Speke reached Ujiji, being the first white men to see Lake Tanganyika. David Livingstone, coming from the south, reached Ujiji in 1869, and it was there that H. M. Stanley found him on Oct. 28, 1871. The first steamer on the lake was launched at Ujiji in 1884. Soon afterwards it became part of German East Africa and was chosen as the lake terminus of the railway (completed in 1914) from Dar-es-Salaam. Ujiji harbour has become very shallow and the terminus of the railway is at Kigoma, 4 mi. to the north Ujiji was occupied by Belgian Congo troops in 1916, and in 1921 was transferred to Great Britain as part of the mandated territory of Tanganyika It is the centre of the lake fishing trade

UKRAINE, a constituent republic of the U.S.S.R., recognized by the soviet government in December 1920, when a treaty was signed defining the relations between the Ukraine and the Union of Soviet Socialist Republics. Area 214,633 sq.mi. Pop. (1946) 40,548,310. It lies between 46° and 52° 20′ N. and 26°

10′ and 40° 14′ E., and is bordered S. by the Black sea, the Crimean A.S.S.R. and the Sea of Azov, W. by Bessaraba, N. by the White Russian S.S.R. and the region of Orel and N.E. and E by the regions of Kursk and Voronezh and by the North Caucasian Area. The Moldavian A.S.S.R. (*see* MOLDAVIA) was linked administratively with the Ukraine until it became a constituent member of the U.S.S.R. in 1940.

Geology.—Geologically and structurally the Ukraine is distinct from Russia to the north of it; the Tertiary sea covered most of it, but extended very little further to the north, and the ice of the glacial epoch hardly reached it, except in the northwest and where Don and Dnieper mark southward extensions of glacial river systems. Its plateau system, the Azov Horst of Suess, composed of granite gneisses, stretches northwestward from the Sea of Azov through Volhynia and Podolia, and is generally supposed to be the eastward continuation of the Hercynian system This horst exerted a strong tectonic effect on the fold system of the Donetz which was thrown up from the end of the Palaeozoic to the beginning of the Tertiary period, and also caused the tectonic disturbances of the post-Cretaceous period indicated by the lines of Karpinsky, a northern line stretching from the Volga through the bend of the Don, the source of the Donetz, the delta of the Desna and Polyesie to Warsaw and a southern from the delta of the Don, past the falls of the Dnieper to the source of the Bug. Recent seismic observations indicate that tectonic disturbances are still going on in the district and there is some evidence that elevation of the plateau region has occurred in post-glacial times

River Formations.—The chief rivers are the Dniester, Bug, Dnieper and the Donetz, a tributary of the Don; tectonic disturbances may account for their parallelism. The soils of the region fall into three main groups. In the ancient forest zone of Polyesie, where morainic clays and sands form the base, are ash-coloured or podzol soils (*See* RUSSIA: *Soils and Their Influence*). A zone of black earth formed on loess under steppe climatic conditions lies south of this region, but the humus content has been diminished by the spread on it of forests as the moister and milder climatic zone pushed southward. The town of Kiev stands on the northern limit of this zone, and its rise may be connected with the lesser density of the forest on the loess to the south of it Spurs of the central Russian plateau are thrust into the northwest But the main feature of the Ukraine is its steppe land, covered with *chernozyom* (black earth) formed on loess, more sandy to the north and more clayey to the south. The rich black earth belt runs generally southwest to northeast, diminishing in humus content toward the north and toward the south. In the southeast, in accordance with more arid conditions, it displays a tendency to salt efflorescences. Along the north shores of the Black sea extends the Pontic steppe. The Black sea was part of an Upper Miocene and Sarmatian sea, which formerly extended inland as far as the Vienna basin, but which shrank in Tertiary times; the Pontic steppe bears traces of this transgression It approaches the sea by a steep incline only broken by the river estuaries, characterized in this region by limans. These are submerged, eroded river valleys locked from the sea by detritus.

Where a stream of great volume enters the sea (*e g*, Dniester, Bug, Dnieper), the bar is pierced in one or two places and something resembling a delta is formed. But in the case of those streams which do not bring down enough water to cover the loss from evaporation in the liman, the bar becomes continuous and the water within the liman is increasingly rich in salts. The mud of these limans has curative properties and small health resorts are dotted along their shores. Along the river valleys are thickets of sedge and reed, with marsh forest and meadow. The Pliocene lime which predominates in the Pontic steppe covers the crystalline substratum, which is, however, often laid bare by the action of streams.

Forest destruction at the source of the streams has led to flooding after each melting of the snows. The heavy mantle of black earth and loess, the loose chalk and the marl, sand and clay of the Tertiary strata on the Ukrainian steppe are readily cut into by running water, and many acres of fertile agricultural soil have been washed away from the ravine slopes. An institute for research into amelioration of this problem was established and efforts were made to prevent further forest cutting, to encourage replanting and to introduce transverse plowing across the slopes and drainage channels round the fields

The chief river is the Dnieper (*q v*) which has formed one of the links between the Black sea and the Mediterranean and the Baltic from ancient times The Pripet river joins the Dnieper a little south of the northern boundary of the Ukraine and almost doubles its volume, the Dnieper from this point often dividing into two or more channels, and having many islands The right bank is high and rocky and the left a low plain, though in three places the plain extends along both banks During the melting of the snows the river overflows the islands and the plains along its shores, leaving them covered with fertile alluvium At the mouth of the left bank Samara tributary, both banks of the Dnieper become precipitous. The post-Tertiary elevation of the Azov horst forced the river to dig its bed into the granite-gneiss rocks, but in many places ledges of these rocks lie across its path and it descends in a series of waterfalls, now being harnessed for production of electric energy. Below the falls the river expands, flowing in several channels, and silting up its liman so quickly that constant dredging is necessary to keep the port of Kherson open even for small seagoing vessels. Of its numerous Ukrainian tributaries, the Tetelev and Ingulez on the right, and the Desna on the left, are the most important, the latter being navigable for a great distance

The present scheme of electrification of the falls includes a scheme for deepening the river channel so as to make it available for large steamers and for providing adequate canals in this region. The lower course of the Dniester (*q.v*) forms the boundary between Bessaraba and the Ukraine. Its left bank Ukrainian tributaries are short, and flow from the Volhynian-Podolian plateau They are full at the melting of the snows and have carved deep canyons, but in summer they almost disappear. Between the Dniester and the Bug, no river reaches the sea, all being shut in by limans. The Bug (*Boh*) is a shallow stream, not navigable even after the spring thaws except near its mouth, and its tributaries in summer become mere chains of ponds; rapids are formed in its bed by ledges of the granite-gneiss horst. The upper course of the Donetz with its white chalk cliffs lies in the Ukraine. On the whole the waterways of the Ukraine are not favourable to navigation, the Dnieper and its tributaries giving the greatest possibilities

Climate.—The climate is everywhere continental, but increasingly so toward the southeast. The Ukraine south of a line through Dniepropetrovsk to Kishinev differs from the north in being exposed to east and southeast winds which prevent the snow brought by the south winds from the Black sea from becoming very thick. If these easterly winds are prolonged and intense, the snow hardly remains at all, this being a contributory cause of bad harvests. Sometimes these east winds bring snow and are so cold and violent that the flocks of sheep are destroyed.

Other causes of bad harvests are a rainless spring, and the return of easterly winds and frosts in May. The maximum rainfall is in summer and falls mainly in heavy showers which may wash away parts of the surface and which, in any case, run off quickly. Winter is severe, the average temperature at Kiev, lat. 50° 30′ N, in January being 34° F., colder than that of Hammerfest, lat. 70° 35′ N. The duration of frost on the Pontic steppe is 2 months and in the rest of the Ukraine 3 to 4 months. Spring in the south is liable to dry east winds bringing sandstorms, but toward the northwest it is moister, with frequent alternations of snow and frost. In summer most of the Ukraine lies south of the 68° F. isotherm and high temperatures prevail in the south in July and August. The amount of rainfall diminishes from the northwest (22 in.) to the southeast (12 in.) and yearly fluctuations especially in the important spring rains are great.

Archaeology.—The Ukrainian steppes and south Russia are of peculiar interest historically and archaeologically. Rostovtzeff points out that the French emigrants who found a home in Russia after the revolution first gave a stimulus to the study of the archaeology of the region. Russian scholars became interested and

a copious literature and rich museum collections now exist. The presence of Palaeolithic man has been demonstrated at Kiev, and the relics of Neolithic man are everywhere abundant The intersection here of routes from the orient via the Caucasus and the Black sea, of Greek influences, of influences from the west via the Danube and from the north via the Dnieper is reflected in the cultural wealth of the early civilizations, while the openness of the steppes to the east led to their repeated submergence by nomads from the steppe. Easy portages connected the rivers, and steppe to the south was open and treeless, while the forests on the loess to the north were younger and less dense than those of the south, and were also intersected by glades; the reasons for the lesser density of forest on the loess steppe are not yet fully worked out.

The conquerors in the region have too often been considered as transitory nomads, but there is ample evidence to prove that the fertility of the region and the ease with which tribute could be extracted from the inhabitants encouraged settlement as well as conquest, thus leading to a rich variety of cultural intermixture. Little is known of the Cimmerians and the extent of their kingdom, but the Iranian Scythians certainly had centres on the steppes between the Don and the Dnieper. These Cimmerian and Scythian kingdoms were the base on which the Greek colonies of the Black sea depended, later history goes to show that such colonies could not exist without a fairly stable civilization on the steppe to the north Sarmatian tribes, Iranians like the Scythians, succeeded to this kingdom, and the blending of Greek and Iranian culture had a marked influence on the civilizations of central and eastern Russia.

The Neolithic civilization of the Ukraine, the so-called Tripolye (*q.v.*) culture, named from the finds at that place, as evidenced by its incised and painted pottery, was peculiarly rich and belonged to an agricultural people. The kurgan or barrow graves, common to steppe and woodland, and containing skeletons daubed with red paint and buried in the contracted position, though probably contemporary, show evidence of a nomadic people, while graves in the Kharkov district seem to indicate an absorption of the steppe nomads into agriculture This juxtaposition of settled agriculture and nomadic tribes is still to be observed in the region to the east, where the Kalmucks and some Kirghiz tribes at the present time lead nomadic lives.

In the course of the 8th and 7th centuries B.C. the mouths of the Dniester, Bug and Dnieper were occupied by Milesian fishing colonies, Tyras on the Dniester and Olbia on the Bug and Dnieper. Olbia became the outlet for the furs, slaves and amber of the north and an inlet for Greek influences, which penetrated as far as the Kama; the Milesian power decayed in the 5th century B.C. and Athens took its place in trading relations with Olbia, the corn of south Russia being increasingly needed for the Mediterranean civilizations. With the advance of the Sarmatians to the steppe between the Don and the Dnieper in the second half of the 3rd century B.C., the Scythians moved farther to the north and west, as evidenced by their remains in Kiev and Poltava, but their advance was checked by Germanic tribes, and anarchy began to prevail in the steppe

From their first appearance on the Dnieper the Sarmatian Alans allied themselves with the Germanic tribes in a struggle against Rome and destroyed Olbia and the Roman fortresses on the Crimea. Celtic civilization in the region is represented in the basin of the Dnieper by La Tène finds, probably remains of the Galatian tribes. Roman influence was felt in the Black sea region under Hadrian and his successors, who established a fort at Olbia, but in the 3rd century A.D. Roman influence declined on the Ukrainian shore. (R. M. F.; X)

History.—From the standpoint of historical development and population, the Ukraine is composed of two different zones The northern and western parts of the Ukraine are the ancient territories of the earliest mediaeval Russian state of the 9th through the 13th centuries, having Kiev as its capital and the valley of the Dnieper as its principal economic artery. Those populous and flourishing regions, divided into many small principalities under the suzerainty of the grand dukes of Kiev, were completely devastated by the Mongol invasions of the 13th century. The present-day population of northern and western Ukraine is composed of the descendants of the original population of Kievan Russia reinforced by immigrations from north and west which took place in subsequent centuries during the Lithuanian, Polish and finally Russian domination over the Ukrainian territories.

The people of the eastern and southern Ukraine are for the most part descended from Ruthene immigrants from the north who, to escape the oppression of the Polish and Lithuanian princes and nobles, escaped "to the frontier" where, though nominally under Lithuanian rule, they formed free democratic communities, and came to be known as Cossacks (*q.v.*). The whole Ukraine formed part of the Polish-Lithuanian empire until 1667, when the portion east of the Dnieper was ceded to Russia by the treaty of Andrussovo. The rest was absorbed by Russia at the second partition of Poland, in 1793.

The "Great Russians" regarded the Ruthenes as belonging to the Russian nation, and their language as a mere dialect. Toward the middle of the 19th century, however, there began in the Ukraine a separatist movement, associated with the names of the Ruthene scholar Kostomarov and the poet Shevchenko, of which the political ideal was the union of all the Ruthenes, including those of Galicia, in a Ukrainian nation. This Ukrainophil movement gathered force, and become a very important factor in the politics of eastern Europe, especially after the outbreak of World War I.

The collapse of the Russian empire in 1917, and the downfall of the Habsburg monarchy which followed, seemed to give the opportunity for realizing the Ukrainophil ideal. In March 1917 a formal demand for the recognition of Ukrainian autonomy was made to the provisional government at Petrograd, and on April 19 a Ukrainian national convention met at Kiev to elect a *rada* (council). This took over the government in June, and was recognized by the Petrograd provisional government in August On November 20, contemporaneously with the bolshevik revolution in Petrograd, the *rada* proclaimed a Ukrainian People's republic, the independence of which was accepted in principle by the bolsheviks, who made no objection when the Central Powers agreed to receive the Ukrainian delegates to the conference at Brest-Litovsk and to negotiate with them a separate peace.

In January 1918, however, the situation had altered. A bolshevik government had been set up at Kharkov, and was making rapid headway against the "compromising" Kiev *rada*, and at Brest-Litovsk Trotsky now declared that a separate peace with the Ukraine would involve the breaking-off of the negotiations with soviet Russia The news from the Ukraine was, however, uncertain; the Central Powers were in urgent need of food supplies from southern Russia; and on February 9 they signed a peace treaty with the Ukrainian People's republic. By subsidiary treaties, signed on the 12th, the Ukraine agreed, *inter alia*, to provide supplies of grain, etc., in return for manufactured articles

Meanwhile the Kiev government had been hard-pressed by the bolsheviks and, in March, appealed to the Central Powers for help. German and Austrian troops now marched into and occupied the Ukraine, mainly with the object of securing the stipulated supplies of food, which had fallen far short of expectations. A proclamation of the German General Eichhorn ordering cultivation to be proceeded with, led to a quarrel with the *rada*, which was dissolved by the Germans, who made Skoropadski *hetman* of the Ukraine Violent unrest followed among the peasants, who demanded the restoration of the people's republic, and on July 30 General Eichhorn was assassinated. An armistice had been concluded with soviet Russia in May In November, with the collapse of the Central Powers, there was a movement against the *hetman*, headed by Petliura, a former member of the *rada*. Skoropadski was overthrown, and Petliura and Vinnichenko, ex-president of the people's republic, established themselves as dictators in Kiev, where they proclaimed the union of the Ukraine with the West Ukrainian republic set up at Lwów (Lemberg) by the Galician Ruthenes. This led to a short war with Poland, to whom Galicia had been assigned by the Allied Powers. Petliura marched to the aid of the Lemberg government, which was threatened by

the advance of General Haller's Polish legion from the western front, but was decisively defeated

In Feb 1919 Petliura, driven from Kiev by a bolshevik rising, took refuge with his armed followers in east Galicia and in 1920 joined forces with the Poles against the bolsheviks. Meanwhile, in March 1919, a second Ukrainian Soviet government had been set up, but was dissolved in June, when Denikin's "Whites" took Kharkov. In December, however, the soviet forces recaptured Kharkov and Kiev, Odessa also falling to them in Feb. 1920, and a third Ukrainian Soviet republic was established In May 1920 the Poles, with Petliura's troops, occupied large parts of the Ukraine, including Kiev, but were forced to retire when the Russian soviet army took the offensive (*see* RUSSIA). By the treaty of Riga (Oct. 12, 1920 and March 18, 1921) Poland and Russia recognized the independence of the Ukraine. On Dec. 28, 1920 a Russo-Ukrainian treaty was signed defining relations between the two soviet republics.

During 1921 the Ukrainian Soviet Socialist republic signed separate treaties with Georgia (Jan. 31), Lithuania (Feb. 14), Latvia (Aug. 3), Estonia (Nov. 25) and Italy (Dec. 27); and also, in conjunction with the Russian Soviet Federated Socialist republic, with Austria (Dec. 7). In 1922 a treaty with Turkey was signed (Jan. 2) and, again in conjunction with the R.S.F.S.R., a trade agreement with Czechoslovakia (June 5). On July 6, 1923 the constitution of the Union of Soviet Socialist republics was adopted, of which the Ukraine became a constituent member. In Sept. 1924 the autonomous Moldavian Soviet Socialist republic was formed as part of the Ukraine, and was proclaimed a constituent member of the U.S.S.R. in Aug. 1940. In the fall of 1941 the Ukraine was overrun by the Germans. The Russians applied the scorched earth policy in their retreat. As a result of the Russian summer offensive in 1943, however, the greater part of the republic was reconquered.

Forests.—In former times forest and forested glades covered much of the area, coniferous in the north and west, and oak in the south, and patches of forest still remain, especially in the north-west and in the Kharkov district The beech occurs in a small region west of Kamenets Podolsk. The Pontic steppe is practically treeless and probably never had much forest except along the Dnieper river, where it still extends as far as Kherson and is found in patches south of that town. Forest clearing was going on as early as the time of the Kiev principality. Later the Mongols and Tatars destroyed huge stretches of forest by setting fire to it, partly to provide pasture grounds for their flocks and partly to prevent the Slavs from taking refuge in the forest. In the 16th century the colonizing Cossacks continued the process and also practically exterminated the wild horses, deer and bison.

Finally the intensification of colonization in the 19th century so diminished the forests that by the 20th century only 8% of the Ukraine was under timber, of which 23% was coniferous and 64.6% deciduous. The abundant wild life of the region has disappeared, the saiga antelope has retreated eastward and only rodents, especially field mice and marmots, the plague of agriculture, are abundant. The loss of bird life has increased insect pests, though the locust which once did so much damage, has been exterminated. Destructive use of fine meshed nets, so that young as well as adult fish were caught, has markedly lessened the pike, tench, carp, crucian and shad in the rivers, and the sturgeon and sterlet which formerly swarmed up their lower courses are fast disappearing.

Agriculture and Industries.—Four-fifths of the population are engaged in agriculture, and in spite of the destruction of the years of civil war 1917–21 and the famine of 1921, production in 1926–27 had reached about 90% of the 1913 level and by 1937 the crop area covered 62,002,100 ac. Rapid increase of population has always been a feature of the Ukrainian race. This increase of population in a region of lessened agricultural production and markedly diminished manufacturing output still further impoverished the peasantry, and the two features of agricultural life which have been so marked a result of this fecundity of the race, emigration and seasonal wandering in search of work, still persist. Collective farms consisting of 96% of the whole peasantry have contributed much to the technical improvement of agriculture, especially since the western part of the black soil belt lies within the borders of the republic. The climate and soil are particularly favourable to agriculture.

After the revolution and famine also, there was a change in the type of cultivation. Maize, which is a more drought-resisting grain, now occupies more than twice the share of 1913, and rye, potatoes, sunflower seed, hemp, grasses and cultivation of melons, watermelons and cucumbers are markedly above the 1913 level Barley, wheat and sugar beet are below that level. In 1937 unirrigated cotton plantations covered an area of 553,280 ac. The many-field system rapidly replaced the three-field system, artificial manures were increasingly used, and mechanical traction in place of the former reliance on horses and oxen slowly made its way; the peasants in many cases combined to purchase more up-to-date agricultural implements; here, as elsewhere in Russia, the demand for such implements exceeded the supply. In good years a surplus of grain for export is produced, but in drought years there is insufficient grain for the needs of the population.

Stock raising is important, especially sheep and pig breeding. Meat, leather and wool are exported. Communal farms and artels increased and paid special attention to improving the breeds of animals. The most important communal agricultural enterprise is the sugar trust which farms 1,235,000 ac.

The manufactures depending on agricultural products in pre-World War I times occupied a smaller share than metal manufactures, but by the 1920s they surpassed them; the depression of the metal trades and the more rapid return to normal conditions of food products, leather goods and textiles was a common feature in most of the countries affected by the 1914–18 war. This was partly due to the more complex nature of the laws of demand and supply in metal industries and partly to the greater initial capital needed for construction and repair of plant. Flour milling is everywhere important, especially near the Black sea ports and macaroni production has increased. Sugar after refining diminished markedly during the disturbed conditions of 1917–22, the peasants giving up sowing of sugar beet in their need for food grains. In 1925 and later years, however, a revival set in. Oil-pressing, brewing, distilling and tobacco manufactures are important A marked post-revolution feature was the development of leather preparation and the manufacture of leather goods and textiles, previously peasant industries, on factory lines. Smaller agricultural occupations are vine growing, fruit cultivation and beekeeping. Apples, pears and cherries are produced in the north and apricots, almonds and peaches in the south. A recent development is the cultivation of *kenaph*, which is replacing jute in the manufacture of sacking

Minerals.—Of the mineral wealth, rock salt from Artemovsk (Bakhmut) and salt from the *limans* of the Kherson region have long been exploited, salt from the latter district being an article of trade in the earliest days of Kiev. Before the railways were built, the *Chumak*, or drivers of oxcarts, in which dried fish and salt were carried from the Black sea to all parts of the Ukraine, and exchanged for grain, were a noted organization Ox-cart transport is still the only available method in rural districts remote from the railway, the roads being too poor for motor transport. In 1928 a society for road improvement was formed and a "road week" on U.S. lines was planned to encourage local councils to provide roads suitable for motor transport.

The coal of the Donetz region began to be exploited in the latter part of the 19th century; it includes good anthracite beds. The production of coal in 1938 amounted to 88,991,986 short tons—about 60% of the entire coal production of the U.S.S.R. The important Krivoi Rog iron region was first developed about 1880 but of the Krivoi Rog ore there were produced in 1938 17,713,961 short tons of metal, 59% of the entire U.S.S.R. production. Manganese production from the Oligocene strata of the Nikopol region reached (in 1937) 1,054,902 short tons. Phosphorite beds are worked in the west, and graphite north of Dniepropetrovsk The mercury and copper of the Donetz are little worked. Good pottery clays are found everywhere, fireproof clays in the Donetz, slate near Dniepropetrovsk, lithographic stone in Podolla and mineral paints in the Donetz, Krivoi Rog and Kherson districts. Building stone, lime, chalk and gypsum (yielding alabaster) are

also found.

Among industries depending on mineral wealth, smelting occupies the first place. Engine construction, the manufacture of machinery and agricultural implements, steamer building, cycle, motor and aeroplane construction developed in the republic.

Electrification proceeded rapidly. The Shterov station in the Donetz region, working on anthracite dust, was opened in 1925–26 and has a capacity of 20,000 kw., that at Artemovsk (1928) 22,000 kw., and others have been opened. The great dam across the Dnieper, the Dnieprostroy, completed in 1932 with immense hydroelectric installations, was destroyed by the Russians in Aug 1941 when the German army occupied this part of the Ukraine. Cement, aluminum and ferromanganese factories were constructed near the falls to work on electricity The export trade of the Ukraine is mainly grain and flour, as in pre-World War I times, and it still fluctuates in dependence on meteorological conditions, though the famine of 1921 led to much more careful selection of drought-resisting plants.

Transport.—The network of railways is well developed in the Donetz region, and there are several east-west and north-south lines; several new lines have been opened and others are under construction. Air transport developed, the first route being opened in 1925 Regular air services link Moscow, Kharkov and Odessa, with stops at Poltava and Kiev if desired and from Odessa, a regular service goes to Batum. The total length of railway in 1931 was 8,406 mi and the navigable rivers 1,739 mi. The Black sea ports form a trading outlet for the Ukraine. Odessa (*q.v.*) is the most important, others are Nikolayev, Kherson, Mariupol and Berdiansk (*qq.v.*). There are regular services to the Mediterranean and Vladivostok and there is much coastal trade.

Population.—The Ukraine includes within its borders about 20% of the total population of the U.S.S.R., and is one of the most densely peopled regions in Russia, averaging 144.2 inhabitants per sq.mi , more than 60% of whom are occupied in agriculture The village settlements are large and, as a rule, are situated on the high and often precipitous banks of streams so as to be safe from the spring floods, and they form almost continuous belts along the higher right bank of the rivers. The watersheds are less settled.

In respect of the percentage of people living in towns, the Ukraine occupies third place in the republics of the U.S.S.R , the Transcaucasian federation coming first and White Russia second. The town population is, however, increasing rapidly, the Ukraine being in a transition stage toward industrialization. The six largest towns are Kiev (846,293), Kharkov (833,432), Odessa (604,223), Dnepropetrovsk (500,662), Stalino (462,395) and Nikolayev (167,108) (*qq v.*) Kiev is the real heart of the Ukraine, "the mother of cities" to the Ukrainians, foremost still in population and in its ancient culture dating back to the foundations of the Slav dominion in Russia. The site has been occupied since the dawn of history, and Aurignacian remains have been discovered Of the whole population, about 80% are Ukrainians (Little Russians), 9% Russians and 5% Jews, other nationalities represented being Poles, Germans, Moldavians, Greeks, Bulgarians and White Russians. The percentage of Russians in the towns rises to 25%, but is small among the agricultural population.

The Ukrainians are broad-headed, tall, long-limbed and broad-shouldered As a rule they are dark-haired and dark-eyed, and have broad faces, bright complexions and straight noses, though here, as elsewhere there has been racial intermixture and light and medium colouring often occurs. Their language began to be differentiated from Great Russian even in the 11th century, and the wedge thrust between the two peoples by the Tatar domination and the subsequent subjection of the Ukraine to Lithuanian and Polish rule emphasized the divergence.

The use of Great Russian in schools and in printed works was a contributory cause of the illiteracy of the Ukrainian peasant. Ukrainian is the official language of the republic and a keen appreciation of the linguistic freedom resulted in marked development of education, the Ukraine taking a high place in the U.S.S.R. in the provision for education, though here, as everywhere in Russia, many children still receive no education. Kiev, Kharkov and Odessa have scientific and educational institutes and the museums and art galleries of Kiev are famous

UKRAINIAN LITERATURE. The Ukrainians are the descendants of the South Russians of the Kiev period, and have consequent claims to regard the Russian literature of the 11–13th century as Ukrainian. But as the literary tradition was preserved only in Muscovy, the period is treated under RUSSIAN LANGUAGE AND LITERATURE. There is a gap between the last South Russian chronicles of the 13th century and the Ukrainian revival of the 16th, the language of the latter being as different from that of the former as early Middle English is from late Anglo-Saxon

The Ukrainian literature of the 16–17th century is entirely dominated by the national and religious struggle against Rome and Poland. In its early stages it had its centre in Galicia and Volynia, and produced a polemist of genius in Ivan Vyshensky (*fl.* 1586–1620). Later it became centred in Kiev, and under the influence of Peter Mohila, metropolitan of Kiev (1596–1647), borrowed Latin methods to fight the Latins. The writers of the period were polemists, rhetoricians and grammarians; they also wrote verse and plays after Latin school models. Some of the early 18th-century interludes in the latter are of interest. In the later 17th and 18th centuries Ukraine was drained of its best intellectual forces, which were attracted to Muscovy, where the church from 1700 to 1760 was dominated by Ukrainian prelates. After 1750 the Ukrainian gentry began to be rapidly Russianized, many of them attaining to eminence in Russian letters (*e.g.*, Gogol, *q.v.*). Of those that remained Ukrainian the most remarkable was the wandering philosopher and "Christian epicure," Gregory Skovoroda (1722–94). The language used during this period was a mixture of Ukrainian, Church-Slavonic, Polish, and in the later 18th century, Great-Russian elements.

Ukrainian folklore is very rich and original. The best-known type of songs are the so-called *dumy* (collections by Antonovich and Drahomanov, 1874–75; Catherine Hrushevska, part i, 1927) They have an historical background (the Cossack wars of the 17th century), but they are elegiac rather than narrative. There is also a great variety and wealth of the lyrical folksongs. They have had a strong influence on modern Ukrainian literature. The first publications of folksongs by Prince Tsertelev (1819) and Maksimovich (1827) were important landmarks in the first stages of the modern Ukrainian revival.

Modern Ukrainian literature dates from Ivan Kotlyarevsky (1769–1838). His *Travesty of the Aeneid* (1798) and his comedy *Natalka of Poltava* (1816) are closely related to the Russian literary tradition, but the use of the vernacular was a new departure. The successors of Kotlyarevsky did not rise above the level of a provincial *Heimatkunst*. A new spirit was introduced by Taras Shevchenko (1814–61). He was born a peasant and a serf, a fact that emphasizes the essentially democratic and rural character of modern Ukrainian literature. A romantic nationalist in his early, a revolutionary internationalist in his later work, Shevchenko had deep roots in Ukrainian folklore He has become the symbol of Ukrainian nationality. His younger contemporary Marko-Vovchok (pseudonym of Marie Markovich, *née* Velinsky, 1834–1907), a Great Russian by birth, wrote stories of peasant life which have made her a standard of good Ukrainian prose

The persecution of the Ukrainian movement in Russian Ukraine, culminating in the practically prohibitive decree of 1876, favoured its growth in Galicia, where such scholars as Michael Hrushevsky (1866–1934), an *émigré* from Russia and Ivan Franko (1856–1916) made of Lwow the centre of Ukrainian culture. Franko was also the most remarkable Galician novelist of the period. In Russian Ukraine the most outstanding writers were the poetess Lesya Ukrainka (pseudonym of Larissa Kvitka, *née* Kossach, 1872–1913) and the novelist Michael Kotsyubinsky (1864–1913).

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Littérature Ukrainienne (1921). (D. S. M.)

UKULELE. A small guitar (*q.v.*) used by the natives of the Hawaiian Islands and adopted as a jazz and solo instrument in England and the United States.

ULAN (*Uhlan*), originally a Polish lancer. The Ulans were cavalry and wore the national dress and czapka (or lancer cap). They were first introduced into the Prussian army in 1740, but failed to distinguish themselves in the first Silesian War, and it was only after the Treaty of Tilsit (1807) that Ulan regiments were again formed in the Prussian army. In the German army the old Ulan regiments have been represented in most cavalry regiments by at least two squadrons. In the Austrian army a "Uhlanpulk" of Poles was formed in 1784 and ordinary Uhlan regiments of Austrian cavalry in 1791. In the Polish army there are a number of Uhlan regiments.

ULAN BATOR ("red knight"), previous to 1921 called Urga (from Orgo-palace), capital of Outer Mongolia, on an affluent of the Tola river. It was the holy city of the Mongols and the residence of the "living Buddha," metropolitan of the Kalka tribes, who ranked third in degree of veneration among the dignitaries of the Lamaist Church.

In 1920, White Russians under the "mad baron" Ungern-Sternberg occupied Urga. After defeating them, 1929, Soviet Russia remained in control of Urga and Outer Mongolia, although Chinese suzerainty has been recognized. Urga, as seat of the government of the Russian-sponsored People's Revolutionary party, was renamed Ulan Bator. When in 1924 the living Buddha died, reincarnation was not permitted, and the palace became a museum. Formerly 13,000 of the city's 85,000 people were lamas; in 1939 theoretically no lamas remained. The two representative bodies, the great and small khuruldan, meet in Ulan Bator. In 1932 a magnificent theatre was opened, with revolving stage and several thousand seats. Ulan Bator has also a radio station, several papers and magazines, high schools, a university, veterinary college, medical school and a military school with Russian advisers.

ULAN UDE (formerly Verkhne-Udinsk), a town of Asiatic Russia, the capital of the Buriat-Mongol A.S.S.R. It is on the Uda river, at its confluence with the Selenga, and has steamer communication with Lake Baikal, and southwards with Mongolia. It is also on the Siberian railway, and grew markedly after the railway was constructed in 1905. The climate is extreme, average July temperature 66.2°, Jan. −17.3° F. The water supply to the railway in winter is a difficulty, since the ground is frozen and water pipes cannot be buried below frost level. Pop. (1939) 129,417. The town was on the 18th-century military Siberian road and was formerly a great centre for the tea trade from Mongolia via Kiakhta. (*See* TROITSKOSAVSK.)

ULCER. An ulcer is a lesion of the skin or any mucous membrane characterized by a loss of the surface epithelium and more or less of the underlying connective tissue. The term is also applied to lesions of the aorta and the valves of the heart in which there is a loss of the lining endothelium. An ulcer has a depressed floor or crater surrounded by sharply defined edges which are sometimes elevated above the level of the adjoining surface. The floor of an ulcer is formed by granulation tissue which is usually infected from bacterial contamination. Since many ulcers are cancers it is most important to the patient to know whether the ulcer is benign or malignant (cancerous). Benign ulcers are usually caused by infections or by nutritional disturbances. The ulcers on the legs of persons with varicose veins are caused by the slow circulation of the blood in the skin. Any infection under the skin such as a boil, a carbuncle or a tuberculous lesion may break through the surface and form an inflammatory ulcer. The significance of an ulcer is best explained by a separate consideration of the different regions of the body in which ulcers develop. When an ulcer of the skin has been present for a month or longer the possibility of cancer must always be considered. If the edges of the ulcer are hard and the patient is past middle life, the probability of cancer is still greater. Ulcers on the vermilion border of the lower lip in elderly men are nearly always cancers. Women rarely develop cancer of the lower lip. Such cancers must be recognized and treated early before they spread and become inoperable The superficial ulcers on the lips, the ordinary "cold sores," are caused by a virus and are of no serious significance

Ulcers in the mouth and throat are frequently caused by infection but are more often cancerous, especially in older individuals. The malignant ulcers usually have hard edges. In diphtheria there is often extensive ulceration of the throat. Ulcers in the oesophagus are nearly always cancers.

Peptic ulcer refers to an ulcer in the part of the intestinal tract bathed by the gastric julce; *i e*, the stomach and the first segment of the duodenum. *Ulcers do not occur* in the duodenum below the ampulla where the alkaline bile and pancreatic secretion enter and neutralize the gastric acid.

Peptic ulcer is a common disease of unknown cause Ulcers in the duodenum are four or five times as frequent as ulcers in the stomach. The patient has pain or distress of some kind in the epigastric region which is related to the time of eating and the kind of food taken Peptic ulcers may bleed into the intestinal tract causing the appearance of tarry stools and the development of anaemia. A large haemorrhage may be fatal. The ulcer may perforate, admitting the intestinal contents into the peritoneal cavity, causing peritonitis. Ulcers in the stomach are frequently cancers but those in the duodenum are rarely malignant. Peptic ulcers in younger persons may usually be controlled or cured by dietary management, but in older individuals peptic ulcers are less responsive to medical management and may require surgical intervention At mid-20th century a majority of surgeons favoured a total or subtotal gastrectomy for intractable peptic ulcer. This operation removes the greater part of or all the gastric mucous membrane which secretes acid Acid plays an important role in the causation of peptic ulcer.

Ulcers in the small intestine occur chiefly in the terminal portion not far from its entrance into the large bowel The most frequent causes of ulcers in the terminal ileum are typhoid fever and tuberculosis In the large bowel single large ulcers are usually cancers. Cancerous ulcers are most frequent in the rectum but may develop in any part of the colon. They cause pain, constipation and blood in the faeces. They are highly malignant cancers and can be successfully removed only when recognized in an early stage Ulcerative colitis refers to a disease in which hundreds of small ulcers develop in the mucous membrane of the large intestine. Some cases are caused by amoebic dysentery and some by bacillary dysentery but in the majority of cases no cause can be established. The cases of unknown causation are the most difficult to treat and it is sometimes necessary to remove the entire large intestine

Ulcers developing in the urinary bladder may be inflammatory or cancerous in nature. Cancers of the bladder are highly malignant and few cures are effected.

Ulceration of the valves of the heart occurs in bacterial endocarditis Bacteria, usually streptococci, lodge in the valve leaflets and produce an inflammation which destroys the surface of the valves and makes an ulcer. This disease was almost invarnably fatal before the introduction of penicillin, but many cases of bacterial endocarditis have been cured by penicillin.

(E T. Be.)

ULEABORG: *see* OULU.

ULEMA, the learned of Islām, theologians, canon-lawyers, professors, judges, muftis, etc., all who, whether in office or not, are versed theoretically and practically in Moslem science in general. (Arab. *'ulamā*, sing. *'ālim*, literally, "knowers," in the sense of *scientes*.) By "science" in this case is especially meant what is learned from tradition, books or men, and through the intellect. In a narrower sense, Ulema is used, in a Moslem state, of a council of such learned men, holding government appointments. If all conception of intermediary priesthood be eliminated, the Ulema may be said to be equivalent to the secular clergy of Roman Christendom (*see* DERVISH). Opposed to them, again, are the *'ārifs* ("knowers," "perceivers," *sentientes*, as opposed to *scientes*), to whom religious knowledge comes in the vision of the mystic, not by tradition or reason (*see* SŪFĪISM).

ULFILAS (*c.* 311–383), the apostle of Christianity to the Gothic race, and, through his translation of the Scriptures into Gothic, the father of Teutonic literature, was born among the Goths at the trans-Danubian provinces about the year 311.

The Arian historian Philostorgius (*Hist. eccl.* ii, 5) says that his grandparents were Christian captives from Sadagolthina in Cappadocia, who had been carried off to the lands beyond the Danube in the Gothic raid of 264, and became so naturalized that the boy received a Gothic name, *Wulfila* (Little Wolf). An authoritative record of the outlines of his life was only discovered early in the 19th century in a writing of Auxentius of Milan, his pupil and companion. At an early age Ulfilas was sent, either as an envoy or as a hostage for his tribe, to Constantinople, probably on the occasion of the treaty arranged in 332. Ulfilas may therefore have been a convert to Christianity when he reached Constantinople,

But here probably he came into contact with the Arian doctrines which gave the form to his later teaching. For some time before 341 he worked as a lector (reader of the Scriptures). From this work he was called to return as missionary bishop to his own country, being ordained by Eusebius of Nicomedia and "the bishops who were with him," probably at Antioch, in 341.

He was now 30 years of age, and his work as "bishop among the Goths" covered the remaining 40 years of his life. For seven of these years he wrought among the Visigoths beyond the Danube, till the success which attended his labours drew down the persecution of the still pagan chief of the tribe To save his flock from extinction or dispersion, Ulfilas decided to withdraw both himself and his people With the consent of the emperor Constantius he led them across the Danube, "a great body of the faithful," and settled in Moesia at the foot of the range of Haemus and near the site of the modern Trnovo (349).

The life of Ulfilas during the following 33 years is marked by only one recorded incident (Sozomen iv, 24), his visit to Constantinople in January 360, to attend the council convened by the Arian or Homoean party. The part played by Ulfilas in these troublous times cannot be ascertained with certainty. It may have been he who, as a "presbyter christiani ritus," conducted negotiations with Valens before the battle of Adrianople (378); but that he headed a previous embassy asking for leave for the Visigoths to settle on Roman soil, and that he then, for political motives, professed himself a convert to the Arian creed, favoured by the emperor, and drew with him the whole body of his countrymen—these and other similar stories of the orthodox church historians appear to be without foundation. The death of Valens, followed by the succession and the early conversion to Catholicism of Theodosius, dealt a fatal blow to the Arian party within the empire. In 383 he was sent to Constantinople by the emperor. A split seems to have taken place among the Arians at Constantinople. Ulfilas was summoned to meet the innovators, and to induce them to surrender the opinion which caused the dispute. No sooner had he reached Constantinople than he fell sick, "having pondered much about the council," and before he had put his hand to the task which had brought him he died, probably in January 383.

The Arianism of Ulfilas was a fact of pregnant consequence for his people, and indirectly for the empire. It had been his lifelong faith, as we learn from the opening words of his own confession—"Ego Ulfilas semper sic credidi." If, as seems probable from the circumstances of his ordination, he was a semi-Arian and a follower of Eusebius in 341, at a later period of his life he departed from this position, and vigorously opposed the teaching of his former leader. He appears to have joined the Homoean party, which took shape and acquired influence before the council of Constantinople in 360, where he adhered with the rest of the council to the creed of Ariminum, with the addendum that in future the terms ὑπόστασις and *obvla* should be excluded from Christological definitions. Thus we learn from Auxentius that he condemned Homoousians and Homoiousians alike, adopting for himself the Homoean formula, "filium similem esse patri suo."

His version of the Scriptures is his greatest monument. By it he raised a barbarian tongue to the dignity of a literary language; and the skill, knowledge and adaptive ability it displays make it the crowning testimony of his powers as well as of his devotion to his work. For the linguistic value of the Gothic version of the Scriptures by Ulfilas *see* GOTHS: *Gothic Language*. It is preserved, though only in a fragmentary form, in the famous *Codex Argenteus* at Uppsala This ms., discovered at the monastery of Werden, near Cologne, was deposited at Prague, carried off by the Swedes in 1648 and presented to Queen Christina. From Stockholm it passed by some means into the hands of Isaac Vossius, and a transcript was made and published by Franciscus Junius in 1655. The ms. was bought by the count de la Gardie and presented to the university of Uppsala. Its uncial letters are formed in silver on a surface of purple vellum.

See Waitz, *Das Leben des Ulfilas* (1840); W. L. Krafft, *Kirchengeschichte der deutschen Völker* (Abth. i, 1854); H. Böhmer in Herzog-Hauck, *Realencyklopädie*, vol. xxi; W. Bessell, *Das Leben des Ulfilas* (1860). C. A. Scott, *Ulfilas, Apostle of the Goths* (1885); G H. Balg, ed., *The First Germanic Bible* (1891), H. M. Gwatkin, *Studies in Arianism*. (1900); Felix Dahn, *Die Könige der Germanen* (1861–1911). (C. A. Sc.; X.)

ULIANOVSK (formerly Simbirsk), a town in the Kuibyshev region, Russian S.F.S.R., founded in 1648, lying on a hill 560 ft. above the Volga at a point where the Svyaga closely approaches it, in 54° 23′ N., 48° 25′ E Pop (1939) 102,106. Its suburbs extend to the Svyaga and to the Volga Suburbs on the left bank of the Volga are cut off from communication during the spring and autumn, but are reached by boat in summer and sleigh in winter. The town has a brisk river trade and has sawmills, flour mills, breweries, distilleries and brickyards. It has railway communication across the Volga and with the west. The historian Karamzin was born here in 1766 and Lenin in 1870. Ulianovsk was the scene of much fighting during the civil war of 1917–1920.

The former province of Ulianovsk was divided among the Gorki, Penza and Kuibyshev regions and the Tatar A.S.S.R. and Chuvash A.S.S.R.

ULM, a city of Germany, in the *Land* of Württemberg, situated on the left bank of the Danube, at the foot of the Swabian Alps, 58 mi S E of Stuttgart by rail and 63 mi N.W. of Munich. Pop. (1939) 75,503. Ulm is mentioned as early as 854; it became a town in 1027, and was soon the principal place in the duchy of Swabia. Although burned down by Henry the Lion, it soon recovered from this disaster and became a free imperial town in 1155. Its trade and commerce prospered and in the 15th century it attained the summit of its prosperity, ruling over a district about 300 sq.mi. in extent, and having a population of about 60,000. In 1803 it lost its freedom and passed to Bavaria, being ceded to Wurttemberg in 1809. In Oct. 1805 General Mack with 23,000 Austrians capitulated here to Napoleon. Ulm is remarkable in the history of German literature as the spot where the Meistersingers lingered longest, preserving without text and without notes the traditional lore of their craft.

Ulm still preserves the appearance of a free imperial town, and contains many mediaeval buildings of historic and of artistic interest. Among these are the town hall, of the 16th century, in the Transition style from late Gothic to Renaissance, restored in recent years; the Kornhaus; the Ehingerhaus or Neubronnerhaus, now containing the industrial museum; and the commandery of the Teutonic order, built in 1712–18 on the site of a habitation of the order dating from the 13th century, and now used as barracks. The magnificent early Gothic cathedral, begun in 1377, and carried on at intervals till the 16th century, was long left unfinished, but in 1844 the work of restoration and completion was begun, being completed in 1890. It has double aisles and a pentagonal apsidal choir, but no transepts. Its length (outside measurement) is 464 ft., its breadth 159 ft.; and the aisles are covered with rich net-vaulting. The tower in the centre of the west façade was completed in 1890, and is of the loftiest ecclesiastical erection in the world (528 ft.). The cathedral contains some fine stained glass, and a number of interesting old paintings and carvings. It belongs to the Protestant Church.

The Danube, joined by the Iller just above the town and by the Blau just below, here becomes navigable, so that Ulm occupies the important commercial position of a terminal river-port. There is water communication with the Neckar, and so to the Rhine The market for leather and wool is important, and the manufactures include wire ropes, borax, paints, cheese, jute, leather, lace, perfumes and cement Brewing and weaving, iron- and brass-founding are carried on as well. As a fortress Ulm has been famous and it is a garrison town.

See E. Nübling, *Ulms Handel und Gewerbe im Mittelalter* (Ulm, 1892–1900); G Fischer, *Geschichte der Stadt Ulm* (Stuttgart, 1863); Pressel, *Ulmisches Urkundenbuch* (Stuttgart, 1873); and *Ulm und sein Munster* (Ulm, 1877); Schultes, *Chronik von Ulm* (Stuttgart, 1881 and 1886); Hassler, *Ulms Kunstgeschichte im Mittelalter* (Stuttgart, 1872); and *Das rote Buch der Stadt Ulm*, edited by C. Mollvo (1904)

ULMACEAE, a family of dicotyledonous trees, the best known and most important members of which are the elms (*q.v.*), forming the genus *Ulmus*. The family contains 13 genera and

about 130 species. *Celtis australis* is the nettle-tree, the fruit of which is edible. *C. occidentalis* is the hackberry (*q.v.*).

ULMANIS, KARL (1877–), Latvian statesman, first prime minister and organizer of the independent republic of Latvia. Born Sept. 4, 1877, in Zemgale (Courland). He was an agronomist. He also studied agriculture in Germany and the United States of America, and, before Latvia became an independent state, he gave many lectures in Latvia on agricultural questions. He was an active supporter of the movement to liberate the Latvian people from Russian and German domination. After the Allied victory of 1918, when Latvia was still occupied by German military forces, he organized all political parties in Latvia around the Democratic block, which later in the same year, united with other political organizations of Latvian refugees in Russia, became the Latvian national council. On behalf of this national council and in the name of the Latvian nation, the independence of Latvia was proclaimed on Nov. 18, 1918, and K. Ulmanis was appointed first prime minister of the interim Latvian government. Under his leadership the young state waged its fight for freedom against the Russian Bolsheviists and the combined German and Russian irregular forces, *i.e.*, the Bermondt army.

After the Latvian army's complete victory, K. Ulmanis led his country until the constituent assembly was elected and gave the country a constitution. Peace was concluded with Russia and Germany, and the young state concentrated all its force on the reconstruction and building up of the administration.

Ulmanis was prime minister from Nov. 18, 1918, to June 18, 1921, when a coalition government was formed by his party colleague, Z. Meierovics. He was again prime minister from Dec. 24, 1925, to May 5, 1926; from March 1931 to Dec 1932, and in May 1934 he assumed the office once more, dissolved the Saeima (parliament) and became dictator. On April 11, 1936, he was also named president. He remained head of the state until it was absorbed into the U.S.S.R in July and Aug. 1940. During the upheavals that attended this union Ulmanis's death was reported, but he was later reported living in the U.S.S.R.

ULPIAN (DOMITIUS ULPIANUS), Roman jurist, was of Tyrian ancestry. His literary activity lay between 211 and 222. He made his first appearance in public life as assessor in the *audutorium* of Papinian and member of the council of Septimius Severus; under Caracalla he was master of the requests (*magister libellorum*). Heliogabalus banished him from Rome, but on the accession of Alexander (222) he was reinstated, and finally became the emperor's chief adviser and *praefectus praetorio*. His curtailment of the privileges granted to the praetorian guard by Heliogabalus provoked their enmity, and he narrowly escaped their vengeance; ultimately, in 228, he was murdered in the palace, in the course of a riot between the soldiers and the mob.

His works include *Ad Sabinum*, a commentary on the *ius civile*, in over 50 books; *Ad edictum*, a commentary on the Edict, in 83 books; collections of opinions, responses and disputations; books of rules and institutions; treatises on the functions of the different magistrates—one of them, the *De officio proconsulis libri x.*, being a comprehensive exposition of the criminal law; monographs on various statutes, on testamentary trusts, and a variety of other works. His writings altogether have supplied to Justinian's *Digest* about a third of its contents, and his commentary on the Edict alone about a fifth. As an author he is characterized by doctrinal exposition of a high order, judiciousness of criticism, and lucidity of arrangement, style and language.

Domitii Ulpiani fragmenta, consisting of 29 titles, were first edited by Tilius (Paris, 1549). Other editions are by Hugo (Berlin, 1834), Böcking (Bonn, 1836), containing fragments of the first book of the *Institutiones* discovered by Endlicher at Vienna in 1835, and in Girard's *Textes de droit romain* (Paris, 1890).

ULRIKE, queen of Sweden, born in Berlin, the daughter of King Frederick William I of Prussia and Sophie Dorothea of Hannover, was educated like her brothers and sisters by the same French governesses and tutors. She was her father's favourite, and he made her coadjutor of Quedlinburg in 1738. Her marriage to Adolf Friedrich, Crown Prince of Sweden, was arranged through Empress Elizabeth of Russia. Frederick II would have preferred to have his youngest sister, Amalie, the future Queen of Sweden. In 1746 her son was born. Ulrike was the leader of the "court-party" after a break with her former trusted friend, Count Tessin, in 1750. Frederick II constantly urged her to be more cautious, more moderate. He refused a loan to her, which she needed for political bribes. She was involved in the abortive "coup d'état" of 1756, and unable to prevent the war with Prussia. But the disastrous course of the war strengthened her position and she was instrumental in arranging peace feelers in 1762. Following her husband's death, early in 1771, she visited in Berlin until 1772, and there Frederick II tried to help her in her increasing difficulties with her son, now King Gustaf III, whom she wanted to advise but whose response was not cordial.

Resembling her brother Frederick II in many respects, she encouraged arts and science, befriended Linnaeus (*q.v.*) and invited Voltaire to settle in Sweden. In 1753 she founded the Royal Academy for Art and Science but did not admit to its fold the most educated Swede of his time, Count Tessin, her former friend, now her political enemy.

Ulrike's letters to her family and well written memoirs have much in common with those of her sister Wilhelmine, but, though partial, are far more reliable. She was a promoter of French cultural influence in Sweden, and in her political aims to abolish the existing constitution and the venal feudal rule, both a follower of her father and a predecessor of her son, though lacking their determination and concentrated will power. Her last years were darkened by the antagonism to her son.

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ULSTER, EARLS OF. The earldom of Ulster was the first title of honour in Ireland of English creation, and for more than a century was the only one. It dates from a grant to de Lacy in 1205.

Hugh de Lacy, 1st Earl of Ulster (d. 1242?), was descended from Walter de Lacy (d. 1085), who fought for William the conqueror at Hastings. The first earl was the brother of Walter de Lacy (d. 1241), who succeeded his father as lord of Meath in 1186. In 1203 Hugh de Lacy drove John de Courci out of Down, and was rewarded by grants of land, and in 1205 by the earldom of Ulster. He was then invested with quasi-viceregal authority, but in 1207 war broke out between the earl and the king's justiciar. King John came to Ireland, and banished the earl to Scotland. He returned to Ireland in 1226, and died at Carrickfergus. On his death the earldom reverted to the crown.

Second Creation.—Prince Edward (afterwards Edward I), transferred "the county of Ulster" (*c.*1255), to Walter de Burgh, lord of Connaught. The earldom remained in the family of de Burgh until the death of William, 3rd earl of this line, in 1333, when it passed to his daughter Elizabeth, who married Lionel, afterward duke of Clarence, son of Edward III. Lionel was succeeded in the earldom of Ulster by his daughter Philippa, who married Edmund Mortimer, earl of March. The third Mortimer, earl of Ulster, died unmarried in 1425, when his titles were inherited by Richard Plantagenet, duke of York, whose son Edward ascended the throne as Edward IV in 1461.

Since that date the earldom of Ulster, which then merged in the crown, has only been held by members of the royal family. In 1928 it was bestowed upon H.R.H. the Duke of Gloucester.

See, for the de Lacy and de Burgh earls of Ulster, *The Chronicle of Florence of Worcester*, edited by T. Forester (1854); *Annals of Ireland by the Four Masters*, edited by J. O'Donovan (7 vols, Dublin, 1851); *The Annals of Loch Cé*, edited by W. M. Hennessy, "Rolls Series" (2 vols, 1871), *Calendar of Documents Relating to Ireland*, edited by H. S. Sweetman (5 vols., 1875–86); W. W. Shirley, *Royal and Historical Letters of the Reign of Henry III*, "Rolls Series" (2 vols., 1862–66); Sir J. T. Gilbert, *History of the Viceroys of Ireland* (Dublin, 1865). For the later history of the earldom *see* G. E. C., *Complete Peerage*, vol. viii (1898).

ULSTER, a province of Ireland occupying the northern part of the island. By the Government of Ireland act, 1920, six of the province's nine counties of Donegal, Londonderry, Antrim, Fermanagh, Tyrone, Cavan, Monaghan, Armagh and Down (*qq.v.*) became grouped under the separate government of Northern Ireland (*see* IRELAND, NORTHERN) which was established. the new area being frequently styled the "Six Counties." Ulster

(*Uladh*) was one of the early provincial kingdoms of Ireland but by A.D. 400 became divided into three states, Oriel (Oirghialla) in the south, Ulidia in Antrim and Down, and Aileach or Tir Eoghan in the north. The O'Neills of Tir Eoghan became dominant over all Ulster, but after the Norman invasion Ulidia fell to John de Courcy, while Oriel was partitioned. In the 15th century English rule practically disappeared from Ulster which, under the O'Neills and O'Donnells became the most Gaelic province of Ireland and found two great champions of native independence in Shane and Hugh O'Neill, Earl of Tyrone, whose grandfather Conn had accepted this English title in 1543. With the suppression of Tyrone (1603) the province was subjected to the crown, and the Flight of the Earls (1607) gave the opportunity for the plantation of Ulster by English and Scottish settlers (*see* PLANTATION).

ULTIMATUM is a technical diplomatic term, derived from the Latin word for "last." It signifies a formal, categorical declaration, addressed by one state to another, to the effect that if certain demands are not met, serious consequences will ensue. These consequences may range from the rupture of the particular negotiations, economic measures, breaking-off of diplomatic relations or threat of force, to the actual application of force in the form of war.

An ultimatum is called simple if it does not indicate the measures to be taken by the government sending it. It is called qualified if it indicates the nature of the measures to be taken Article i of convention iii, adopted by the second Hague conference (1907), regulates in detail the formalities to be observed with regard to an "ultimatum with a conditional declaration of war." The practical importance of these provisions was greatly diminished by the provisions of the covenant of the League of Nations and of the charter of the United Nations, limiting the right of the member states to use war as an instrument of national policies. It was also diminished by the disregard with which many states treated these provisions.

Diplomatic history abounds with examples of ultimatums. Thus on Aug. 4, 1914, the British ambassador, Sir Edward Goschen, submitted to the German foreign minister, Gottlieb von Jagow, a written statement that, unless Germany would give assurances by midnight that it would proceed no further with the violation of Belgian neutrality, the British government felt bound "to take all steps in their power to uphold the neutrality of Belgium." Again, on Sept. 3, 1939, at 9 A.M., the British ambassador, Sir Neville Henderson, informed the German government that, unless the German government would give assurances to the British government by 11 A.M. of the same day concerning the suspension of all aggressive action against Poland, a state of war would exist between the two countries as of that hour.

(H. J. MU.)

ULTIMOGENITURE, the custom by which the youngest son inherits the homestead, is known in English law as Borough English. In England it obtained in parts from Gloucester to Cambridgeshire. Under the name of Mainète and Jungerrecht it was known in northern France and northern Germany. In Assam it is found among the matrilineal Garos who possess the dual organization and speak a Tibeto-Chinese language, among the matrilineal Khasias who speak an Austric language, among patrilineal Lusheis, Meithels, Nagas and Kachins, speakers of Tibeto-Chinese languages. Cases are known in Africa.

This custom has been regarded as derived from the *jus primae noctis*, the youngest son being of undoubted paternity. This view has been successfully traversed by Blackstone, Westermarck and Frazer. It has been ascribed among settled peoples, such as Nagas and Meithels, to the custom of making provision for the elder sons as they marry and set up house independently. The rule requiring elders to marry before juniors is found among communities which do not now practise ultimogeniture. Among people like the Lusheis, who practise shifting cultivation, it is due to the custom by which the sons of chiefs, on marrying, swarmed off to found new villages The view that it is connected with domestic worship is supported by the Khasi evidence, where the youngest daughter "inherits the religion"—in organic association with the homestead. With the Garos it is inseparably connected with the general system of marriage.

See Blackstone's *Commentaries on the Laws of England*, vol. ii; O. Elton, *Origins of English History*, 1st ed. (1888); E. Westermarck, *History of Human Marriage*, 5th ed.; Sir J. Frazer, *Folklore in the Old Testament* (1918).

ULTRACENTRIFUGE: *see* CENTRIFUGE.

ULTRAMARINE is the colour principle of the gem lapis lazuli (*q.v.*) which, besides its use as an ornament, formed the blue pigment used by painters in the middle ages. Ore containing the colour was ground and the powdered lapis lazuli separated from the other mineral matter by an oil pasting process. The blue pigment so obtained is said to have been literally worth its weight in gold. The fact that the product was imported into Europe gave it its name—ultramarine, "beyond the sea."

The value of the material caused great efforts to produce it artificially and these succeeded in the late 18th of the 19th century. It appeared on the market almost simultaneously in France and Germany. To be sure, the ultramarine of those early days was a weak, poor product from the present point of view, but it was the start of a development leading to the pigment of today.

The present process of manufacture is this: more or less equal amounts of china clay, sulphur and soda ash (sodium carbonate) are taken, together with considerably smaller amounts of silica and rosin or pitch. Variations in the proportions of the ingredients are used to cause variations in the shade of the product from a greenish to a reddish blue. The mixture is very finely ground and loaded into crucibles with porous walls. More than 1,000 of these are stacked in a single furnace, which is then slowly fired up to a top temperature of about 750° F. and complicated reactions occur among the ingredients of the mix. When the top temperature has been reached, the fire is drawn, the furnace sealed and allowed to cool over a period of about two weeks. During this cooling period the atmosphere of the furnace exerts an oxidizing action upon the crucible contents, of much importance to the character of the product. The crude ultramarine is removed from the crucibles, is washed free from salts, very finely ground and separated by successive sedimentations from water suspension into a series of particle sizes. The varying characteristics required for different uses of ultramarine are satisfied by selection of the desired shade and particle size. For some purposes, the product requires further special surface treatments.

The main fields of use of ultramarine are paints and lacquers, calcinine, linoleum, paper both in whitening and colouring, coloured roofing material, laundry blueing. It has a particularly brilliant blue colour, is very light-fast and is resistant to not too strong alkali, but not to acids. The structure of ultramarine was a matter of much controversy until F. M. Jaeger finally settled the matter in 1929 by the use of the X-ray. Ultramarine, or better, the ultramarines, consist of a framework or lattice of cubical form with truncated corners, built up of aluminum and silicon atoms joined to one another through oxygen atoms. The ratio of aluminum to silicon atoms can vary within limits, but their combined number is always 12. Commonly the silicon atoms outnumber the aluminum atoms. The connecting oxygen atoms number 24. Within the lattice and in the spaces formed by the truncated corners of adjacent lattices are atoms of sodium and sulphur not rigidly fixed as to number or position.

It will be clear from the above why there is a family of ultramarines and why variations in composition exist The usual percentage limits within which the components fall are the following:

Silicon	17.75	to 20.0%	by weight
Aluminum	12.3	to 15.5%	by weight
Sodium	12.8	to 15.3%	by weight
Sulphur	1.0	to 14.0%	by weight
Oxygen	Balance (except for small amounts of water and impurities)		

The shade and properties of the ultramarines will vary with changes in the proportions of the components. (A. P. B.)

ULTRAMICROCHEMISTRY. The term "ultramicrochemistry" refers to a set of chemical techniques by which chemical analyses and other chemical manipulations are performed on the most minute amounts of material. If a standard analytical method

requires about $\frac{1}{10}$ gram or sample, the micromethod for the analysis would require about $\frac{1}{100}$ gram and the ultramicromethod about $\frac{1}{1000}$ gram. It is less ambiguous, then, to term ordinary scale or macro-operations as "decigram methods," micromethods as "milligram methods" and ultramicromethods as "microgram methods" (1 microgram = 0 000,001 gram = about 0 000,000,035 oz) Microchemistry is then "milligram chemistry" (1 milligram = 0.001 gram) and ultramicrochemistry is "microgram chemistry" It is also termed "drop analysis" because a sample of blood or other solution being analysed is usually less than a drop.

Systematic ultramicrochemistry originated in the Carlsberg laboratory in Copenhagen about 1930. The techniques developed there were used chiefly to analyze traces of enzymes, or biological catalysts, in tiny slices of tissues of plants and animals. The techniques applied to this purpose became known as "enzyme histochemistry." They were widely employed by K Linderstrøm-Lang and his co-workers of the Carlsberg laboratory, as well as by many others, to the solution of fundamental biological problems.

A broader chemical approach was made by Paul L. Kirk and his co-workers at the University of California, starting about 1933. Instead of specific applications to limited types of biological problems, the aim of the California group was to make all kinds of chemical operations practical with microgram quantities, so that any chemical study could be made, regardless of the type of material studied Although the chief applications of these techniques were also expected to be biological in nature, the general applicability was demonstrated when they were used to develop the chemistry of plutonium, the man-made element used as an explosive in the atomic bomb Microgram manipulation was made necessary in this case by the fact that only microgram quantities of plutonium could be made by methods then available, and larger amounts could not be manufactured until extensive chemical information was available. Virtually the entire chemistry of plutonium was elucidated before there was as much as a milligram of the material in existence and the huge production plants were constructed with a scale-up of more than a billionfold—an all-time industrial record.

Up to about 1940, the strictly chemical techniques were largely confined to volumetric operations, *i.e.*, measurement of liquid volumes as a means of analysis. This was true of both the Copenhagen and California groups as well as for several other laboratories in which microgram chemistry was being studied or used. Included in these developments were methods for study of chemical changes through gasometric methods depending on measurement of gas volumes, respiration of single cells and of very small organisms or bits of tissue, enzyme catalysed reactions in droplets and various manipulative techniques. During World War II, further advances occurred in ultramicroweighing, submicrogram chemical analysis through colour measurement and chemical study of reacting systems containing only a few micrograms of material through improved manipulative techniques.

Liquid Volumetric Techniques.—Analytical methods depending on measurement of volumes of liquids were peculiarly adaptable to ultramicroanalysis and were the first techniques developed. Titrations were readily performed with burets made from fine capillary tubes, which delivered small volumes of reagent solutions with an accuracy of ±0 02 microlitres or better (1 microlitre = 0 000,001 litre; 1 litre = approx. 1 quart). Liquid samples were measured with the same accuracy by use of the same fine graduated tubing The blood of a grasshopper, or a droplet from a child's fingertip, could then be measured accurately and its constituents accurately determined by titrating this bit of blood with a capillary buret Operations other than titration usually needed to be done If so, techniques for precipitating down the corpuscles, removing the protein, ashing the blood, filtering it, stirring it or boiling it were developed and could be used without ever having a greater volume than about one drop of liquid. By such means, quantitative analysis for nitrogen, urea, sugar, amino acids, lactic acid, ammonia, chloride, sodium, potassium, calcium, phosphorus and other common constituents of blood could be performed. Adaptations of these procedures are applicable to the analysis of all types of materials other than blood. They can be valuable in the clinical laboratory by avoiding the difficulty of obtaining large amounts of blood from patients; *e.g.*, infants They are useful to the research worker who can study insects, some single cells, small plants and animals and their parts which by common methods could not be analysed at all. They can be used for the study of minute amounts of inorganic material such as the radioactive isotopes obtained by the nuclear physicist. The dangers of radioactivity are less with the small sample, and very often only the smallest samples can be obtained

Gasometric Ultramicromethods.—Methods depending on gas volume changes have been chiefly useful in measuring the respiration rate of cells, tissues and small organisms. Some of these devices have been made sensitive enough to measure the minute trace of oxygen used by single invisible protozoan cells; the most delicate direct instrument used in 1946 was that of B. B. Cunningham and Kirk. Several such instruments could determine the rate of oxygen consumption with slightly larger organisms or tissues One ingenious device which has been widely used both for respiration and enzyme studies is the Cartesian diver micromanometer which was first described by Linderstrøm-Lang.

Gas analysis also was highly developed as an ultramicrotechnique during World War II. Most significant were the methods of P. F. Scholander and his associates who succeeded in analysing as little as ten microlitres of gas mixtures for their constituent gases with approximately the same accuracy as is possible with large samples. These techniques were applied to various physiological studies.

Weighing.—Although very sensitive balances were developed early in the 20th century, little refinement or use had been made of them until 1942. P. L Kirk, Roderick Craig and J. Gullberg succeeded that year in combining earlier weighing principles and refining them in a quartz fibre balance which could carry a total load of about 100 milligrams and weigh a sample of 0 3 milligram with a sensitivity of about 0 005 microgram. A human breath weighs about 750,000 micrograms; a dime, 2,500,000. With little loss in load capacity, the sensitivity could be increased by about tenfold. This instrument for the first time made weighing a practical technique of ultramicroanalysis and opened the way for development of all types of investigation of ultrasmall samples which require weight determination.

Colorimetric Submicrogram Analysis.—Most significant of developments in ultramicrochemistry during World War II was the initiation of submicrogram analysis by means of the spectrophotometer. By using specially designed capillary absorption cells, the sensitivity of the colorimetric methods could be so increased as to allow the accurate analysis of amounts of many materials as low as one or a few millimicrograms (1 millimicrogram = 0 001 microgram = 0 000,000,001 gram). By 1946 little application had been made of this type of technique in practical research work, but the field of application is so broad in all phases of chemistry, biochemistry and biology that developments along this line were expected to outdo all past efforts toward chemical study of the microscopic world.

Miscellaneous Techniques.—The development of fine manipulative methods for separating and handling minute objects, such as the nuclei of cells, has progressed markedly to supplement the quantitative techniques which constitute the foundation of ultramicrochemistry. Improved microscopic methods using fluorescence from ultra-violet light and improved methods of staining certain constituents of cells and tissues for identification purposes have come into use.

For the first time in history, the ultramicrochemist possesses the tools with which he can carry chemical investigations into the cells, the very seat of life processes of plants and animals, and elucidate their nature. He can elaborate the complete chemistry of a new synthetic element before the amount of it on earth is the size of a small pin head He can facilitate or make possible all sorts of research investigations which were completely impossible without these extremely delicate techniques. Medicine, agriculture, radiochemistry and biology can now advance in their basic chemical knowledge just as they advanced as a result of the in-

vention of the microscope, except that now it is chemical vision which is magnified, and now can be seen not only what is present but how much and how it is composed.

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ULTRAMONTANISM, the name given to a certain school of opinion in the Roman Catholic Church (Lat. *ultra*, beyond, *montes*, the mountains). The expression *ultramontane* was originally no more than a term of locality, characterizing the persons so described as living—or derived from—"beyond the mountains"; but from the very beginning we find it used as a party appellation to describe those who looked "beyond the mountains" in order to obtain a lead from Rome, who represented the papal point of view and supported the papal policy. Thus, as early as the 11th century, the partisans of Gregory VII were styled ultramontanes, and from the 15th century onward the same name was given to the opponents of the Gallican movement in France.

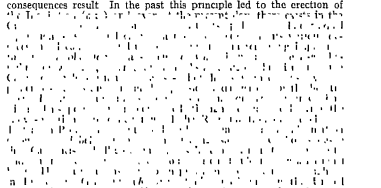
It was not until the 19th century that "ultramontane" and "ultramontanism" came into general use as broad designations covering the characteristics of particular personalities, measures and phenomena within the Roman Catholic church At the present time they are applied to a tendency representing a definite form of Catholicism within that church; and this tendency, in spite of the individual forms it has assumed in different countries, everywhere displays the same essential features and pursues the same ends It follows, from the very nature of ultramontanism, and from the important position to which it has attained, that the official organs of the church and all the people interested in the continuance of the actual state of affairs deny that it exists at all as an independent tendency. It is indisputably legitimate to speak of ultramontanism as a distinct policy, but it is very difficult to define its essential character

(i) The first and fundamental characteristic of ultramontanism is its carrying to a logical issue the concentration of all ecclesiastical power in the person of the Roman Pontiff. (*See* PAPACY.) To the *curial system*, so evolved, continually fortifying its position in the domains of theology, ecclesiastical law, and politics, the *episcopal system* stands in opposition. The system admits that the pope represents the unity of the church, and acknowledges his primacy, while at the same time it claims on behalf of the bishops that, in virtue of the divine ordinance, they possess an inalienable right to a share in the government of the church (*see* CHURCH HISTORY; FEBRONIANISM). The struggle between these two systems continued well into the 19th century, and, though episcopalism was not infrequently proscribed by the Curia, it still survived, and until the year 1870 could boast that no ecumenical council had ventured to condemn it This was done for the first time, in 1870, at the Vatican council (*q v*), whose decrees, recognizing the universal episcopate and the infallibility of the pope, marked the triumph of that doctrine by which they had been long anticipated. The Catholic church, in all countries, has become more and more dependent on the Curia · the bishops have lost their autonomous standing, and their position is little more than that of papal delegates, while all important questions are referred to Rome or settled by the nuncios.

(ii) A second peculiarity of ultramontanism is that it claims for the Catholic church the functions of a political power, and asserts that it is the duty of the secular state to carry out its instructions and wishes. Since the conditions of the age no longer allow the pope to depose a temporal sovereign, the practical application of this conception of the relationship between the spiritual and temporal powers has taken other forms, all of which, however, clearly show that the superiority of the church over the state is assumed. This may be seen in the attitude of ultramontanism toward secular law. It assumes that God has conferred on the individual and on society certain rights and competences as inalienable possessions. This "natural law" ranks above all secular law, and all state legislation is binding only in so far as it is in harmony with that law. As to the provisions of this natural law, and the consequences they entail in individual cases, these can be decided only by the church, *i.e*, in the last resort, by the pope. Thus, even at the present time, the opinion is very clearly expressed in ultramontane quarters that, in the event of the state issuing laws contravening those of nature or of the church, obedience must be refused. The attitude of ultramontanism, for instance, toward the right claimed and exercised by the state to make laws concerning marriage is wholly negative, it recognizes no marriage laws except those of the church, the church alone being regarded as competent to decide what impediments are a bar to marriage, and to exercise jurisdiction over such cases.

(iii) Since ultramontanism cannot hope to realize its political ambitions unless it succeeds in controlling the intellectual and religious life of Catholic Christendom, it naturally attempts to extend its sphere of influence in all directions over culture, science, education, literature and the forms taken by devotion The development of these efforts may be easily traced from decisions of the congregation of the index and the holy office in Rome. Ultramontanism, too, labours systematically to bring the whole organization of education under ecclesiastical supervision and guidance.

(iv) In the fourth place, ultramontanism is the embodiment of that intolerance toward other creeds which is the logical consequence of the authoritarian claims of the Catholic church The general presuppositon involved is that a man cannot be saved except within the Catholic church. Since, however, on the one hand—in virtue of a theory advanced by Pius IX against the emperor William I of Germany, in a letter which has since become famous—every Christian, whether he will or no, belongs to that church by baptism, and is consequently pledged to obey her, and, on the other hand, since the state lies under the obligation to place the "secular arm" at its disposal whenever one of its members wishes to secede, the most far-reaching consequences result In the past this principle led to the erection of



Ultramontanism fears that any infusion of a national element into ecclesiastical life would entail the eventual separation of the people in question from papal control, and would lead to developments fraught with danger to the supremacy of the papacy

A MUCH DISPUTED PROBLEM

The relationship of ultramontanism to Catholicism is a much-disputed problem The ultramontane maintains that there is no justification for distinguishing between the two; but, even within the pale of the Roman church, the identification provokes dissent, and is repudiated by all who are shocked by the effects on the life of the church of an overcentralized political Catholicism. It was on these grounds that in Jan. 1904, it was proposed in the chamber of the Bavarian Reichsrath that the clergy should be deprived of the suffrage. The years between the Treaty of Frankfurt (1871) and the outbreak of World War I witnessed a growing difficulty on the part of Catholic Germans to reconcile ultramontane doctrine with the political and industrial development of united Germany. This was the real background of what is known as the *Kulturkampf* (*see* GERMANY, *History*).

The collapse of Germany after World War I (1914–18) tended, on the whole, to stimulate ultramontanism (*e.g*, in Bavaria); but the republican elements which combined in 1919 to uphold the constitution of Weimar, proved strong enough to resist the more extreme manifestations of this tendency.

It may be admitted that for all the principal contentions of ultramontanism, analogies may be found in the past history of the Catholic church Thus, in the middle ages, we find extremely bold pronouncements with respect to the position of the papacy in the universal church; while political Catholicism had its beginnings in antiquity and found very definite expression, for instance, in the bull *Unam sanctam* of Boniface VIII. Again, the attempt to subordinate all intellectual life to ecclesiastical control was a feature of the mediaeval church, and the fundamental attitude of that church toward heresy was fixed during the same period But since then much has been altered both in the church and her secular environment. The state has become independent of the church, legislates on its own sole authority, and has recognized as failing within its own proper sphere the civilizing agencies and social questions formerly reserved for the church Again, education, science, art and literature have been secularized; the printing press carries knowledge into every house, the number of illiterates diminishes from year to year in every civilized country, and the clergy are no longer the exclusive propagators of culture, but merely one factor among a hundred others.

The origin of modern ultramontanism is preceded and conditioned

by the collapse of Catholicism in the period of the French Revolution Pius VI and Pius VII were expelled from Rome, deprived of the papal states, and banished to France In that country the church almost completely lost her possessions, in Germany they were at least considerably curtalled; in both the hierarchical organization was shattered, while the Catholic laity surveyed the catastrophe in complete passivity. But from this severe fall the church recovered with comparative readiness, and the upward movement is contemporaneous with the rise of ultramontanism. The birth of that system, however, cannot be fixed as a definite event by the day and the hour, nor was it created by any single personality Rather it was the product of the first post-revolutionary generation Neither is it merely fortuitous that the reaction proceeded from France itself For in no other country had hostility to religion attained such a pitch or assumed such grotesque forms, and consequently in no other country did the yearning for religion manifest itself so unequivocally, when experience had demonstrated the necessity of a return to law and order. And in the other states of Europe there existed, more or less, a similar desire for peace and an equal dread of a fresh outbreak of revolutionary violence. In contrast to the struggle for an ideal freedom, which was at first hailed with tempestuous delight only to reveal itself as a dangerous tyranny, men became conscious of the need for a firmly established authority in the reconstruction of society. At the same time, the repression of idealism and sentiment during the period of "illumination" was amply revenged, and the barren age of reason gave place to Romanticism. These tendencies in contemporary opinion favoured the renovation of the Catholic church.

The papacy signalized its reinstation by restoring the Society of Jesus (1814) and re-establishing the index. In Germany ultramontanism had to contend with great difficulties; for here ecclesiastical affairs were not in so desperate a case that the most drastic remedies possessed the most powerful attraction, while, in addition, the clergy were unwilling to renounce all scientific work. The result was that a series of struggles took place between the old Catholicism and the new ultramontanism But even here ultramontanism gained ground and derived inestimable assistance from the blunders of government after government. The growth of Jesuitical influence at Rome—more especially after the return of Pius IX from exile—implied a more definite protection of ultramontanism by the papacy. The proclamation of the dogma of the Immaculate Conception in 1854 was more than the decision of an old and vexed theological problem, it was an act of conformity with a pietistic type especially represented by the Jesuits. The Syllabus of 1864, however, carried with it a recognition of the ultramontane condemnation of some aspects of modern culture (*see* the articles PIUS IX and SYLLABUS). Finally, in the Vatican council, the Jesuits saw another of their favourite theories —that of papal infallibility—elevated to the status of a dogma of the church (*see* VATICAN COUNCIL and INFALLIBILITY).

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ULTRASONICS IN MEDICINE. The study of ultrasonic energy as a separate science began in the early 1920s, when high-frequency acoustic vibrations were first employed for underwater communication (this led to the development of Sonar, or sound navigation and ranging, during World War II). In the following decades, several thousand articles on various applications of ultrasonic energy were published, and many articles were written concerning the medical applications of ultrasonic energy.

Commonly these high-frequency sound waves or ultrasonic vibrations are produced by using a piezoelectric crystal. Certain crystals such as quartz will become electrically charged on opposite surfaces when they are subjected to mechanical pressure. This property is called the piezoelectric effect. The reverse effect also occurs, and the crystal will undergo mechanical vibration when opposite sides are subjected to an alternating electric field. It is comparatively easy to construct a piezoelectric transducer which converts electrical oscillations into mechanical vibrations which, in turn, produce sound waves. Such vibrations can be transmitted through a "sound head" to the surface of the body which is to be treated

The term ultrasonic (beyond sound) is self-defining. The acoustic spectrum is described as being divided into infrasonic, sonic and ultrasonic regions.

The terms ultrasonics and supersonics have been used interchangeably. Aeronautic engineers adopted the term supersonics to denote velocities greater than those of sound Medical investigators adopted the term ultrasonics to indicate frequencies higher than those audible to the human ear

Unlike electromagnetic waves, sound waves require a material medium for their propagation The mechanical forces accompanying pressure alternations and cavitations caused by ultrasonic energy play the major role in causing biologic effects. In addition to these mechanical effects are also thermal effects which are due largely to the absorption of the sound energy Ultrasonic energy also accelerates many chemical processes, particularly oxidative processes.

If one observes living cells under the microscope during ultrasonic irradiation, one may see such phenomena as whirling of the protoplasm, appendages being sheared off, filaments of spirogyra torn to pieces, laking of red blood corpuscles and paramecia rendered immobile and later torn open.

The mechanical and thermal effects of ultrasonic energy may cause either mechanical or thermal death of animals. The explosive violence with which cavitations occur may bring about the dissociation of molecules, and the heat produced by ultrasonic energy may reach levels which will destroy life.

When it is applied in large dosage, ultrasonic energy is a dangerous agent. Nevertheless, agents which are harmful in large doses may be of therapeutic and diagnostic value in smaller appropriate doses This proved to be the case with regard to ultrasonic energy.

Ultrasonotherapy is a term which indicates the use of ultrasonic energy in medical therapy, and medical scientists in the early 1950s were just beginning to investigate the therapeutic possibilities of this agent. Ultrasonoscopy, the employment of ultrasonic energy diagnostically, gave promise of proving valuable The employment of ultrasonic waves for detecting flaws in metals was well established by mid-century Similarly such detectors were being employed in medicine for disclosure of certain lesions in the human being A device to aid in medical diagnosis operates on the same principle as does the reflectoscope which sends pulsed ultrasonic waves into a medium and picks up their reflections from the opposite surface or from any irregularities that lie in their path. This principle was employed in medicine to detect the presence of gallstones and foreign bodies as well as in measuring the thickness of the intestinal wall, in detecting various abnormal growths and in measuring the size of the ventricles of the brain (sonography).

The bactericidal and viricidal effects of ultrasonic energy had been demonstrated Destruction of luminous bacteria by ultrasonic energy had been reported, and it had been shown that some bacteria are less resistant than others to the action of ultrasonic energy.

Early studies had been made on the employment of ultrasonic diathermy with the thought that it might produce valuable selective heating effects in various tissues of the human body Ultrasonic diathermy will heat bone cortex and bone marrow in living animals to higher levels of temperature than can be achieved by any other similar procedure. Also ultrasonic radiation will heat nerve tissue selectively, raising the temperature of nerves to higher levels than that of surrounding tissues. Although the employment of ultrasonic energy in diagnosis and in therapy would seem to have considerable promise, its exact sphere of usefulness had not yet been fully determined at midcentury, and it should be employed only in the hands of especially well-trained and highly qualified experts.

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ULTRA-VIOLET RAY: *see* LIGHT AND RADIATION IN RELATION TO HEALTH.

ULUNDI (Zulu for "high place"), the royal kraal of Cetywayo, situated in the Mahlabatini district of Zululand, about 3 mi. N. of the White Umfolosi river, and 115 mi N.N E of Durban. The valley of the White Umfolosi there forms an extensive basin called the Emhlabatini, and from the time of Chaka to the overthrow of Cetywayo in 1883 was the exclusive place of residence of the Zulu kings. "The basin on the south side of the river is regarded as the cradle of the Zulu race; there all their

early chiefs are buried, hence the term Emakosini (*ie*, at the grave of the chiefs) applied to the district (*see* Blue Book C. 5143) During Cetywayo's reign a garrison of 3,000 was kept at Ulundi About a mile from the Kraal on July 4, 1879, a Zulu army about 20,000 strong was totally defeated by Lord Chelmsford The British loss was about 100, the Zulu 1,500 After the fight the royal kraal was burned. On Sept. 1, at the site of the kraal, Sir Garnet (afterward Lord) Wolseley announced the partition of Zululand into 13 petty chieftainships; but on Jan. 29, 1883, Cetywayo was reinstalled by the British at Ulundi as chief over two-thirds of his old dominions Attacked at Ulundi in July 1883 by the rival chief Usibepu, Cetywayo and his 5,000 followers fled to the Nkandhla bush The royal kraal was again destroyed and Ulundi ceased to be a rallying point The magistracy for the district is situated 5 mi N. of the site of Ulundi. (*See* ZULULAND)

ULVERSTON, market town, urban district, Lonsdale parliamentary division, Lancashire, England, in the Furness district, 8 mi NE. from Barrow-in-Furness, and 256 mi. from London by the London Midland Region railway. Pop. (est. 1938) 9,317. Area, 4.99 sq mi The church of St. Mary, founded in 1111, retains the original (Transitional) south door, but is mainly Perpendicular in style with an altar-tomb of 1588. Ulverston is second in importance to Barrow in the district. Conishead Priory, 2 mi SE, a mansion on the site of a priory founded in the reign of Henry II, is now a hydropathic establishment. Formerly Ulverston had a considerable trade in linens, checks and ginghams, but is now dependent on iron and steel works, chemical works, breweries, tanyards, and hardware, paper and wooden hoop factories. Through its connection with Morecambe bay by a ship canal, 1 mi. in length, it has a shipping trade in iron and slates

Ulverston, otherwise Vlureston, Olvestonum, occurs in Domesday book, where Vlurestun is named as a manor in possession of Turulf, who was probably the original Saxon owner. Early in the 12th century the manor passed to Stephen, count of Boulogne, who gave it to Furness abbey. In 1196 the abbot granted the vill of Ulverstone with the inhabitants to Gilbert Fitz-Reinfred, who granted it a charter and made it a free borough. The lordship became divided. One part passed to the Harringtons and finally to Henry Grey, duke of Suffolk, on whose attainder in 1553 it was forfeited to the crown; the other, returned to the abbey at the dissolution, was surrendered to the crown Early in the 17th century the crown alienated the manor, which descended to the family of Buccleuch. In 1280 Roger de Lancaster obtained a charter from Edward I for a weekly market on Thursday and an annual fair of three days on the eve of the Nativity (Sept. 7). The council now maintains the markets.

ULYSSES: *see* ODYSSEUS.

UMBALLA or AMBALA, a city and district of India, in East Punjab. The city is 3 mi E. of the river Ghaggar, 902 ft. above the sea. Pop. (1941) 44,964. It has a station on the North-Western railway, with a branch line to Kalka at the foot of the hills (39 mi), which was continued to Simla in 1903. Umballa has a large military cantonment which was first established in 1843. The cantonment, which lies 4 mi. S.E. of the native town, is well laid out with broad roads. Pop. (1941) 62,419.

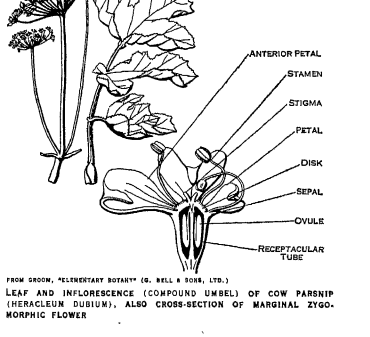
The DISTRICT OF UMBALLA has an area of 1,851 sq.mi With one small exception it consists of a level alluvial plain, sloping away gradually from the foot of the Himalayas, and lying between the rivers Jumna and Sutlej. These rivers do not materially affect the district, which has a drainage system consisting of the numerous torrents which pour down from the hills The principal of the northern streams is the Ghaggar, into which the minor streams empty themselves, some within and some beyond the limits of the district. The Ghaggar is the only perennial stream within the district, but dwindles to a tiny rivulet in the dry season, and disappears altogether beyond the border of the district. In 1941 the population was 847,745. The principal crops are wheat, maize, pulse, millets, rice, cotton and some sugar cane. There are factories for ginning and pressing cotton, and also for grinding wheat. Two opposite corners of the district are watered by the Sirhind and the Western Jumna canals Umballa is one of the territories previously held by numerous Sikh sirdars, which were attacked by Ranjit Singh. This caused the movement of British troops in 1809 which resulted in the treaty with Ranjit Singh, by which he was required to withdraw his army from the left bank of the Sutlej. In June 1849, after the Second Sikh War had brought the Punjab under British rule, the chiefs were deprived of all sovereign power. In March 1869 a grand durbar was held at Umballa on the occasion of the visit of the amir Shere Ali

UMBEL, in botany, an inflorescence in which the stalks of the flowers all spring from the top of the main stalk, thus usually producing a flat-topped flower head, as in the carrot, parsnip and fennel (*See* FLOWER)

UMBELLIFERAE, a plant family of polypetalous dicotyledons belonging to the order Umbelliflorae, which includes also the families Araliaceae (ivy family) and Cornaceae (dogwood family). It contains 200 genera with about 2,700 species, occurring in all parts of the world but chiefly in north temperate regions. It is well represented in the British flora by 35 genera. The plants are annual or perennial herbs, rarely shrubby as sometimes in *Bupleurum*, with generally a very characteristic habit, namely stout erect stems with hollow internodes, alternate pinnately compound exstipulate sheathing leaves and compound umbels of small, generally white, flowers.

An example of an annual is the common fool's parsley, *Aethusa cynapium;* carrot (*Daucus carota*) is a biennial; others are perennial, persisting by means of tubers or rhizomes—such are hogweed (*Heracleum*), *Angelica*, *Peucedanum*, and others. Some genera have a creeping stem as in *Hydrocotyle* (pennywort), a small herb with a creeping filiform stem and, in the British species, entire leaves *Bupleurum* has simple, entire, often perfoliate leaves. *Azorella*, a large genus in south temperate regions, has a peculiar caespitose habit, forming dense cushions often several feet in diameter and persisting for many years; they resemble those of the Australian *Raoulia* (vegetable sheep) *Eryngium*, represented in Britain by sea holly (*E. maritimum*), is a large genus of rigid often glaucous herbs with spiny-toothed leaves, which in some South American species with narrow parallel-veined blade and broadly sheathing base recall those of a monocotyledon such as *Agave* or *Bromelia*. In sanicle (*Sanicula*), *Astrantia* and others the leaves are palmately divided.

There is also considerable variety in the development of the umbel, which is usually compound but sometimes simple, as generally in *Hydrocotyle* and *Astrantia*, rarely reduced to a single flower as in species of *Hydrocotyle*. In *Eryngium* the flowers are



FROM GROOM, "ELEMENTARY BOTANY" (G. BELL & SONS, LTD.)

LEAF AND INFLORESCENCE (COMPOUND UMBEL) OF COW PARSNIP (HERACLEUM DUBIUM). ALSO CROSS-SECTION OF MARGINAL ZYGOMORPHIC FLOWER

crowded into dense heads subtended by a whorl of rigid bracts A terminal flower, distinguished by its form and dark colour, is sometimes present as in carrot (*Daucus*) The presence or absence of bracts and their form when present afford useful diagnostic characters. When present at the base of the primary rays of the umbel they form the involucre, and the involucel when at the base of a partial umbel In *Astrantia* the simple umbel is enveloped by a large, often coloured, involucre

The small epigynous flowers are usually hermaphrodite and regular, with parts in fives The sepals are usually very small, often represented only by teeth on the upper edge of the ovary; the petals are usually obovate or obcordate in shape, often with the tip inflexed; the stamens have long slender filaments bent inward in the bud but ultimately spreading; the two carpels are in the median plane; the two-celled ovary is surmounted by an epigynous glandular disk, which bears the two styles. Each ovary-cell contains a single pendulous anatropous ovule with a ventral raphe and a single integument. The flowers are rendered conspicuous by being massed into more or less dense flat-topped inflorescences (umbels) A resemblance to the rayed heads of Compositae is suggested in the frequently larger size of the flowers on the circumference of the umbel which are often sterile and zygomorphic from the larger size of the outer petals This arrangement allows a large number of flowers to be visited by insects in a short time. The flowers are generally white, sometimes pink or yellow, very rarely blue; they are generally scented, but the whole plant has an odour from the general presence in the tissues of an ethereal oil or resin The flower is widely open, the petals and stamens radiating from the central disk, on which honey is secreted, and is thus accessible to short-tongued flies Cross-pollination is necessary, the flowers being generally protandrous.

The fruit is very characteristic; a schizocarp which splits down the septum to form two dry one-seeded mericarps which are at first attached to, or pendulous from, an entire or split central axis or carpophore. The form of the mericarp affords valuable characters for distinguishing genera. On the outer surface of each are generally five ridges (primary ridges), between which are sometimes four secondary ridges; oil-cavities, vittae, are often present in the intervening furrows.

The family is classified according to the nature of the flower and fruit. Engler divides the family into three main classes, *Hydrocotyloideae, Saniculoideae, Apioideae;* the first two with two subfamilies each, the last with eight. The 35 British genera represent 7 of the 12 subfamilies The following may be mentioned: *Hydrocotyle* (pennywort), *Sanicula* (sanicle), *Conium* (hemlock, *q v*), *Smyrnium* (Alexanders), *Apium* (celery, *q v*), *Carum* (caraway, *q v*), *Myrrhis* (cicely), *Foeniculum* (fennel, *q.v.*), *Aethusa* (fool's parsley, *q v*), *Angelica* (*q v.*), *Pastinaca* (parsnip, *q v.*), *Heracleum* (hogweed), *Daucus* (carrot).

It is represented in North America by about 70 genera. The more common ones are *Sanicula* (black snakeroot), *Osmorrhiza* (sweet cicely), *Cicuta* (water hemlock), *Sium* (water parsnip), *Thaspium* (meadow parsnip), and *Angelica.*

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UMBER: *see* MANGANESE; PAINTS, CHEMISTRY OF.

UMBRELLA BIRD, the name for a species of the genus *Cephalopterus*, belonging to the American family Cotingidae. The males are black and bear a peculiar umbrellalike crest from which characteristic the name is derived They also have long, plumed wattles depending from the throat.

UMBRIA (Ὀμβρική), the name of an ancient and a modern district of Italy.

1. The ancient district was bounded in the period of the Roman supremacy by the Ager Gallicus (in a line with Ravenna) on the north, by Etruria (the Tiber) on the west, by the Sabine territory on the south and by Picenum on the east. The Via Flaminia passed up through it from Ocriculum to Ariminum; along it lay the important towns of Narnia (Narni), Carsulae, Mevania (Bevagna), Forum Flaminii, Nuceria Camellaria (Nocera) and Forum Sempronii; and on the Adriatic coast Fanum Fortunae (Fano) and Pisaurum (Pesaro) . To the east lay Interamna (Terni), Spoletum (Spoleto), Fulginium (Foligno—on a branch of the Via Flaminia which left the main road at Narnia and rejoined it at Forum Flaminii) and the important town of Camerinum on the side of the Apennines toward Picenum On the side toward Etruria lay Ameria (Amelia) and Tuder (Todi), both on the direct road from Rome to Perusia, Iguvium, which occupied a very advantageous position close to the main pass through the Apennines, and Hispellum (Spello). Not far off was Asisium (Assisi), while far to the north in the mountains lay Sarsina. Under the empire it formed the sixth region of Italy.

The name Umbria is derived from the Umbri, one of the chief constituent stocks of the Italian nation. The origin and ethnic affinities of the Umbrians are still, like their geographical location in early times (1200–1000 B.C.), quite unknown (Randall MacIver, *Iron Age in Italy*, 140 [Oxford, 1927]), but their language proves them to have been an Aryan people closely allied with the Oscans and in a remoter degree with the Latins

The process by which the Umbrians were deprived of their traditional predominance in upper and central Italy and restricted to their confines of historic times cannot be traced in detail Their easternmost territory in the region of Ancona was perhaps wrested from them by the Picenes, a branch of the Sabine stock; and it is probable that they were partly displaced in the valley of the Po by the Gaulish tribes which began to pour across the Alps from about 500 B C Their chief enemies were undoubtedly the Etruscans (*q v.*), who eventually drove them into that upland tract athwart the Apennines to which the name of Umbria belonged in historical times without eradicating the Umbrian element of population in the conquered districts In Etruria proper the persistence of the Umbrian stock is indicated by the survival of numerous Umbrian placenames, and by the record of Umbrian soldiers taking part in Etruscan enterprises, *e g*, the attack on Cumae in 524 B C Indeed it is not unlikely that the bulk of the population in Etruria continued to be of Umbrian origin, and that the Romanization of this country was facilitated by the partial absorption of the Etruscan conquerors into the Umbrian multitude

Against the Romans the Umbrians never fought any wars of importance. After the downfall of the Etruscan power they made a belated attempt to aid their Samnite kinsmen in their decisive struggle against Rome (308 B.C.), but their communications with Samnium were impeded by the foundation of a Roman fortress at Narnia (298 B C), and at the great battle of Sentinum (295 B.C.), which was fought in their own territory, the Umbrians did not lend the Samnites any substantial help. It is perhaps on account of this defection that in 200 B.C they received from the Romans a portion of the Ager Gallicus reconquered from the Senonian Gauls. They offered no opposition to the construction of the Via Flaminia through the heart of their country, and in the Second Punic War withheld all assistance from Hannibal. In the Social War (90–89 B.C.), they joined the rebels tardily and were among the first to make their peace with Rome. Henceforth they no longer played an independent part in Italian history.

The material prosperity of Umbria, in spite of its unfavourable position for commercial intercourse, was relatively great, owing to the fertility of the numerous small valleys which intersect the Apennine system in this region. The chief products of the soil were olives, vines and spelt; the uplands harboured the choicest boars of Italy The abundance of inscriptions and the high proportion of recruits furnished to the army attest its continued populousness. Among its most famous natives were the poets Plautus (b. at Sarsina) and Propertius (b at Assisi).

The Umbrians in addition to the city (*tota*) had a larger territorial division in the *tribus* (*trifu*, acc.) as is gathered from Livy (xxxi, 2, "per Umbriam quam tribum Sapinium vocant"; *cf.* xxxii, 37) and from the Eugubine Tables ("trifor Tarsinates," vi, B, 54). Ancient authors describe the Umbrians as leading effeminate lives, and as closely resembling their Etruscan enemies in their habits There is conclusive proof of strong Etruscan influences in Umbria, and their alphabet is undoubtedly of

Chalcid-Etruscan origin, while the language, which is known from one or two inscriptions from Fulginium and Tuder, and from the so-called *Iguvine Tables*, the earliest parts of which may go back to the 5th cent. B.C. (*see* IGUVIUM), is a dialect which sprang from the Oscan, but is marked by some phonetic changes. Etruria also taught the towns near it (*e.g.*, Tuder and Iguvium) the art of minting, for they alone had a coinage. The Umbrians counted their day from noon to noon But whether they borrowed this likewise from the Etruscans is not known. In their measuring of land they employed the *versus*, a measure common to them and the Oscans, 35 of which went to the Roman *jugerum*

2. The modern territorial division is situated in the middle of the peninsula, between Tuscany and the Marches on the north and east, and Lazio (Latium) and the Abruzzi on the south and west, and comprising the two provinces of Perugia and Terni, with an area of 3,281 sq mi.; pop. (1936), 725,918. Umbria and the provinces of Ancona and Pesaro and Urbino taken together form an area slightly more extensive than that of the sixth region of Augustus The surface is mountainous, but affords good pasture, and there are numerous fertile valleys Many treasures of art and architecture are preserved, and Umbria is in this respect one of the most interesting regions of Italy. (*See* PERUGIA.) Modern Umbria formed down to 1860 a part of the states of the church.

Three main lines of railway run through the territory. One from Florence to Rome skirts the borders of the province on the west, running north and south. Another Rome-Florence line bisects the territory north and south, while the Rome-Ancona runs across the province from northeast to southwest. The cross communication is given by three branch lines. In the north a narrow gauge line from Arezzo to Fossato passes through Gubbio. Perugia, the capital of the province, stands on the line from Terontola to Foligno, while on the extreme south a line passing through Rieti and Aquila, and ultimately reaching Sulmona, starts from Terni on the Rome-Ancona line There is also an electric railway from Terni via Perugia to Umbertide, on the line between Arezzo and Fossato.

The great steelworks of Terni (*q.v.*), the chloride factory at Nera Montoro near Narni, the chemical manure works at Narni, Foligno and Assisi, the wool and jute works of Terni and Foligno, the cotton spinnery of Spoleto may all be mentioned, while the hydroelectric plants of Umbria, which are concentrated at Terni, are of great importance, and are able to help those of Lazio and Tuscany. (T. A.)

UMBRIAN LANGUAGE. The dialect in which the *Iguvine Tables* (*see* IGUVIUM) are written is usually known as Umbrian, as it is the only monument we possess of any length of the tongue spoken in the Umbrian district before it was Latinized. The language is that of a certain limited area, which cannot yet be shown to have extended very far beyond the eastern half of the Tiber valley (from Interamna Nahartium to Urvinum Mataurense).

Umbrian has diverged from Oscan in the following matters:

(1) The palatalization of *k* and *g* before a following *i* or *e*, or consonant *i* as in *tiçit* (i.e., *dçit*)=Lat. *decet*; *muieta* past part. passive (pronounced as though the *i* were an English or French *j*) beside Umb. imperative *mugatu*, Lat. *mugire*.

(2) The loss of final *-d*, *e.g.*, in the abl. sing. fem. Umb. *tôtā*=Osc. *toutād*

(3) The change of *d* between vowels to a sound akin to *r*, written by a special symbol ♀ (*d*) in Umbrian alphabet and by RS in Latin alphabet, e.g., *teŋa*, in Umbrian alphabet=*dursa* in Latin alphabet, "let him give," exactly equivalent to Paelignian *dida*.

(4) The change of *-s-* to *-r-* between vowels as in *erom*, "esse"=Osc *esum*, and the gen. plur. fem. ending in *-arum*=Lat. *-arum*, Osc. *-asum*.

To this there are exceptions, *e.g.*, *asa*=Lat *ara*, which are generally regarded as mere archaisms. Unfortunately the majority of them are in words of whose origin and meaning very little is known, so that (for all we can tell) in many the *-s-* may represent *-ss-* or *-ps-* as in *osatu*=Lat *operato*, *cf* Osc. *opsaom*

(5) The change of final *-ns* to *-f* as in the acc. plur. masc. *vitluf*=Lat. *vitulōs*.

(6) In the latest stage of the dialect the change of final *-s* to *-r*, as in abl plur. *arver*, *arvis*, *ie*, "arvorum frugibus."

(7) The decay of all diphthongs.

(8) The change of initial *f* to *v*, as in *vutu*=Lat *lavito*

Save for the consequences of these phonetic changes. Umbrian morphology and syntax exhibit no divergence from Oscan that need be mentioned here, save perhaps two peculiar perfect-formations with *-l-* and *-ŋçi-*; as in *ampeitust*, fut perf. "impenderit," *combifiançiust*, "nuntiaverit" (or the like).

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UNAMUNO, MIGUEL DE (1864–1936), Spanish scholar and man of letters, was born at Bilbao on Sept 29, 1864. He was educated in Madrid, receiving a doctor's degree in philosophy and letters, and in 1892 was appointed to the chair of Greek language and literature at Salamanca university In 1900 he became rector of the university. He was always vitally interested in practical affairs and later in a campaign by means of newspaper articles and addresses against governmental corruption and abuses he was so outspoken that he was removed from the rectorship of the university. The coup d'état of Primo de Rivera in 1923, which established a military directorate, aroused him to such vehement denunciation that in Feb. 1924, he was exiled to one of the more remote of the Canary Islands. The sentence aroused much criticism and the government granted amnesty in July, 1924, but Unamuno refused to return to Spain and took up his residence in Paris. In letters Unamuno was a man of wide culture and of great influence in Spanish-speaking countries In his poems there is vigorous thought and lofty passion which strains at the bonds of rhyme, while his blank verse is weighted with mysticism There are many excellent sonnets in the collection *Rosario de Sonetos líricos* (1911). His most remarkable poem was *El Cristo de Velasques* (1920), a long series of mystic meditations, which is often compared by critics to the work of William Blake His novels are made impressive by their philosophical quality. Superfluous details and descriptive writing are suppressed and the stage is stripped for the interaction of passions and ideas *Niebla* (1914), *Abel Sanchez* (1917), *La Tia Tula* (1921) and *Tres Novelas Ejemplares* (1921) are all important, but his masterpiece is generally acceded to be *Del Sentimiento Tragico de la Vida* (1913; trans into English, 1921). Much of his thought, as well as more colourful descriptive writing, is to be found in the *Ensayos* (7 vol., 1916–19), while warmth of feeling for the people and countryside of Spain is shown in *De mi país* (1903); *Por tierras de Portugal y de España* (1911) and *Andanzas y Visiones* (1922). In the *Vida de Don Quijote y Sancho* (1914; trans. into Eng 1927) he preached the cult of quixotism as an ideal.

A number of selections and extracts from his essays are translated in *Essays and Soliloquies* (1925); other translations are *The Agony of Christianity* (1928) and the novel *Mist* (1929).

UNAO, a town and district of India, in the Lucknow division of the United Provinces. The town is 10 mi N.E. of Cawnpore. Pop. (1941), 20,107.

The DISTRICT OF UNAO has an area of 1,762 sq.mi. It consists of a flat alluvial plain, lying north of the Ganges. Rich and fertile tracts, studded with groves, alternate with stretches of waste land and plains of barren *usar*, the whole being intersected by small streams used for irrigation. The Ganges is the only navigable river in the district, while the Sai forms its northeastern boundary. Pop. (1941) 959,542.

UNCERTAINTY PRINCIPLE, THE. This principle, which was formulated by Werner Heisenberg (in 1927), and which plays a fundamental role in quantum mechanics (*q.v.*) states that it is impossible to specify or determine simultaneously both the position and velocity of a particle as accurately as is wished. It is, to be sure, possible to fix either of these quantities as precisely as desired, but only at a price, for the greater the precision in one, the greater the inevitable lack of definiteness in the other. A

more exact formulation is as follows: there is no way in which quantum-mechanical language permits us to say that a co-ordinate x and its conjugate momentum p_x simultaneously have values x' and p'_x with arbitrarily small uncertainty. Instead, if Δx and Δp_x denote the uncertainty in x and p_x respectively, there exists the inequality

$$\Delta x \Delta p_x \geqq \frac{h}{4\pi} \qquad (1)$$

where h is Planck's constant 6.62×10^{-27} ergs $\times$ sec. It is to be emphasized that the restrictions imposed by the uncertainty principle apply only to a pair of dynamical variables which are canonically conjugate There is no limit in principle to the precision with which values can be assigned to a co-ordinate and a momentum conjugate to another independent co-ordinate, as, for example, the x component of position and the y component of momentum.

Because h is so small, the indeterminism caused by the uncertainty principle is of no consequence in ordinary experience. For instance, the resulting error in the position or velocity of a rifle bullet would be completely inconsequential even for the most refined ballistic calculation On the other hand, the Heisenberg uncertainty principle is of great interest and importance in the interpretation of atomic experiments, and has startling philosophical implications

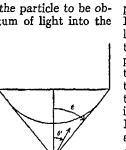
For discussion of the place of the uncertainty principle in the general scheme of things in quantum mechanics *see* QUANTUM MECHANICS: *Statistical Significance*. A quantitative definition is given there of the uncertainty in terms of root mean square deviation, as well as an outline of how the uncertainty principle is derived from the basic equations of wave mechanics, of which it is a necessary consequence.

A standard illustration of the uncertainty principle is furnished by the resolving power of a microscope, which shall be taken as an example.

Let the particle be at such a distance that the cone of rays scattered by the particle and entering the lens of the microscope have an angular opening ϵ, as shown in the figure. It is shown in optics that the resolving power of the instrument is

$$\Delta x = \frac{\lambda}{\sin \epsilon} \qquad (2)$$

where λ is the wave length. In order for the particle to be observed it must scatter at least one quantum of light into the microscope. (If more than one quantum is scattered, the particle will receive extra recoil kicks, and the uncertainty will be even greater than with the estimate.) The theory of the Compton Effect (*q.v.*) and related subjects shows that a light quantum of frequency ν is endowed with a momentum $h\nu/c$, where c is the velocity of light. Consider for simplicity the case where the initial and scattered quanta fall in the same plane as the axis of the microscope, and make angles θ, θ' with the latter, as shown in the figure. Since momentum is conserved in the interaction between the particle and the light quantum, the x component of momentum imparted to the particle is $(\sin\theta - \sin\theta')\frac{h\nu}{c}$ (Here the Compton change of frequency on scattering has been neglected, but this is a second order effect.) As θ' is comprised within the limits $\pm\epsilon$ in order to enter the microscope, the x component of momentum imparted to the particle may be anywhere between



$$(\sin\theta - \sin\epsilon)\frac{h\nu}{c} \text{ and } (\sin\theta + \sin\epsilon)\frac{h\nu}{c}$$

Hence the observation inherently introduces an uncertainty in the momentum of the particle amounting to $\Delta p_x = 2 \sin\epsilon \cdot \frac{h\nu}{c}$. Combining this result with (1) and remembering that $\lambda = \frac{c}{\nu}$, it is seen that $\Delta p_x \Delta x = 2h$. The fact that ϵ does not appear in this result illustrates the futility of trying to defeat the uncertainty principle with any choice of aperture.

Too much significance should not be attached to the fact that the error is apparently 8π times the minimum allowed by (1), for the estimate (2) of resolving power is accurate only to order of magnitude

In classical mechanics, if the initial position and velocity are known, together with the forces acting, then a particle's path can be computed for all future time On the other hand, the uncertainty principle prevents specification of the initial conditions in quantum mechanics, and as a result the future of a particle cannot be definitely predicted. Because of this the law of cause and effect ceases to apply, though the ambiguity is, of course, important only on the atomic scale Instead the future of a particle can only be statistically predicted in quantum mechanics, but the type of information supplied is just that needed to describe actual experiments. For instance, in the theory of the scattering of alpha particles, quantum mechanics gives directly the formula for the distribution-in-angle of the scattered particles, without correlating a particular scattering angle with a particular distance of closest approach to a scattering centre. Such a correlation is involved in classical theory, but it is necessary to integrate over all distances of approach, and the latter are supernumerary quantities not capable of being observed in the experiment; hence it is unimportant that they are uncertain in the quantum-mechanical interpretation. In fact, it must be regarded as an element of strength in quantum mechanics that the statistics governing the distribution of distances of approach is self-contained in the formalism, and not introduced as an additional hypothesis as in the classical treatment

It is to be emphasized that in making observations on a system, it is necessary to exchange energy and momentum with it This exchange of necessity spoils the original properties of the system. The resulting lack of precision with which these properties can be measured is the crux of the uncertainty principle. In the microscope example, for instance, the momentum of the particle was rendered uncertain by the impact with the light quantum by which it was being observed.

The fact that there are intrinsic limits to the precision of experimentation obviously has profound philosophical significance. In particular, metaphysicians can argue whether nature inherently lacks determinism, or is instead completely deterministic With the latter view, the ambiguity involved in the uncertainty principle, or the apparent breakdown of the law of cause and effect is to be considered as arising only by virtue of the "spoiling" by the experimentation. It is in a certain sense a meaningless question which view is correct, as the properties of nature that are inherently incapable of observation have no realistic significance. In this connection it is well to quote a few sentences from an article by P. W. Bridgman in *Harper's Magazine*, vol. 158, pp. 443–451 (1929):

> The immediate effect [of the uncertainty principle] will be to let loose a veritable intellectual spree of licentious and debauched thinking. This will come from the refusal to take at its true value the statement that it is meaningless to penetrate much deeper than the electron, and will have the thesis that there *is really* a domain beyond, only that man with his present limitations is not fitted to enter this domain. . . . The existence of such a domain will be made the basis of an orgy of rationalizing. It will be made the substance of the soul . . . the principle of vital processes will have its seat here; and it will be the medium of telepathic communication. One group will find in the failure of the physical law of cause and effect the solution of the age-old problem of the freedom of the will, and, on the other hand, the aetheist will find the justification of his contention that chance rules the universe.

The safest conclusion is perhaps that man should remain humble in the face of nature since there are inherent limitations to the precision with which he can observe the latter.

See W. Heisenberg, *The Physical Principles of the Quantum Theory* (1930) The uncertainty principle was first formulated by Heisenberg in the *Zeitschrift fur Physik*, vol. 43, pp. 172–198 (1927), and somewhat amplified by Niels Bohr in *Nature*, vol. 121, p. 580 (1928). An interesting popular article on the philosophical implications of the

uncertainty principle is that by P. W. Bridgman in *Harper's Magazine*, vol 158, pp. 443–451 (1929) (J. H. V.)

UNCLE SAM, the popular name for the United States. The origin of the name is unknown, but is attributed to the initials U.S., placed on property of the government. It came into existence about the time of the outbreak of the War of 1812, spread rapidly, and within a few years was recognized universally.

UNCONSCIOUS. Sigmund Freud, about 1885, began an era of thought by stating that ideas, feelings and memories outside consciousness may affect a person's behaviour even though he cannot report upon them. William James called this the most important step forward in the time he had been studying psychology.

Just as the activities of all units of an army are not always integrated, so all aspects of the mental processes and behaviour of an individual are not co-ordinated. Some mental systems which affect behaviour unconsciously are independent of and unrecognized by the controlling part of the personality.

Disparate and sometimes conflicting uses of "unconscious" occur in popular and scientific writings. The word has been used synonymously with "inanimate" or "subhuman" to describe whatever is incapable of discriminating or behaving. Individuals have been termed unconscious under many different circumstances —when unresponsive to stimulation because of absentmindedness, day-dreaming, hypnosis, sleep, anaesthesia, etc; when not discriminating between different stimuli; when acting sheerly on the basis of conditioned responses (*see* below); when not sensing, because one or more factors are preventing adequate stimuli from affecting their nervous systems. A person may also be called unconscious if he is not attending to something, if he lacks insight into the nature of a situation involving him, if he forgets something; if his actions are purely instinctive; if he does not recognize the character of the determinants of his behaviour; if some of his acts are involuntary; if he cannot communicate all he is aware of, by word, gesture, facial expression or other means; if he deliberately ignores facts he knows; or if he makes discriminations but is unaware that he does.

The actions, ideas, emotions, needs or drives of a person are also often called unconscious in many of the above meanings, as well as in another sense—not mental. Various theoretical schools deny that unconscious processes exist, on the grounds that consciousness and mind are equivalent, that what is unconscious is therefore not mental, and that hence the concept of unconscious mental processes is self-contradictory. Freud contended that this apparent paradox arises from misunderstanding the psychoanalytic use of "unconscious," which refers to processes that (1) are dynamically repressed away from awareness, the organ of perception; (2) can be brought to awareness only by special techniques like hypnosis and psychoanalysis; and (3) are not controllable voluntarily.

The numerous uses of the word "unconscious" reflect great theoretical disagreements, and sometimes the same process is conscious in one sense and unconscious in another. For example, after a bell has been sounded routinely one minute before repeated feedings, the salivation that normally occurs upon presentation of food can eventually be elicited by the bell—a conditioned response. Psychologists who do not accept introspective reports as valid consider that behaviour indicating discrimination between the presence and absence of a stimulus is evidence of consciousness. Hence a conditioned response is such evidence—a sign, in the example, of consciousness of the bell. Other psychologists do not agree that mental processes are merely neural function evidenced by discriminatory behaviour, believing they also involve awareness of this discrimination. Some of the latter group hold that this consciousness is associated with every mental process, and since conditioned responses are often given a purely neurophysiological explanation, they are not mental—unconscious.

Various schools explain how it is determined which mental processes are conscious and which unconscious by using one or both of two concepts—the economy principle and the pleasure principle. The economy principle is that ordinarily one, or at most a few, thoughts or acts are attended to at a time. The organism appears to function most efficiently when it does not dissipate the energy of attention but concentrates this consciousness on a restricted range of activities, allowing the rest to be relatively or completely automatic. Moreover, certain activities, including composing, complex judgments and highly practised muscular acts, are often accomplished best automatically. If unattended processes develop unusual characteristics or threats to the organism's welfare, a guarding mechanism swiftly turns attentive consciousness to them. Along with this change appear expressions indicating surprise, characteristic objective signs of the onset of the new state of consciousness. Presumably this is associated with increasing "neural vigilance," a phrase of Henry Head meaning high-grade physiological efficiency in a part of the nervous system, which he postulated as developing as consciousness turns to the functions of that part.

Subjectively, various levels of unconsciousness merge imperceptibly into one another. The ordinary waking state differs from hypnosis which differs from sleep which differs from deep anaesthesia. Functional levels of the nervous system also exist, each with its own threshold. Stimuli may be strong enough to cross the threshold to one level and affect behaviour, without being capable of reaching the level of highest neural vigilance. Thus, behaviour may be affected and awareness not be. There is a range of intensity of stimulation at which perception and learning occur without awareness.

Freud described how the pleasure principle operates, thrusting painful thoughts and desires into unconsciousness and permitting pleasant ones to remain conscious. He considered painful those which produce shame, guilt or injury to self-esteem. These are repressed into unconsciousness, which psychoanalytic theory sharply delimits from consciousness, recognizing little merging. They are censored and kept from consciousness unless altered into dream symbols, slips of the tongue, jests or some other acceptable guise.

Because dreams seem distorted and for other reasons, unconscious processes are frequently called irrational. Clinical evidence indicates that one class of these is not illogical but shrewdly devoted to fulfilling socially unacceptable, anarchic desires for independence and self-centred pleasure. Other classes are not irrational either, but are determined by subthreshold stimulation, unconscious conditioning or forgotten events. They elicit unaccountable behaviour because they are not available to awareness. Society forces us to explain our acts, so we make them appear to ourselves and our fellows to arise logically from accepted principles of our culture. That this mechanism is called rationalization does not mean unconscious processes are irrational.

(Ja. G. M.)

UNDERGROUND RAILROAD, a term used popularly to designate an organized system existing in the northern states of the United States prior to the Civil War by which slaves were secretly helped by sympathetic northerners and in defiance of the Fugitive Slave laws (*q.v.*), to make their way to Canada, and thus to freedom. The name arose from the exaggerated use of railway terms in reference to the conduct of the system. Levi Coffin and Robert Purvis were the "presidents" of the road. Various routes were known as "lines," stopping places were called "stations," those who aided along the stages of the route were "conductors" and their charges were referred to as "packages" or "freight." The system reached from Kentucky and Virginia across Ohio, and from Maryland across Pennsylvania and New York or New England. The Quakers of Pennsylvania perhaps initiated the system; the best known of them, Thomas Garrett (1789–1871), is said to have helped 2,700 slaves to freedom. One of the most picturesque conductors was Harriet Tubman, a Negro woman called "General" Tubman by John Brown, and "Moses" by her fellow Negroes, who made about a score of trips into the south, bringing out with her perhaps 300 Negroes altogether. Levi Coffin, a native of North Carolina, in 1826 settled at New Garden (now Fountain City), Ohio, where his home was the meeting point of three "lines" from Kentucky. In 1847 he removed to Cincinnati, where he was even more successful in bringing out

slaves. Estimates of the number of slaves who reached freedom through the system vary from 40,000 to 100,000.

See W. H Siebert, *The Underground Railroad* (1898), a scholarly study containing maps of routes and bibliography W. Still, *The Underground Railroad* (1872), R C Smedley, *History of the Underground Railroad* (1883), and *Reminiscences of Levi Coffin* (1880) are personal records of participants

UNDERWOOD, FRANCIS HENRY (1825–1894), U.S. author, was born in Enfield, Mass , on Jan 12, 1825 He attended Amherst college for a year and then went to Kentucky to study law and teach. He was admitted to the bar in 1847 An original antipathy to slavery was heightened by close observation and hastened his return to Massachusetts in 1850

After a year of law practice he was appointed clerk of the state senate and two years later became a literary editor for the Boston publishing house of Phillips, Sampson and company The idea came to him at about this time of starting a magazine in New England, similar to *Harper's* in New York, in which the Free Soil movement could find a voice. He was peculiarly fitted for the task, combining in himself both practical connections in the publishing trade and wide personal associations among the most distinguished writers of his day—Emerson, Lowell, Holmes, Longfellow, Charles Eliot Norton and Whittier. He entered into correspondence with these and other men, securing manuscripts and promises of material, and by 1853 had contracted for publication with J P. Jewett and company, publishers of *Uncle Tom's Cabin.*

Unfortunately the firm failed before a beginning could be made, and Underwood turned doubtfully to Phillips, Sampson and company, who had once turned down Harriet Stowe's novel for fear of alienating its southern trade Chiefly through the influence of Mrs Stowe, they were finally persuaded to publish the *Atlantic Monthly,* so named by Holmes, and the first number was issued in Nov. 1857 with Lowell as editor

Underwood, assistant to the editor, was responsible for sifting all copy for undesirable material. Two years later the *Atlantic,* already a success, was taken over by Ticknor and Fields, and there Underwood's association with the magazine ended. Recalling early plans of its makers, he wrote in 1882 "The *Atlantic Monthly* was started with the definite purpose of concentrating the efforts of the best writers upon literature and politics under the light of the highest morals." In 1859 he became clerk of the superior criminal court of Boston, which position he left after seven years to engage in private enterprise. He was twice appointed U.S. consul in Scotland by President Grover Cleveland; in 1866 to Glasgow, and in 1893 to Leith. He wrote a number of books, the best known of which was *Quabbin, the Story of a Small Town* (1893). It is a novel based on life in his own home town of Enfield and was written in Glasgow. His biographies of Longfellow, Lowell and Whittier are notable for their personal recollections. *Cloud-Pictures,* a collection of short stories, appeared in 1872. Other books include a *Hand-Book of English Literature* (1871) and a *Hand-Book of American Literature* (1872).

He died in Edinburgh on Aug. 7, 1894.

UNDERWOOD, OSCAR WILDER (1862–1929), U.S. politician, was born at Louisville, Ky, on May 6, 1862. He studied at the University of Virginia (1881–84), was admitted to the bar in 1884, and practised law thereafter in Birmingham, Ala. From 1895 to 1915 he was a member from Alabama of the national house of representatives, and during his last two years chairman of the committee on ways and means. After the Democrats came into power in 1913 he had a large share in framing the tariff bill passed the same year. In 1914 he opposed the Panama Canal Tolls Repeal bill, but supported the resolution authorizing the president to use armed force in Mexico. He was opposed to the woman suffrage amendment to the federal constitution, holding that the question was a state issue. He also opposed the national prohibition amendment. In 1914 he was elected to the U.S. senate, and in 1920 re-elected. In 1919 he favoured the antistrike clause of the Cummins railway bill. A strong supporter of the peace treaty of Versailles, in Dec. 1919 he offered a resolution in the senate providing that the president of the senate should appoint a committee of ten senators to work out some acceptable plan for adopting the peace treaty; but this was blocked by Senator Lodge. In April 1920 he was chosen Democratic leader in the senate He was a U.S. delegate at the Washington Conference on the Limitation of Armaments which assembled in Nov. 1921. At the Democratic national convention held in New York city, June 1924, Senator Underwood was an unsuccessful candidate for the presidential nomination. In 1927 he was made a member of the American delegation to the Pan-American congress He published *Changing Sands of Party Politics* (1927). He died at Woodlawn, Va , on Jan. 25, 1929.

UNDERWRITING: *see* INSURANCE, ARTICLES ON

UNDSET, SIGRID (1882–1949), Norwegian author, was born at Kalundborg, Denmark, on May 20, 1882. After completing her studies at the Christiania Mercantile college, Mme Undset entered a city office in 1899 and remained a clerk until 1909 She thus gained an intimate acquaintance with the empty and unenlivened existence of the girls with whom she came into contact, and used her experience in her first literary works, initiated in 1907 by *Fru Marta Oulie* In 1912 she achieved fame by the great Christiania novel, *Jenny* (Eng. trans , 1920), remarkable for its courageous treatment of the erotic problem. After revealing in one of her minor works (1919) the religious crisis in her mind which in 1925 caused her to join the Roman Catholic Church, Mme. Undset published *Kristin Lavransdatter* (1920–22), Eng. trans., part I *The Bridal Wreath* (1923), part II *The Mistress of Husaby* (1925), part III *The Cross* (1930), a remarkable novel of the 14th century. Mme. Undset's work shows psychological depth and an ability to appraise the mind and temper of bygone ages Her work *Olav Audunsson,* a novel of the 13th century (1925), Eng trans., *The Axe* (1928), has the same qualities. Other works are *In the Wilderness* (1929); *The Burning Bush* (1932); *The Faithful Wife* (1937); and *Men, Women, and Places,* an autobiography (1939). She was awarded the Nobel prize in 1928. She died at Lillehammer, Norway, June 10, 1949

See J Bing, *Sigrid Undset* (1924).

UNDULANT FEVER: *see* BRUCELLOSIS.

UNEARNED INCREMENT, in economics, a term frequently applied to that part of the value of land which is due to the growth and development of the community using it, to the construction of buildings, roads, railways, canals, docks, harbours, upon it, or to the working of minerals beneath it Thus a piece of land in one part of a country, although beautiful or fertile, may be worth very little, while in another part of the same country a piece of land of similar area required for a railway, or by a railway made accessible for residential purposes, may rise in value by a hundredfold or a thousandfold. The gains thus made by some landowners are so obvious and so great that the specific taxation of the unearned increment has been often proposed and in some countries carried into effect (*see* article on LAND TAXES). Among others, John Stuart Mill favoured a progressive tax on land Henry George's tax amounted to a proposal to absorb the whole of the surplus value (*see* SINGLE TAX).

UNEMPLOYMENT. Although the rough meaning of the term unemployment requires no explanation, there are some complications in trying to define it precisely. If we think of unemployment as being the difference between full employment and actual employment then the difficulties must arise in connection with either or both of these terms. Obviously there are some problems in any attempt at measuring actual employment; there are always borderline cases such as part-time or intermittent workers. But these problems are not nearly so great as those connected with full employment.

Concepts of Full and Actual Employment.—In defining full employment we can start from the elementary proposition that it is not a concept applying to the total population of a country. Plainly there are a large number in any community who do not seek paid work under any circumstances. Many people are unable to enter the labour market. This may be because of physical or mental disabilities (*e.g.,* cripples) or legal regulations (children) or social conventions (unmarried daughters of rich families) or, most important of all, preoccupation with unpaid duties (housewives). Often there is overlapping between these

categories (*e.g.*, housewives also come under social convention), but the classification nevertheless is useful. On the other hand, there are always some people who are unwilling to work—the idle rich and the vagrants, ne'er-do-wells and misfits of society.

In some cases, both these points—inability and unwillingness—apply Thus, as a first approximation full employment can have no meaning in relation to that section of society which under no circumstances is able or willing to work.

Nor would it be true to say that full employment exists when all those who are willing and able to work can find work. Obviously this is impossible, for the number among those potentially able and willing to work who are actually in the labour market at any one time will depend on a number of factors but principally on the reward for working or, more simply, the wages offered Therefore, full employment can be considered to exist when individuals actually work as much as they are willing to work at any given reward for working; and as a corollary there are a number of "levels" of full employment depending on the reward currently offered and possibly a number of levels for the same reward in different years. It is, in fact, impossible to be much more precise about the notion of full employment and of the many attempts which have been made to define it more accurately none can be reckoned as successful. A fundamental difficulty is that at any one time the number seeking work at the ruling wage rate may not be known, nor that of persons seeking work at any other wage rate.

Thus, to take a simple example, if there is a sudden rise in wage rates (unaccompanied by a parallel price rise) will the number prepared to work rise or fall? For higher returns more people may be willing to work; but others, if their wants in life are simple and easily satisfied, may prefer to work less.

Other difficulties, and this is where the problem of actual employment appears, are to be found in the concept of "work" For it is not simply a question of employment or nonemployment but also one of partial employment. The question arises of how to treat workers who are unable to secure more than a few hours' work a week, or those who are willing to work only a few hours a week. This naturally leads to another problem: in what category are to be placed those whose work is, in some sense or other, of less than normal productivity? This is an extremely important point in practice because the number of street singers, back-garden vegetable growers, etc., always increases tremendously during a depression. If these people are regarded as actually being in employment or are excluded from the labour force deemed to be seeking employment, any estimates of unemployment will be grossly too low. This point was of particular importance in the U S. in the 1930s when the amount of low-productive family labour on farms increased considerably. To put the issue in another way, unemployment must also include underemployment. Another point, too, must be noticed. To speak in terms of the labour force seeking employment and wages paid implies that unemployment is a phenomenon concerning the wage-earning classes only and, in fact, this is the problem with which most economic analysis is concerned and the measure which statisticians try to establish. This means that unemployment is essentially a phenomenon of economies organized on a capitalist basis; where there is no wage-earning class there can be no unemployment, in the technical sense. Nor could it exist if all labour were centrally directed to jobs. It should be noted that unemployment is not large in primitive agricultural countries like India because there is only a small wage-earning community and if this is thrown out of employment it can always obtain low-productive work on the land.

Some of these difficulties (*e.g.*, the treatment of those willing to work only intermittently) affect both the concept of full employment and the measure of actual employment in the same way and therefore can be ignored in so far as unemployment is concerned, being the difference between the two. This is not the case for most of them, however, and it is therefore impossible to give any single, precise definition of unemployment. But because it is a matter which is of extreme practical importance and has necessitated a good deal of legislation, certain conventional rules for measuring unemployment have been established which should be considered

STATISTICS OF UNEMPLOYMENT

There are two main types of statistical information which throw light on the facts of unemployment—employment series and unemployment series. The former type shows numbers on employers' pay rolls at a certain date in each month. The traditional way of deriving this information, as developed in the U.S., was to conduct a sample inquiry among employers in different industries every month and to check these reports against the periodical census returns. Direct unemployment series have been obtained by a number of different methods. The oldest is data based on trade-union returns. In the 20th century this has given way to such methods as employment exchange data on persons seeking employment or social insurance data on numbers registered as unemployed or monthly sample information on unemployment Finally, estimates by private bodies, such as those of the National Industrial Conference board in the U.S , have sometimes been the main source of information.

Deficiencies of Unemployment Data.—All these methods have theoretical disadvantages as indicators of unemployment. The employment data are obviously of much less value than the unemployment data; for it is quite clear that if the total labour force is increasing through immigration or larger population then total employment may increase, and yet at the same time unemployment may not diminish and may even increase.

The only real reason for using employment data at all is that they often cover a wider field than unemployment data and, provided there is some general knowledge of the changes occurring in the labour force, may, if used with care, give some useful information Of the unemployment series, there are obvious deficiencies in trade-union data, whether of the Danish type (based on trade-union unemployment insurance fund data) or the Australian (direct reports from union secretaries). The value of data derived in this way depends entirely on whether the workers in any one industry covered by a trade union are typical of all workers in that industry and on how many industries are covered by trade unions. Employment exchange statistics may also be misleading if, on the one hand, they do not cover all workers seeking employment, and, on the other, include those who are actually at work (*e.g.*, on a part-time basis) or those who are totally incapable of work. In many ways, social insurance data are much superior but even here a number of snags arise. These data often exclude certain industrial or occupational groups such as agricultural workers (the scheme in Great Britain covered this category only after 1937). The treatment of long-term unemployed who have become ineligible for benefit always gives trouble And then there are always a number of "fringe" workers who for one reason or another do not (or are not entitled to) register as unemployed but among whom the percentage incidence of unemployment is usually higher than among those properly within the scope of the scheme.

For these reasons it is usually the case that social insurance data underestimate the amount of unemployment. In some ways, the sample survey of the type conducted in the U.S, and Canada is potentially the most accurate means of assessing unemployment for there are no restrictions of coverage because of date of entry into industry, age, kind of industry, occupation or sex. The chief deficiency is that, to count as unemployed, a man must be without work from Monday to Friday or Saturday in the inquiry week and therefore unemployment for shorter periods than five or six days tends to be ignored in the statistics. Little can be said at this general level about private reports on unemployment; their validity and usefulness obviously depend on the particular methods adopted.

This summary of the deficiencies of the various types of data should be sufficient to guard against too facile acceptance of published figures at their face value. But at the same time it must be made clear that, despite deficiencies, there is a wide measure of agreement among administrative definitions and treatment of unemployment which does in practice help the solution of some complex theoretical problems. Typically, it is not construed to be reasonable to force a person to take a job vacated because of an industrial dispute or to accept one which pays substantially

smaller wages or requires more hours of labour than those which obtain in his usual occupation or are prevalent in the community where the work is performed; or to expect him to make unusual sacrifices. In such cases as these, men are usually reported as being unemployed and there is no disharmony here with the theoretical points discussed. Similarly, common sense definitions are usually adopted to decide when a man is too ill to work and (except in the case of the sample surveys) to deal with unemployment lasting for periods of less than a week. On the other hand, insurance regulations usually refuse to recognize for benefit purposes unemployment resulting from voluntary quitting (unless through acts or conditions attributable to the employer which justify such quitting, such as injustice, acts of persecution or unreasonable changes in the conditions of employment) or loss of a job because of misconduct. Here there is some disharmony with theoretical requirements, as such men are clearly still in the labour market; therefore, this is another case where the statistical measures of unemployment may underestimate its extent.

World Statistics.—Having examined some of the general characteristics of unemployment statistics and noting their merits and demerits, the next stage is to survey the statistics and see what general comments about unemployment can be made.

TABLE I.—*International Index of Employment**
(1937 = 100)

Year	Mining, manufacturing, construction, commerce and transport†	Manufacturing only‡	Year	Mining, manufacturing, construction, commerce and transport†	Manufacturing only‡
1929	96	94	1939	103	106
1930	91	84	1940	101	106
1931	80	73	1941	108	115
1932	70	68	1942	113	125
1933	80	72	1943	116	133
1934	86	81	1944	114	133
1935	89	85	1945	111	122
1936	94	91	1946	116	119
1937	100	100	1947	124	129
1938	90	90			

*Chain index method used. Weighted arithmetic averages of national indexes taken.
†Countries covered for mining, etc. Union of South Africa (Europeans only), Canada, U.S., Japan, Austria, Czechoslovakia, France, Germany, Hungary, Ireland, Netherlands, Poland, Great Britain, Yugoslavia.
‡Countries covered for manufacturing only: as above, plus Chile, Denmark, Finland, Italy, Norway, Sweden, Switzerland, Australia and New Zealand, and less Czechoslovakia and Yugoslavia.
Source: International Labour Office, *Year Book of Labour Statistics*, 10th issue (Geneva, 1949).

Table I is an international employment series from 1929 to 1947. It shows changes in employment in a number of important countries in manufacturing industry alone and in mining, manufacturing, construction, commerce and transport. Despite the general increase in world population in the 1930s, the influence of the very heavy unemployment of 1932–33 and, to a lesser extent, the slump of 1938 can be seen in these figures.

Table II, however, is much more useful. Here are given statistics of the percentage ratio of unemployment to total numbers seeking work for Canada, U.S., Denmark, Netherlands, Sweden, Switzerland, Great Britain and Australia for a number of years between 1929 and 1948 and also an average for 15 countries for the years between 1929 and 1938.

TABLE II.—*Percentage of Unemployment in Various Countries**

Year	Canada‡	U.S.§	Denmark‖	Netherlands‖	Sweden‖	Switzerland‖	Great Britain ||, ¶	Australia‖	World average‖
1929	4.2	3.2	15.5	7.1	11.2	1.8	10.4	11.1	6.2
1931	17.4	15.9	17.7	18.1	16.1	2.6	21.3	27.4	16.5
1935	26.5	24.9	28.8	31.0	23.4	10.8	19.9	25.1	20.7
1936	19.0	20.1	26.3	26.3	21.1	11.8	16.7	19.5	17.3
1937	13.1	14.3	21.0	20.2	19.8	10.0	13.0	9.5	10.8
1938	15.1	19.0	22.4	27.2	19.0	8.6	12.0	8.7	12.6
1939	14.1	17.2	18.4	21.7	9.2	6.5	9.8	9.7	9
1943	2.2	1.9	6.3	6	5.7	1.4	0.8	1.1	5
1945	3.8	1.9	8.2	6	4.3	1.6	1.0	1.2	6
1947	3.0	3.6	4.0	6	2.8	0.8	3.0	1.2	5
1948	3.1	3.4	4.7	6	2.8	0.6	1.4	0.9	5

*These figures are only roughly comparable. For full details see I.L.O. *Year Book*.
†Estimated.
‡Labour force sample surveys. U.S. figures here differ slightly from estimate 1 in Table VI.
§Trade-union statistics.
‖Unemployment insurance statistics.
¶Employment exchange statistics.
**World average based on *International Labour Review*; *i.e.*, covers Germany, Austria, Australia, Belgium, Canada, Denmark, U.S., Great Britain, Japan, Norway, Netherlands, Poland, Sweden, Switzerland and Czechoslovakia.
‖Not available.
Sources: International Labour Office, *Year Book of Labour Statistics*, 10th issue (Geneva, 1949); *International Labour Review* (Geneva, June 1939).

TABLE III.—*Average Yearly Percentage of Unemployed among Members of Certain Trade Unions, Great Britain**

Year	%	Year	%	Year	%	Year	%	Year	%
1881	3.5	1891	3.5	1901	3.3	1911	3.0	1921	14.8†
1882	2.3	1892	6.3	1902	4.0	1912	3.2	1922	15.2†
1883	2.6	1893	7.5	1903	4.2	1913	2.1	1923	11.3†
1884	8.1	1894	6.0	1904	6.0	1914	3.3	1924	8.1†
1885	9.1	1895	5.8	1905	3.9	1915	1.1	1925	10.5†
1886	10.2	1896	3.3	1906	3.6	1916	0.4	1926	12.2†
1887	7.6	1897	3.3	1907	3.7	1917	0.7		
1888	4.9	1898	2.8	1908	7.8	1918	0.8		
1889	2.1	1899	2.0	1909	7.7	1919	2.4		
1890	2.1	1900	2.5	1910	4.7	1920	2.4		

*Persons on strike or locked out, or sick or superannuated, excluded. Percentage for earlier years based on expenditure on unemployment benefit. Series discontinued after 1926.
†Figures from 1921 exclude pottery trades; from 1924 exclude building trades
Source: 19th *Abstract of U.K. Labour Statistics*, Papers by Command 3140 (London, 1928)

It should be emphasized that these statistics differ considerably in coverage of the respective labour forces and to some extent in definition of unemployment, and therefore direct comparison between countries is rather hazardous. Nevertheless, they are most useful for showing the general experience over this period, in all the countries under review unemployment was at its peak in 1933 and fell off enormously after the outbreak of war in 1939. The rough generalization that the "twin scourges" of mankind, war and unemployment, at least do not occur simultaneously has some validity. It also seems legitimate to note that countries with a large agricultural labour force (Canada, Denmark, Australia) suffered heavy unemployment as well as the countries, such as Great Britain, relying mainly on industry.

Great Britain.—The statistics for Great Britain are worth close attention not only because of the important role of that

TABLE IV.—*Percentage of Unemployed among Insured Workpeople, Great Britain**

Year	Wholly	Temporary†	Total	Year	Wholly	Temporary†	Total
1922‡	—	—	17.0	1935‖	12.5	2.2	14.7
1922‖	—	—	14.3	1936‖	11.2	1.9	13.1
1923‖	—	—	11.7	1937‖	8.5	1.5	10.0
1924‖	—	—	10.3	1938‖	9.5	2.5	12.0
1925‖	—	—	11.3	1939‖	8.0	1.5	9.5
1926‖	8.7	3.8	12.5	1940¶	8.0	1.0	9.0
1927‖	7.4	2.3	9.7	1941¶	1.5	0.5	2.0
1928‖	8.2	2.6	10.8	1942¶	1.0	—	1.0
1929‖	8.2	2.2	10.4	1943¶	0.5	—	0.5
1930‖	11.8	4.3	16.1	1944¶	0.5	—	0.5
1931‖	16.7	4.6	21.3	1945¶	1.0	—	1.0
1932‖	17.6	4.5	22.1	1946¶	3.5	—	3.5
1933‖	16.4	3.8	19.9	1947¶	3.0	1.0	3.0
1934‖	13.9	2.6	16.7	1948¶	1.5	—	1.5

*Includes agriculture after 1937. Excludes men at government training centres after 1940. Excludes persons classified as unsuitable for ordinary employment, 1941–47. After that only excludes disabled persons requiring employment under sheltered conditions. After July 1948 includes all persons registered as unemployed at employment exchanges and not simply insured persons.
†Temporarily stopped. Includes persons on short time or otherwise stood-off on the understanding that they are to return to their employment within six weeks of date of suspension.
‡Figures refer to persons aged 16–64.
§Figures refer to persons aged 14–64.
‖Figures refer to males aged 14–64 and females aged 14–59.
Source International Labour Office, *Year Book of Labour Statistics*, and issue (Geneva, 1937), 6th issue (Montreal, 1942), 10th issue (Geneva, 1949).

country in world economy but also because the figures are unparalleled for the length of time covered and, until the late 1930s, for their scope and reliability.

The first table to examine is Table III, which gives trade-union data on percentage unemployed from 1881 to 1926. The proportion of the labour force covered by these figures changed considerably over this period and doubts have often been expressed about their reliability as a general indicator of unemployment. From the period (1920–26) during which the figures overlapped with the unemployment insurance statistics it does appear, however, that the trade-union statistics were a reasonably good guide. Some interesting features of the figures stand out, the most obvious being the low average level of unemployment before 1914 compared with the postwar period; *i.e.*, that for one reason or another, in Great Britain at any rate, unemployment was

a much less severe problem in the 19th century than in the inter-war period. But it is also clear that there were bad individual years (1886, 1893) and that therefore the dispersion of unemployment around the mean level was quite high. The virtual disappearance of unemployment in World War I is also clearly recorded.

Table IV shows the percentage unemployed among insured workpeople in Great Britain, 1921–48. There are a number of reasons why care must be taken in the interpretation of these figures, some connected with changes in the scope of the insurance scheme (*e.g.*, the late inclusion of agriculture, the extension to the 14- to 16-year-old group and the raising of the income limit from £250 to £420 in the late 1930s) and others connected with changes in the definition of unemployed, such as the treatment of men attending government training centres or the change in 1940 to the system whereby any two (instead of any three) days within a period of six consecutive days should be treated as a continuous period of unemployment. And it need not be reiterated that Great Britain's insurance statistics, in the treatment of marginal workers, are subject to many of the difficulties already listed. This, however, is not nearly so important when concerned, as here, with the percentage unemployed rather than the total volume. With these reservations in mind, the main conclusions to be drawn from Table IV are fairly obvious. Unemployment was very high at the beginning of the period because of depression and strikes; it gradually fell to about 10% in 1928–29, but rose to a new high level in 1932 and was, in fact, only wiped out by the outbreak of World War II. It should be noted that unemployment in the years after World War II was much less than in any other peacetime years of the period, even the early 1930s. The other main point to note is that the numbers temporarily stopped are a much higher proportion of the total unemployed, as one might expect, in 1926 (the year of the general strike) and 1947 (the fuel crisis).

Table V shows something about unemployment in different industries in the interwar period. It can easily be seen from this table that there was a large difference between the experience of the heavy industries such as coal mining, iron and steel and shipbuilding, on one hand, and the light industries (*e.g.*, papermaking, hosiery and bread and biscuits), on the other. There was also a contrast between the old industries, such as cotton textile, and the new, such as electrical apparatus.

United States.—As there was no national insurance scheme for unemployment in the U.S. before 1935, private estimates, such as those of the National Industrial Conference board and the American Federation of Labor, are the only available source of information before that date. As the main basis of these estimates was to extrapolate data on total labour force and numbers in employment from the decennial census figures and then take the difference as a measure of unemployment, no great degree of accuracy can be claimed for the result, if only because any given absolute error in one of these two basic magnitudes implies a much greater percentage error in the residual, by virtue of the small size of this figure compared with the others. Nor did the establishment of a social insurance scheme in 1935 automatically provide good data on unemployment, as in so many other countries. Simply because of the great size and variety of conditions in the U.S., the system had to allow for local modifications at the state level. Therefore, meaningful aggregate data for the entire nation are not easily obtained from this source. After 1940, the position improved as monthly data were collected on a sample basis on employment, unemployment and the labour force. This method seems to provide very satisfactory estimates and therefore after that date U.S. data can be taken as extremely reliable.

Table VI shows percentage unemployment, based on different estimates, for the years 1930–48. Although the discrepancies between estimates 1 and 2 over the years where they appear jointly seem very large, it should be noticed that the year-to-year movements are much more comparable and therefore, even though doubts may be attached to the absolute volume of unemployment during this period, the relative changes from one year to another seem reasonably clear. The main differences which emerge in any comparison with the British figures (Table IV) are the relative lightness of unemployment in the U.S. in the 1920s, a time when many British staple industries were severely depressed, and the persistence of heavy unemployment in the later 1930s up to and beyond the outbreak of World War II in Europe

Some partial statistics on unemployment by industry are shown in Table VII. As in Great Britain, there was a wide difference in the incidence of unemployment; whereas in 1932 percentage unemployment in all industries was 22, it was 42 in metals and 64 in building on the one hand and only 19 in printing on the other. It must be emphasized, however, that these figures are based on labour-union data and are therefore subject to the general limitations of such sources.

Finally, the relative extent of unemployment in different regions in 1940 and 1947 is brought out in Table VIII. It is interesting to note that unemployment in the southern, or less industrialized areas of the U.S., was apparently less than in the other parts of

TABLE V.—*Unemployment Percentage Rates by Industries, Great Britain**

	Agriculture	Coal mining	Iron and steel	General engineering†	Motor vehicles, cycles, aircraft	Shipbuilding	Electrical apparatus
1929	‡	16·2	19·8	9·7	7·0	24·2	5·2
1931	‡	38·3	45·0	27·6	20·4	62·4	14·1
1933	‡	34·9	38·0	25·1	15·6	59·3	13·7
1935	‡	25·2	22·8	12·8	8·4	42·5	8·7
1937	4·4	14·7	11·0	5·4	4·8	23·8	5·2
1938	6·1	23·5	21·2	7·4	6·8	21·1	8·0
1939	6·1	11·1	10·6	5·4	4·3	17·2	5·8

	Building	Paper	Cotton	Hosiery	Boots and shoes	Bread, Biscuits, etc.	Distribution trades
1929	13·3	4·4	13·2	6·2	13·1	7·2	6·2
1931	22·5	13·7	38·4	18·6	19·3	12·7	12·0
1933	24·1	9·2	29·2	11·6	17·3	11·7	12·1
1935	16·8	6·5	29·9	11·8	14·6	10·7	11·1
1937	13·8	4·2	11·5	8·2	11·0	8·6	8·8
1938	15·1	9·2	16·3	12·0	12·4	9·0	9·4
1939	14·4	4·9	13·9	6·7	8·6	8·0	8·8

*Includes casual and temporary stoppages as well as wholly unemployed.
†Includes steel founding.
‡Not available
Source: International Labour Office, *Year Book of Labour Statistics*, 6th issue (Montreal, 1942).

TABLE VI.—*Estimated Percentage Unemployed, United States*

Year	Estimate 1*	Estimate 2†	Estimate 3‡	Year	Estimate 1*	Estimate 2†	Estimate 3‡
1930	—	8·3	—	1939	20·8	17·6	—
1931	—	15·9	—	1936	18·2	14·2	—
1932	—	23·8	—	1937	15·8	12·2	—
1933	—	24·7	—	1938	20·5	18·4	—
1934	—	21·9	—	1939	18·7	16·4	—
1935	—	21·8	—	1940	—	14·1	14·6
1936	—	20·1	—	1941	—	6·2	9·9
1937	—	16·5	—	1942	—	—	4·7
1938	—	19·0	—	1943	—	—	1·9
1939	21·0	17·9	—	1944	—	—	1·2
1930	9·7	8·0	—	1945	—	—	1·9
1931	17·4	14·4	—	1946	—	—	3·6
1932	25·0	22·7	—	1947	—	—	3·6
1933	26·4	23·4	—	1948	—	—	3·4
1934	23·5	19·5	—				

*American Federation of Labor figures
†National Industrial Conference Board figures.
‡Bureau of the Census figures (based on monthly sample surveys).
Source International Labour Office, *Year Book of Labour Statistics*, 6th issue (Montreal, 1942); National Industrial Conference Board, *Economic Almanac for 1949* (1948)

TABLE VII.—*Unemployed Percentage by Industries, United States**

Year	All industry	Metals	Building	Printing	All other trades
1929	12	7	25	4	8
1930	21	20	40	7	14
1931	26	30	52	13	17
1932	32	42	64	19	20
1933	25	43	67	22	20
1934	26	37	57	28	28
1935	23	33	52	25	17
1936	17	23	33	22	14
1937	13	9	26	20	10
1938	18	24	37	22	14
1939	13	10	28	17	9

*Based on labour-union statistics. Unemployed occupied on public and civil works excluded.
Source: International Labour Office, *Year Book of Labour Statistics*, 6th issue (Montreal, 1942).

TABLE VIII.—*Unemployment Percentage by Regions, United States**

Region	1940	1947
New England	15·2	3·2
Middle Atlantic	15·1	3·6
East North Central	15·0	3·2
West North Central	11·2	2·6
South Atlantic	10·2	3·2
East South Central	11·2	3·6
West South Central	11·2	3·2
Mountain	11·2	3·2
Pacific	15·1	3·6

*Based on monthly sample surveys.
Source: International Labour Office, *Year Book of Labour Statistics*, 6th issue (Montreal, 1942).

the country both in a year of relatively heavy and one of relatively light unemployment. It is possible, however, that this conclusion might be vitiated somewhat by the much greater amount of suppressed or disguised unemployment, in the shape of family labour on farms in the south.

TABLE VIII.—*Regional Unemployment, United States*
(Percentage Unemployed)

Area	March 1940	April 1947
Northeast*	17·7	5·2
North central†	15·0	4·3
South‡	13·2	5·3
West§	10·1	6·0

*New York, New Jersey, Pennsylvania and New England states
†North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Michigan and Ohio.
‡Delaware, Maryland, Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Tennessee, Mississippi, Alabama, Georgia, Florida, Arkansas, Louisiana, Oklahoma and Texas
§Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Arizona, Nevada, Washington, Oregon and California
Source: U.S. Bureau of the Census

CAUSES OF UNEMPLOYMENT

To understand the causes of unemployment it is necessary to make a clear distinction between the different types and forms. Although it may be impossible to place any individual worker in any one category, the main distinction which economists usually make between general (or mass) and particular (or frictional) unemployment is indispensable for analysis. The first heading covers both the type of unemployment that occurs over the course of the trade cycle, such as that which struck the world in the early 1930s, and also the long-term trend toward increased unemployment that some authorities predicted for such mature economies as the U.S. It is essential to include both concepts under this heading, for obviously the stagnation type of unemployment might persist even if means of levelling out the fluctuations of the trade cycle were devised and, conversely, cyclical unemployment has certainly been found in the past in economies far from mature in the usual sense of the word, as a glance at the trade-union statistics for Great Britain in the 19th century (Table III) will show. Particular unemployment embraces such main categories as casual or intermittent work and seasonal work on the one hand, and what is usually called structural unemployment on the other. These sorts of unemployment will clearly persist however successful is the attempt to eliminate mass unemployment.

But it will be convenient to delay detailed examination of the causes of these categories until we have completed examination of the first type.

General Unemployment.—In the early 1930s, when unemployment had grown to formidable proportions, in the more advanced countries of the world it was the lot of about 20% of the labour force, and in some individual countries the figure was nearer 30% (Table II). This was by far the worst period in history for unemployment; for not only did it reach unprecedented heights but in many countries it lasted for a long time, being wiped out to any considerable extent only by the onset of World War II. It was this feature of long duration of unemployment which gave rise to the speculation about chronic unemployment being a permanent feature of advanced economies. For, whereas in the 19th century there had been bad individual years (*e.g.*, 1886, 1893; *see* Table III), the tide had usually subsided fairly quickly. But the strong evidence about the existence of mass unemployment in the 1930s should not allow us to forget the coexistence of particular unemployment. Although the theory of general unemployment will indicate why the average level of unemployment was 19.9% in Great Britain in 1933, it will not indicate why it was as high as 59.3% in shipbuilding but only 9.2% in the paper trades, why it was 34.6% in Wales but about 11% in London and the southeast. Nor does the theory of general unemployment have anything to say about the marked seasonal fluctuations which have always characterized unemployment.

Thus, to summarize the statistical evidence, there are good grounds for believing that unemployment is not one problem but many. And therefore it may be well to split up the theoretical analysis as suggested.

Examination of statistics has shown the tremendous problems created, or liable to be created, for western economies by general unemployment. From the beginning of the 20th century there was an increasing amount of attention paid to this phenomenon by economists, and, in fact, this topic in some cases replaced the traditional teaching of the theory of value as the keystone of economic thought. This general tendency received a tremendous impetus in the 1930s, being particularly associated with the publication in 1936 of Lord Keynes's *The General Theory of Employment, Interest and Money*, in many ways the most important book on economics since Adam Smith's *Inquiry into the Nature and Causes of the Wealth of Nations* was published in 1776. This work for the first time provided the basis for a satisfactory theoretical account of general unemployment. Until that date, it has sometimes been said, there were as many theories as there were economists.

Although not without a good deal of heated discussion and some modification of the more controversial arguments put forward by Lord Keynes, many economists accepted his central hypotheses and methods of argument.

The following sections elaborate some of the more important propositions in the theory as they were advanced by Lord Keynes.

National Income and National Output.—Although these notions are complicated in their details, the general concept behind them is fairly straightforward. If the economic life of any country is examined (and to sharpen the issue it can be regarded for the moment as self-contained, having no trading with other countries), it is fairly easy to see that over the course of any given period of time, say a year, there will be a certain amount of work done, resulting in the production of a number of different commodities—so many tons of coal mined, so many units of electricity generated, so many ton-miles of goods conveyed, etc. From this can be derived the concept of a national output over the year consisting, broadly, of the totality of work done by all the individual members of the community. Thus, over any given period of time it is possible to aggregate the amount of work done or services performed (there is no difference in principle between the man who makes butter and the man who sells butter—each is making a contribution to the general economic life of the community) into a meaningful total. Now, of course, there are a number of difficulties in the actual computation of this total. The most obvious is that there is no means of adding all the physically dissimilar products which form part of the complex pattern of modern life except in terms of money value. That is, to reach the total national output, it is necessary to add the value of steel bars, fountain pens, furniture, etc., produced over the course of the year.

This carries two immediate complications: the first is that the national output must be limited to those items which in fact can easily be measured in money terms and therefore, for instance, housewives' services must be excluded; and the second is that if a comparison is made between the national output in two different years it must be noted that any change may be the result either of a change in the physical volume of output or of a change in the value of money, the standard used for measuring this output, or, as is almost always the case, a mixture of the two. Another important problem arising in the calculation of national output must also be mentioned. It has been said above that the national output must be thought of as the aggregate of a number of tons of coal, units of electricity, etc. But, in fact, the value of electricity generated will include as an item of cost the value of any coal used in the process. Therefore, to add all the coal produced and all the electricity generated would obviously be duplication. Consequently, statisticians and economists adopt various conventions such as taking the "value added" by one industry to the materials it takes over from other industries (rather than the gross value of output) in attempts to eliminate this sort of duplication.

This gives some idea of the meaning of national output (or national product, as it is sometimes called). What is its relation-

ship to national income and national expenditure? On the basis of the definitions used here, these are really three different ways of looking at the same magnitude and, therefore, provided the correct definitions are chosen, must add up to exactly the same sum. This can be seen most easily by thinking of an independent producer such as a small shopkeeper or plumber who works on his own. His output is the value of his goods sold or services performed, less the cost of such things as materials bought from other tradespeople and used up in the course of his activity. Now clearly his income must be exactly the same size; for what is available for spending must inevitably be his receipts less necessary business expenses. And equally clearly his expenditure, if defined in the broadest sense to include purchases of securities and increases in bank deposits, etc., as well as acquisition of goods and enjoyment of services, must come to exactly the same total. Now it can be seen that the identity, output = income = expenditure, holds good in the case of independent producers. In fact, it holds good for all types of producers, and so long as nonproducers such as housewives and children are regarded as simply spending agencies for the producers in a household, it holds good for the community as a whole and therefore, according to Keynes, national output = national income = national expenditure.

Another point to make is that this identity holds good for an "open" economy having trading relations with other countries as well as the "closed" economy so far considered. This is clear when the value of imports exactly equals the value of exports and, in the case where these values differ, application of the same broad notion of expenditure will preserve the identity.

The exact relation of this topic of national output and national income to the main problem of unemployment must now be considered. It is evident that the size of the national output must be closely related to the level of employment, at any rate over a short period of time where technical innovations, etc., are unlikely to alter the productivity of labour materially. Therefore, if the forces controlling the level of national output can be discovered, this will in effect be a discussion of the causes of general unemployment. If it is remembered that a fall in national output is more or less equivalent to an increase in unemployment, no difficulty will arise. "More or less" must be noticed, however; for a fall in national output may take the form of a fall in prices rather than in physical output and therefore bear no very direct relation to the level of employment. But this complication can be ignored for the time being, while the central problems involved are discussed, and will be returned to later.

Keynes points out that the national income (alias output) can be dissected into the two subtotals which are the relevant tools for the analysis of employment and income fluctuations—investment (or saving) and consumption. Of the stream of goods and services produced each year, some pass more or less directly into final consumption, whereas others are primarily designed to last for some time and help in the production of other goods for final consumption. Whereas clothing, food, fuel, etc., fall in the first category (*i.e.*, consumption goods), plant and machinery, buildings (industrial and private) fall in the second (*i.e.*, investment goods). Therefore, total income or output can be entirely resolved into consumption and investment. (Any difference between the value of consumption goods coming onto the market and being taken off the market—that is, any accumulation or diminution of stocks over the period—is put in the latter category, for these goods are not contributing to present but to future consumption in just the same way as machinery and houses.) If, on the other hand, this matter is looked at in another way it can be seen that incomes received must be spent or saved; nothing else is possible, if saving is defined in the broadest sense, to cover all such items as adding to cash holdings as well as buying government securities or depositing sums in the post office savings bank, for in this case saving is essentially being defined as "not spending." Therefore, if income on the one hand equals investment plus consumption and on the other equals saving plus consumption, it must follow that investment equals saving. There is nothing very remarkable about this equality and, in fact, it follows directly from the definitions chosen. Nevertheless, it caused some difficulty and one or two apparent objections must be cleared up. One lies in the particular sense in which "investment" is used; it is not the same as the everyday usage of the word which implies the purchase of intangible claims or securities as well as the acquisition of physical assets such as houses. Here the word is used to denote purchases of the latter type exclusively. Therefore, the outlay of a businessman in building a new factory is investment; the sum paid by the public to acquire shares in his firm is not. Another point is that the savings-investment identity does not imply equality between investment and the total of positive saving. For over the course of each year some individuals spend less than their total income on consumption goods and services and hence save, but others spend more than their income and therefore dissave. The magnitude required is the net figure derived by subtracting the second item from the first. Still another point is that both income and investment may be taken either as gross or net of that amount of investment needed to maintain the existing stock of capital equipment intact. Although the savings-investment identity holds in either case (the difference between net and gross simply consists of making an equal addition to both magnitudes), it is simpler and more relevant to take the net concepts. Therefore, this connotation must be understood in all subsequent references to income, investment and saving, unless otherwise indicated.

Now a new problem arises. It is clear that the amount of investment which actually takes place in any one year is equal to the amount of saving taking place, but it is also equally clear that, by and large, the people who save are not the people who invest. What are the motives which inspire investment and savings and how does equality come about? These questions and their answers will be seen to be at the core of the theory of employment.

Let investment be considered first, with those sections of the community principally concerned, together with the motives that guide their decisions. Obviously most attention must be paid here to businessmen for, although governments that build battleships and roads, individuals that build houses and traders that add to their stocks are all said to invest, by far the largest role is played by businessmen in their decisions to add to their machinery and plant, their buildings and stocks of materials, semifinished goods, etc. Now the essential question the businessman must ask is whether his new building will yield sufficient profits to make the enterprise worth while. This in turn depends on two factors: (1) the expected series of returns (after deduction of operating costs) likely to accrue over the life of the machine, and (2) the rate of interest payable on the sum borrowed (or, alternatively, if capital is available without borrowing, what rate of interest could be obtained if this capital were lent to other firms or enterprises). For the decision to invest must depend on the comparison between the expected series of returns, suitably adjusted for the fact that these returns lie in the future and for any special risks involved, with the current rate of interest payable on the sum borrowed or raised in the form of share capital. The expected series of returns depends on a whole host of miscellaneous factors which are best summarized in the portmanteau phrase "business confidence," taking into account all such factors as the expected state of trade, the possibility of changes in taste on the part of the consuming public, the potential threat of new supplies or new inventions, etc. The rate of interest is largely under the control of the banking authorities. The relative importance of these two factors depends very considerably on the expected length of life of the investment planned; the longer the life the greater the allowance for futurity of returns and hence the more important the rate of interest and the less important such factors as the rate of amortization of capital. This is a complicated subject, but essentially the point is that, if equipment is expected to last only a short period of time or if the risks attached to investment are very great, a small fall in the rate of interest will have little effect on the level of investment. If, on the other hand, the building of long-lived capital equipment such as houses is a major fraction of investment, then a reduction in interest rates can be expected to give a considerable impetus. So much for the forces motivating investment.

For saving purposes some economists divide the community

into the three different categories of government, business and personal. Government saving obviously depends largely on general policy of taxation and expenditure and therefore may be roughly taken as an autonomous factor. At the same time it should be noted that there is an automatic tendency for tax receipts to rise (assuming unchanged tax rates) and expenditure, such as that on unemployment benefit, to fall in a time of boom and for the reverse to happen in a slump. Therefore, the amount of government saving does partly depend on national income. Business saving consists of two parts, the sums put aside to cover depreciation of plant and machinery and those put to general reserve; but as we are dealing only with net saving here we shall not err very far in neglecting the former. Additions to general reserves clearly depend to some extent on the level of income, although they are also influenced by such factors as the desire for a margin of security or the possibility of needing finance for future expansion. It seems fairly safe to say, however, that the ruling rate of interest does not influence them very much. Now comes the third category—personal savings. In normal times this is important (it was nearly half the total savings in Great Britain in 1938) and although its importance was reduced in post-World War II years, it was expected to increase again when more normal times returned. Much the most important factor here is the level of income, for as a man's income increases it is almost inevitable that there will be a gap between receipts and spending. Whereas the very poor spend every penny, the millionaire will find it difficult not to save a large proportion of his income. It must be noted that this income factor has a dual importance; for saving may increase, either because the income of everyone rises in some similar manner (say, in equal proportions) or because, although there is no rise in national income, there is a redistribution of income from the poorer to the richer classes. Therefore, saving can be said to depend on both the level and the distribution of income. It has been frequently maintained in the past that personal saving is also closely dependent on the rate of interest—that it is the stimulus of the return to be secured from buying securities or making bank deposits that impels people to save. But obviously this is debatable if only because those who save to secure a certain income in their old age will need to accumulate a smaller capital sum if the yield on it is to be larger. Therefore, many economists became inclined to be rather sceptical about the influence of the rate of interest on savings and disregard it as a factor of particular importance. Finally, even if the over-all income level, the distribution of income and the rate of interest remain unchanged, the amount of saving may still tend to alter if people's general attitude to thrift and the ownership of property change. This, however, is likely to be the case only over a fairly long period of time and need not affect the consideration of short-period problems.

To summarize this part of the Keynes argument: businessmen are principally responsible for investment and their decisions depend on expected profits and on the rate of interest; government savings are largely an act of policy while business and personal savings mainly depend on the level of income and its distribution, with a further very secondary relation to the rate of interest. The question that must now be answered is simply this: how are these plans reconciled with one another? Keynes had shown that recorded or realized investment and saving must be equal to one another; but if investment and savings plans are made by different sets of people inspired by varying motives, what is the mechanism which transforms planned inequality into realized equality? This is the central problem of employment theory and it is on this point that *The General Theory of Employment, Interest and Money* broke away completely from previous tradition. For until then it had always been argued, though with varying degrees of confidence and persuasion, that the equilibrating factor between investment and savings plans was the rate of interest. That is, it was argued that if investment tended to outrun saving the rate of interest would rise to such a level that investment would be curtailed and saving expanded to bring the two into equality; and if saving tended to outrun investment the rate of interest would fall. But, as has been seen, there is good reason for doubting the importance of the influence of the rate of interest on either investment or saving; in both cases it is often a minor factor. The solution which Keynes suggested was that the investment and saving plans were brought into equality by changes in the level of income; that if investment planned exceeded saving then the level of income would tend to rise and that if saving planned exceeded investment it would tend to fall—in each case preserving the equality of realized investment and saving. This concept of income shifting from one level to another in response to people's divergent plans for investment and saving is really fundamental to the whole structure of this way of thought. But although the fundamental idea is relatively simple to grasp, the details of the operation of the mechanism are by no means straightforward and must be examined at some length.

Let it first be asked, what happens if an investment, say the building of a new factory costing $5,000,000, is made. What will be the effect on the level of income? In general terms, according to Keynes, income will have to rise to a level sufficiently high to secure additional savings of $5,000,000 Specifically, the process of events will be something of this sort. The investment adds $5,000,000 to the flow of spendable income without any corresponding increase in the supply of consumption goods. Now suppose that people are prepared to save half of this incremental income but want to spend the rest. The first reaction will clearly be a reduction of dealers' stocks or, in other words, a sort of negative investment, albeit involuntary, partially offsetting the initial positive investment. This, however, will be only a temporary effect and will disappear as soon as dealers have had time to replace their stocks. Therefore, it may be said that there is an initial increment of income of $5,000,000; the recipients spend half of this and save half; the recipients of the $2,500,000 again spend and save half and so on. The increment in income resulting from the increment in investment will be $5,000,000 plus $2,500,000 plus $1,250,000 plus . . and the total sum can in fact be shown to be $10,000,000. Additional saving, on the other hand, will be $2,500,000 plus $1,250,000 plus $625,000 plus . . ., a total of $5,000,000, exactly sufficient to offset the incremental investment. This general process by which an increment in investment leads to a multiple increment in income is known as the multiplier effect, the multiplier being the ratio of the increment of income to the increment of investment; *i.e.*, in our example, 2. The value of the multiplier is a way of indicating how much of additional incomes are saved. It was assumed that one-half of additional incomes would be saved and hence the multiplier is two, the reciprocal of this fraction; if we had postulated saving of one-third of additional incomes, the multiplier would have been three. Therefore, we may say that the multiplier tells us precisely how much the level of income will have to change in order to bring the investment and savings plans of the population into harmony with one another. And, of course, it applies equally well in the case of a downward movement in planned investment in relation to saving.

It follows, therefore, that anyone who decides to invest more (less) will generate a degree of rise (fall) in income, depending on the willingness of the community to save out of additional income. But what happens if someone decides to save more of his current income? Is the process a parallel one or not?

The process of events is in fact something like this. If the community suddenly decides to save a larger proportion of its income the immediate reaction will be a piling up of unsold goods in shops, warehouses, etc. That is, dealers perform investment to offset the increment in saving. But this action is involuntary and obviously will soon lead to a reduction of orders from manufacturers. Thus, the increased desire to save will be transmuted into a reduced demand for current output and the level of output will tend to fall. It will continue to fall until people no longer wish to save more than the community is currently willing to invest.

Further Details of Employment Theory.—Keynes showed that, on one hand, saving and (to a lesser extent) investment depend on income; and, on the other, the level of income depends on people's relative willingness to save and invest. At first sight

it might seem that this is circular reasoning of the type that *A* depends on *B* which depends on *A*. But this would be mistaken. The point is that income affects the amount of saving and investment, whereas it is affected by the relative willingness to save and invest Thus, if at any given income level people decide to invest more, there is a rise in output and income; this in turn provides expectations of increased profits and hence is a further inducement to invest. But the increment in income provides an even greater incentive to save and therefore a stable position of income is reached, the desire to invest exactly offsetting the desire to save. If, on the other hand, the desire to save out of a given income increases there will be a fall in income; this will cut down the inducement to invest but nevertheless the reduction in income and output will not be indefinite, for the amount people desire to save will fall off *even* more quickly as the community's standard of living falls and therefore a stable lower position will in fact be reached. Therefore, a whole series of stable positions of output and employment must be conceived, ranging between full employment on the one hand and deep slump on the other (as will be seen below, it is possible in some circumstances for an economy to go "over the top," beyond the position of full employment, but this may be neglected for the time being), at any of which positions the willingness to save and invest may be brought into equilibrium with one another. A further point must also be noticed. Although an increased (decreased) desire to invest will almost always result in an actual raising (lowering) of the level of investment, an increased (decreased) desire to save will not in general lead to an increment (decrement) of saving. For in both cases the necessary equality between investment and saving is preserved by *income movements* which affect the amount saved. Therefore, although investment and saving must always be equal, they are not equal partners In the whole process.

If the desire to save at any given income level were reduced by some means, there would tend to be a rise in income and employment. It is therefore sometimes thought that the main need is to reduce the desire to save. In most cases this is quite true. For a reduction in the desire to save may not only lead to a higher level of output and employment but also to a higher level of investment (and saving) than is currently taking place and hence an accumulation of capital equipment which will ensure higher output and higher income per head in future years. But, at the same time, in the sort of position which prevails in the immediate aftermath of war there is usually a large unsatisfied demand for consumers' goods and hence a reduced desire to save does not lead *to* an increase *in employment* but simply substitutes consumption for investment. Or, in other words, the desire to save can only be considered as the villain of the piece in positions of less than full employment.

To put it very simply, the whole problem posed by Keynes could be stated in this way: investment and saving must always be equal to one another, and therefore any change in the desire to save or invest at a given income level will generate such a change in income as to bring these desires into harmony again. But some more elements still have to be fitted into the jigsaw to make the design complete. The most important is the problem of the rate of interest. For, if the older notion that the rate of interest is the equilibrating factor between people's willingness to invest and save is rejected, what explanation can be put in its place? Here again Keynes put forward revolutionary notions in his book, but it may be as well first to clear up a common misapprehension which is closely involved with this problem of interest determination.

It had often been thought that an addition to the quantity of cash, bank notes and bank deposits would in some way of its own accord influence the level of income and employment. But no one ever quite explained why it should do so and, in fact, more reflection shows that it does not, for it is the spending of money rather than its creation which inflates the level of demand for consumption or investment goods and hence the level of output. This distinction is vitally important and in order to illustrate it more clearly it is necessary to consider the most typical forms in which money is created. The most common way is by the process of open-market operations which, briefly, increases the reserves of cash or central bank credit held by the commercial banks and thus enables them to increase their deposits. This can be done either by the purchase of government bonds or by advances to businessmen. If the former is considered first, the most likely result is that the price of government bonds will tend to rise and the public will then be induced to sell bonds to the banks, the final effect thus being for the public to hold more money (in the shape of bank deposits) and the banks to hold more securities. The statement that the price of bonds will rise is, of course, equivalent to saying that the rate of interest will fall, for if the price of a 3% bond rises from $100 to $150 this means a reduction in yield from 3% to 2%. What determines the extent of price rise will be examined shortly. But it must first be noted that, if the fall in the rate of interest has no consequences, then the story is complete—*the only* effect of this creation of credit is to alter the relative amounts of money and securities held by the public and the banks. At first sight, additions to bank advances seem to fall in a different category for it appears that these flow straight into the expenditure stream as businessmen use them to purchase materials, hire labour, etc. This is an illusion. For it is not the creation of the advances but the spending of them which is responsible for the increment in expenditure and if businessmen chose not to spend these extra deposits there would, in fact, be no effects on total demand Similar considerations to these apply to the creation of money by other means and therefore the general principle can be laid down that additions to the stock of money do not, of themselves, add to the flow of money expenditure.

To return to the rate of interest: What determines the willingness of the public to switch from bonds to money as interest rates fall? Keynes's answer to this lies in another question: For what purposes does the public hold money? It is essential here to distinguish between the two functions of money as a medium of exchange and as a store of value. The public needs money to conduct the everyday business of life but the amount it needs for this purpose is a fairly constant fraction of the transactions in process; *i.e.*, of the level of national income. In addition, it needs money as a form in which to hold wealth. There are various forms in which wealth may be held—real property and securities, for instance, as well as money—and all these have varying advantages. The essential point is that the rate of interest ruling at any one time is the force which determines the proportions in which wealth is held in these forms. For, whereas bonds, for example, will give an annual yield but have some risks of depreciation, money has no annual yield but no risk of depreciation (in terms of money). Therefore, the public is always tending to distribute its assets between these different forms in order to attain some optimum compromise between yield and liquidity. If the rate of interest tends to fall, the relative attraction of money increases compared with that of bonds and a larger proportion of assets will be held in the former category. If, on the slightest sign of a fall in interest rates, there is a wild rush to sell securities for money, then in fact the fall in interest rates will be small. Therefore, we can now answer the question: How far will interest rates fall if new money is created? If the level of income remains unchanged people's demand for cash for transaction purposes will also remain unchanged; therefore, the rate of interest must fall to that point where people are willing to hold more cash and fewer securities in the light of the relative advantages of each type of asset.

But this leads to another point: Is there any justification for assuming the level of income unchanged and hence the demand for money for transaction purposes? This in turn extends to other ramifications of the theory of employment. The first is that, although the additional stocks of money have no direct influence on income and output, they are liable to cause a fall in interest rates and this, as was seen before, will have some effect on the willingness to invest, even if none on the desire to save, and hence there will tend to be a rise in the level of income and output. The second is that the demand for money for transaction purposes is closely related to the level of income. Therefore, if for any reason this rises there will tend to be an increased demand. If the total

supply of money is fixed, the only way of attracting money into active circulation is to persuade people holding capital assets in this form to part with it, and this will be done only if interest rates rise sufficiently to make them want to switch from money to securities. Therefore, it must be emphasized that an increase in the rate of investment *contains within itself the seeds of destruction* if the total stock of money is fixed; and conversely with a decrease.

This completes the main outline of Keynes's theory of employment—a complex pattern of interweaving strands. It may perhaps be summarized once more as follows: the principal factors are the willingness of people to invest, which in turn depends on the expected rate of profits and the rate of interest, and to save, which largely depends on the level of income; any divergence between willingness to invest and save at any given income level will tend to disappear through movements of income upward or downward from that level.

To conclude this discussion of the theory of income and employment advanced by Lord Keynes, some more complications must be briefly mentioned. So far movements in income have been described as if they automatically meant parallel movements in employment. But obviously this is likely to be true only within fairly narrow ranges; all people know from personal experience that prices tend to fall in slumps and rise in booms and hence movements in income are more than proportionate to movements in employment. Apart, however, from possible effects on the demand for money for transaction purposes, and hence interest rates, the only important modifications that become necessary in the central theory concern those extremities where price rises outstrip wage rises. Over a large range of income levels over-all wage rates and prices may be expected to move proportionately, though this, of course, does not imply similar changes in all individual prices and wage rates. But when there is a position of overfull employment, prices tend to rise faster than wage rates, hence profits rise rapidly and, as this may be expected to lead to some redistribution of incomes, the relationship of saving to income tends to alter. Another complication is due to the existence of government financial operations but the essence of this can be summarized by saying that if a government has a surplus of expenditure over receipts this is equivalent to additions to the income expenditure stream resulting from an increased level of investment, for in both cases there is an addition to the level of expenditure and no addition to the value of output of goods available to meet that expenditure. Yet another complication comes from foreign trade, but again the treatment is, in principle, straightforward. For if any country has a surplus of the value of exports over imports then this is exactly equivalent to an increment in the budget deficit or the level of internal investment, for it implies that exporters are receiving larger incomes than the value of goods being paid for by importers. Hence it can be treated in a precisely analogous way to the other factors.

Particular Unemployment.—The causes of general unemployment having been dealt with, it is necessary to examine the causes of those other various types of unemployment called particular or frictional. Here the works of William Henry (later Lord) Beveridge may be referred to, for it was his *Unemployment: A Problem of Industry* (1909) which first suggested the lines of analysis. If casual unemployment is taken first of all, it is fairly easy to see that there are some obvious causes. On the one hand, a good deal of work is intermittent in character and hence there are wide fluctuations in demand for labour. The classic example of this kind is dock work, where traditionally a reserve of labour was kept to meet peak demands for loading and unloading, the typical method of engagement being by the hour or day only. But all such temporary unemployment as that resulting from fires, floods, industrial disputes, etc., must also be placed under this heading. It must also be remembered that there is always a certain amount of marginal labour which for one reason or another—mental or physical incapacity or simply unwillingness to work regularly—may be absorbed into employment only in boom periods, such as wartime, when it is impossible to obtain all the labour required from normal sources. This point is of particular importance when standard rates of wages, irrespective of efficiency, have to be paid to all workers. Because these people are occasionally employed they must be regarded as part of the labour force seeking employment, but it is obviously their intermittent suitability for employment, rather than the intermittent character of demand in any one industry, which is the reason for unemployment of this sort. Therefore, both these kinds of factor contribute to the existence of a more or less permanent reserve of labour.

The second type of particular unemployment is seasonal. The meaning of this is obvious—that the conditions of demand (*e.g.*, Christmas postal services) or production (*e.g.*, potato harvesting) may make for alternate slack and busy periods in any one year. But the causes are perhaps a little less evident. For although it is clear that workers in seaside resorts are only likely to be needed in summer and that the demand for sausages is stronger in winter, it is equally clear that no seasonal unemployment would exist if proprietors of "board-residence" houses became workers in sausage factories in winter, and vice versa. The reason this does not happen so neatly is to be found partly in the fact that the numbers out of work and seeking employment in summer may not be exactly the same as those in winter and partly in that the process of moving from one job to another is not so simple as it may sound. It is unlikely that the sausage factories will all be found in or near the seaside resorts and it is not necessarily true that the ability to polish shoes or make beds in a seaside lodging house is evidence of good qualifications for packing sausages into cartons.

Structural Unemployment.—This problem is both more difficult to understand and of more gravity than those just discussed. The principal feature distinguishing structural from other types of unemployment is that it is associated with permanent changes in the working of the economy. These changes may be in tastes or in techniques or in relative importance of different localities. As an example of the first, the long-term tendency for Great Britain's consumption per head of alcoholic beverages to fall and that of tobacco to rise may be given, in the second case there are such phenomena as the replacement of cotton fabrics by synthetic fibres, or coal-fired locomotives by diesels; and in the third case there is the U.S. example of the competition of the cotton textile industry in the south with that in New England. Now it is of course true, as in so many economic problems, that in any particular case more than one of these causes are at work (*e.g.*, so many changes in tastes are the result of, or at least closely associated with, changes in techniques), but it is essential to keep these separate points clear in any analysis. These sources of unemployment were of major importance in the period between World Wars I and II. The reasons were to be found largely in the dislocation of the structure of world trade brought about by World War I (*e.g.*, the rise of new textile industries) and the increased rate of technical innovations. Some authorities would also argue that the very act of trying to raise standards of living must of itself magnify problems of this nature, because tastes are likely to be more fickle and pliable where living standards are high (and hence many goods inessential and liable to sudden fluctuations in demand) than where standards are low but stable. But whether such contentions be reasonable or not, the essential fact is that, as with other types of particular unemployment, it is necessary to explain not only why or how often a man loses his job but also why he does not get another immediately. The case of getting other jobs obviously depends partly on the level of general unemployment but it also depends on the mechanism for informing workers of other opportunities and for persuading them to seek out these other opportunities, as will be brought out in the following discussion of remedies for unemployment.

In conclusion of this analysis of the main causes of unemployment, both general and particular, it must be repeated that at any one time all these forces are likely to be at work and inextricably intermingled. It will never be possible to point to an individual and say "he is a product of general unemployment," or, "if there were no structural changes he would not be employed." But despite this fact, the separate analysis of the various causes of

unemployment is vital, as the discussion of remedies will make clear.

REMEDIES FOR UNEMPLOYMENT

Just as the causes of unemployment have been dealt with under two separate headings, general and particular (not including structural) so, too, the remedies can be treated in this way.

General Unemployment.—*It is important to note that some* commonly proposed remedies can be rejected immediately as unsuitable, on the basis of the foregoing theoretical analysis. The most important of these is the frequent assertion that it is only necessary to lower the wage rates of workers in order to secure greater employment. At first sight this sounds very plausible, for if the individual storekeeper wants to sell more of his wares he may often succeed by lowering his prices. But this analogy does not necessarily hold; for the vital point is that workers as a whole are not only the nation's producers but also the nation's consumers and if their wage rates are lowered their buying power is also reduced. Therefore, any general reduction in wage rates will, apart from possible reactions on the demand for money for transaction purposes and hence interest rates, be largely self-defeating.

Other suggested remedies are to be found in proposals for reducing the supply of labour by emigration, by raising the school-leaving age or lowering the retirement age, by restricting the number of female workers or by sharing the work by putting everyone on a part-time basis. There are various fine points connected with each of these proposals which need not be explored here, but the fundamental objection is common to all: none of them does anything to raise the level of income per head of the population. If the labour force is reduced by emigration, at the same time the number of consumers is also reduced, and it is therefore probable that the percentage of unemployment will remain unchanged. Similarly, if the work is shared by short-time employment, again nothing is done to increase the level of income and the level of demand in relation to the value of output.

Another suggested remedy is the combine or monopoly argument. If any one firm is able to get into a monopolistic position in an industry it can often increase its profits (compared with the freely competitive situation) by cutting output and raising prices. Therefore, it is sometimes argued, when profits fall in a trade recession it is necessary only to cut output to remedy the situation. The fallacy in extending the argument from one firm to all needs no elaboration.

The fundamental requirement of any remedy for general unemployment is that it must raise the level of aggregate demand in relation to the supply of goods currently coming onto the market, or, to put the same point in different language, it must raise the level of planned investment in relation to planned saving. Such a process must add more to the flow of potential expenditure than it takes away and therefore must lead to an expansion of the level of income and employment. But the attack on the propensity to invest and the propensity to save can take several forms. In the first place, an attempt can be made to boost investment by the business sector—or private investment as it is usually called. Secondly, a government deficit might be regarded as analogous to private investment in its income-creating potential. Therefore, an attempt can be made to expand public "investment." It must be noted here that public "investment" in this sense does not mean only the construction of battleships, electric power stations, roads and so on, but simply the excess of any type of expenditure over receipts from taxes, fees, etc. In other words, "investment" may expand because of increased expenditure on the traditional functions of law and order, education, etc., or because of a reduction in revenue, as well as because of the purchase of capital goods. Over-all planned investment may also be expanded by increasing the gap between exports and imports (or, more accurately, between visible and invisible exports and visible and invisible imports). The other possible means is to attack the propensity to save and this may take a dual form, dealing both with the allocations to reserve of business enterprise and with the savings of private individuals. To put the matter in another way, steps can be taken to reduce the propensity to save and increase the propensity to consume.

Which of these particular lines of attack or which combination of them should in practice be followed depends on the particular circumstances of the country concerned. There are really two points to consider here: first, what are the relative magnitudes of the different components of investment or saving; and second, which of these components is most liable to sudden vicissitudes or which has any marked downward trend over the years. Thus, in the U.S., the ratio of the level of imports or exports to the level of over-all income and the ratio of the difference between imports and exports to the level of over-all investment are normally so small that these factors do not feature high in the remedial measures for unemployment. On the other hand, the possibility of being dragged into depression by a sudden decline in exports is always a very real one for a country like Great Britain and, therefore, measures for combating unemployment resulting from this factor must merit close attention. But as a rough generalization it is probably not far from the truth to say that the real problem in most countries organized on a capitalist or semi-capitalist basis is private investment, both because of its size relative to the other components of investment and because of its tendency to sudden unpredictable fluctuations. Therefore, nearly all plans for full employment pay detailed attention to this aspect of the problem.

What sort of measures can be taken to effect the necessary changes in planned investment and saving? From the latter half of the 1930s this subject received perhaps more attention from governments than any other economic topic. Broadly speaking, the proposals fall under the three main headings of fiscal policy, monetary weapons and direct controls, and they will be discussed in that order.

Fiscal Policy.—Essentially, fiscal policy is concerned with influencing the level of public "investment" or the level of private saving and only indirectly with the level of private investment or the excess of exports over imports. Several ways have been pointed out by economists in which these ends can be pursued. First, the government may do nothing in a time of trade depression. It may seem paradoxical to suggest this as a remedy for unemployment, but in fact this policy was not usually followed in the past and actions were often taken which had the effect of raising the level of unemployment, such as the attempt to balance the budget by raising tax rates in Great Britain in 1931. If the government does nothing to alter rates of taxes and rates of unemployment benefit, according to this view, it will automatically tend to have an excess of expenditure over revenue and hence help to mitigate the severity of the depression. This "automatic" budget deficit will come about for a number of reasons, the principal ones being the tendency for tax receipts to fall more than proportionately to the fall in the level of incomes (if operating on a progressive tax system), the reduction in insurance contributions, when more men become unemployed, and the greater likelihood of people defaulting on tax payments on the one hand, and the rise in the total of unemployment benefit paid out, or the amount needed to support farm prices (in the U.S.), on the other. This is called "*built-in flexibility*" in the U.S.

The second type of suggested fiscal policy is to increase expenditure without increasing revenue in time of depression, or "deficit spending," as it is usually called. This variation of expenditure could, in principle, assume many forms, but practical proposals relate to variations in government expenditure on capital equipment or on government purchases for stock. The idea of government public works in time of depression has a long history, going back to the early 19th century; but it was given its most forceful early expression by the Minority report of the Royal Commission on the Poor Laws and the Relief of Distress (1909), Sidney and Beatrice Webb being closely connected with it. Subsequently it was put forward a large number of times and featured in nearly all the British government-sponsored documents on employment policy appearing after 1935. It was, of course, one of the main features of the New Deal program in the U.S. and of the Swedish recovery program in the 1930s. The idea of government storage of raw materials and semi-finished goods in bad times and their

release in time of boom was also another frequently mentioned device. Its sponsors claimed an advantage over the public works idea in that it is more flexible—purchases can be directed to those items which are particularly in oversupply; but it also has quite apparent disadvantages, such as the heavy costs of storage and the risk of loss from premature obsolescence.

The next main group of fiscal measures has the basic motif of decreasing revenue but maintaining expenditure, or "deficit without spending," as economists call it. As in the case of deficit spending, this type of action could, in principle, take a large number of forms. In practice, one of the most common suggestions is the variation of social insurance contributions. The idea behind this is that social insurance funds should aim at a balance over a period of years only and, therefore, provided that in boom years contributors' payments exceed benefits paid out, it is perfectly legitimate for the reverse to take place in slump years. There is an automatic tendency for this to occur, but if a deliberate policy of varying rates of contributions is adopted the tendency can be transformed into a certainty. The chief difficulty about varying other rates of taxation is that it is usually not possible to do this—or at any rate reap the benefits of it—without considerable time lags, and, therefore, if action has to be taken quickly it may not be very useful. Exceptions are to be found, however, in such items as the British purchase tax, which can be altered without any formal parliamentary procedure.

The next group of suggested fiscal policies is "spending without a deficit," or the policy of maintaining a balanced budget but raising the level of both receipts and expenditure. This type of policy is aimed at reducing the private propensity to save rather than increasing the level of public "investment." The general idea behind it is quite simple—that any increment in taxation will, in general, tend to be paid by the upper-income groups; and, because the greater part of personal saving is performed by these classes, saving will tend to decrease more than proportionately with post-tax incomes. On the other hand, it is unlikely that the extra government expenditure will be distributed in the same proportions among the different income groups as the taxes and, in fact, it is highly probable that, if it takes the form of such social welfare payments as old-age pension or family allowance, it will be distributed almost exclusively to the lower-income groups. The net result of these government operations is that income is redistributed from the rich, who are likely to save a high proportion of their incomes, to the poor, who are likely to spend a high proportion. This is the main point behind spending without a deficit but it should be noted that this policy would also work in the right direction if the government were to buy goods and services with its extra receipts as distinct from making grants of various types to the lower-income groups. In that case, it would not be necessary to examine the distribution of the government payments among the different people responsible for the production of these goods. According to sponsors of this remedy, the very fact that the government essentially acts as a spending agency for the rich, who would otherwise save, is sufficient to start the ball rolling.

The last type of fiscal measure to be examined is that which aims neither at increasing public "investment" nor at raising the (balanced) level of expenditure and receipts. Instead, it is proposed to readjust the structure of taxation in any country in such a way that a larger proportion of revenue is derived from those taxes, such as income tax, which impinge most on the higher-income levels, and a smaller proportion from such taxes as excise duties or sales taxes which usually bear more heavily on the lower-income groups. By such a rearrangement of taxation it is hoped that the propensity to save will be sufficiently reduced to conquer unemployment.

Monetary Policy.—Here exposition can be briefer for belief in the potentialities of restrictive monetary policies was not so pronounced at mid-20th century as it was formerly. The main action which the banking authorities can take is to increase the supply of credit, or lower the rate of interest, or both. The effect of lower interest rates on the level of investment, however, seems to many economists to be problematic and unlikely to influence the level of saving appreciably. Therefore, according to them, it hardly seems probable that a downward movement of interest rates is likely of its own accord to cure a deep depression, even though there may be rather more reason for believing that a rise in interest rates can be more effective in halting a boom. And they point out that any change in the quantity of money as such has no other effects of great consequence; bank notes do not walk into shops and ask for goods and therefore any increment in the supply will not of itself avail much.

Direct Controls.—The principal types of direct-control measures suggested attempt to deal with the other two components of investment—private investment at home and the excess of exports over imports, or foreign balance, as it is usually called. It has often been suggested (*cf.* Sir William (later Lord) Beveridge, *Full Employment in a Free Society* [1944]) that a national investment board should be set up. In this particular context the idea was to influence capital works in both the private and public sectors of the economy, but the most essential point is that it is an attempt to soften the capricious nature of private investment. Many schemes were also proposed for control of exports and imports in time of depression. It is not possible to outline all these plans but it may be noted that they have been proposed at national and international levels. The national schemes comprise all such devices as tariffs, quotas and control of capital movements; the international schemes are incorporated in such bodies as the International Monetary fund to prevent malpractices in manipulating exchange rates, the International Bank for Reconstruction and Development (for encouragement of international loans) and the International Trade organization, which proposed many devices for liberating and stimulating world trade.

This is a brief summary of the various fiscal, monetary and direct measures for dealing with unemployment. Some of the principal snags involved in these policies may also be sketched. The first point is that the possibility of successful action depends on whether concern lies with the type of depression which has occurred at regular intervals since the 19th century or, in other words, the problem of cyclical unemployment; or whether policies are to be devised to deal with the stagnation type of unemployment. (It will be remembered that, in dealing with causes of unemployment, it was argued that both notions must be construed under general unemployment.) If fiscal policies are considered, obviously some such measure as the redistribution of income through public finance operations could conceivably be used as a remedy in either situation, but others, such as the balancing of social insurance funds over a period of years, are anticyclical weapons. Therefore, the means chosen must depend to some extent on the type of general unemployment that has to be dealt with in any particular country at any particular time. Nevertheless, some general difficulties in implementing policies to deal with either type can be indicated. The fundamental difficulty in dealing with cyclical unemployment is the timing of the remedial measures. So many policies—and this is one objection of some economists to "built-in flexibility," for instance—work fully only when heavy unemployment actually arrives; and it is precisely this state of affairs which they are supposed to prevent. In fact, it can actually be shown that if government measures are mistimed they may increase the fluctuations of employment over the trade cycle, rather than reduce them. With regard to stagnation unemployment, some economists point out that remedial measures may imply a recurrent government deficit or excess of expenditure over receipts. Over the trade cycle, others hold, this is unlikely as it is reasonable to expect that any deficit in the slump can and will be met by a surplus in the boom. But, if antiunemployment measures have to be taken over a long period of successive years this is impossible and it must follow that the national debt will increase all the time. Many authorities are loath to agree that it should occur and therefore imply definite limits to the possibilities of remedial action.

It may sound reasonable to move from this abstract plane of discussing difficulties of counterunemployment policies to some recital of the experience of different governments in applying such policies during the great depression of the 1930s. Unfortunately,

however, it is not easy to base any conclusions on these experiences, partly because relatively few governments pursued what is understood to be the right kind of policy and partly because those who *did often failed to do* it on a sufficiently large scale. Although a number of conclusions can be drawn from the U S. experience about the speed with which public works can be inaugurated, for instance, it must be remembered that even there, despite all the talk of deficit spending, "pump priming" and the like, private investment was reduced from $17,600,000 in 1929 to an annual average of $6,250,000 in 1931–38, whereas government expenditure on goods and services of all types rose only from $11,000,000 in 1929 to $11,700,000 in 1931–38 (average). Similarly, although the adoption of remedial measures in Sweden more or less coincided with a revival of activity and employment there, this tells very little about the possibility of such measures actually preventing the unemployment ever occurring in the first place.

Particular Unemployment.—Less discussion of remedies for particular unemployment is necessary, not because it can be regarded as unimportant, but partly because the best cure for particular unemployment is to cure general unemployment—for instance, the obstacles to movement from one area to another or the inducements to employers to hire men for short periods are much less if a state of general prosperity is prevailing—and partly because the remaining remedies for particular unemployment are more obvious and less subject to argument than those already discussed for general unemployment.

The main type of remedy for particular unemployment is to improve the mobility of labour, both between different jobs and different areas. The establishment of labour exchanges on a nation-wide basis, where all employers with vacancies and all employees seeking work may register, is an obvious step. But all such schemes as those for cutting down restrictive practices, training workers for new or skilled occupations, travel grants to help them move from one area to another will assist in this field. On the other hand, it is often suggested that jobs should be made mobile too, that some control should be exercised over the location of new industries taking the place of those declining through structural changes in the economy. Thus, in Great Britain, considerable powers were exercised after World War II over the location of new industries or new factories, and efforts were made to direct them to the old depressed areas such as south Wales, where it was feared that a local surplus of labour might reappear after the war.

Casual or Seasonal Unemployment.—A number of miscellaneous policies have been proposed or adopted to deal with this problem. A good deal of attention has been given to the reform of the methods of industrial engagement, discouraging or forbidding employers to maintain a permanent reserve of labour in their industry. A good "intelligence" system organized through labour exchanges, control over the location of new factories and even such devices as the placing of government orders in off season, or encouragement to manufacturers to make for stock at those times can help enormously in cutting down seasonal unemployment.

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UNEMPLOYMENT INSURANCE. Prior to 1912 no country had a national system of compulsory insurance. The British National Insurance act of 1911 was the first to incorporate compulsory unemployment insurance into the institutional structure of a nation. After that time it became a part of the legal structure of most of the leading nations of the world. The decade of the 1930s witnessed significant new developments, particularly in Great Britain, Sweden and the United States.

Trade unions and friendly societies had granted assistance to unemployed members since the middle of the 19th century. A few towns and cantons in Switzerland established voluntary publicly subsidized funds from 1893 onward. In 1895 St. Gallen, Switzerland, attempted a compulsory system but the scheme ceased operation after two years. A more successful method was developed, known as the Ghent system, under which municipalities and other local authorities supplemented the benefits paid by trade unions and other associations of workingmen to their members. This system of co-operation between the local authorities and the trade unions was extensively used in Belgium, the Netherlands, the Scandinavian countries and France.

The British act of 1911 covered but a few industries and 2,250,000 workers. It was frankly experimental. The industries were construction, shipbuilding, mechanical engineering, iron founding, construction of vehicles and sawmilling. Very few women were covered. It was essentially an insurance plan under which the employers and workers each contributed 2½d. per week and the exchequer a sum equal to one-third of the total receipts from employers and employed. The rate of benefit was 7*s.* a week for adults, half-rates for persons between 17 and 18 years of age. A one-week waiting period was followed by a right to draw a week of benefits for every five contributions paid up to a maximum of 15 benefit weeks in one year. To obtain benefits a person had to show that he had worked in an insured trade in 26 weeks during the preceding five years, had applied at the employment office for work, had since been continuously unemployed, was capable of work and had not exhausted his right to benefit. He could be disqualified if idle voluntarily, through misconduct or because of a labour dispute. An insurance officer passed upon his application. His decisions could be appealed to a court of referees consisting of an employer, a workman and an impartial chairman; from them to an umpire appointed by the crown.

The act permitted an association of workers which paid allowances to the members to administer for those members the benefits payable under the act. This tended to encourage voluntary systems of unemployment assistance. So did another provision permitting the repayment to workers' associations, whether in insured trades or not, of one-sixth of their expenditures on account of out-of-work allowances to their members.

An employer who kept a workman continuously employed for a year and paid at least 4*s* contributions in respect to him might obtain a refund of one-third of his own share of the contributions. Workmen who attained the age of 60 and had paid 500 contributions were permitted a refund of their contributions, with compound interest, minus benefits they had received. Contributions first became payable in July 1912 and benefits became payable Jan. 1913. Obviously this was an inadequate period for the accumulation of reserves, but World War I prevented any strain on the insurance system during its early years. Administered at first by the board of trade, it was put under the ministry of labour in 1917. A national system of employment exchanges was set up as a preliminary step to the establishment of insurance.

During World War I, employment in the insured trades was good and, though the collection of contributions went on, very little was paid out in benefits. The result was a succession of surpluses of income over expenditure down to the end of the war. In 1916 an act was passed which brought into insurance for a period of five years or until three years after the end of the war, whichever was longer, certain additional trades and all munitions workers not already insured. The chief trades brought in were the metal, chemical, rubber, leather and ammunition trades. Thus, the total number covered by the insurance scheme at the end of 1916 was about 3,750,000, of whom about 1,000,000 were females. These

workers were brought into the scheme because it was anticipated that there would be considerable unemployment among them on the cessation of hostilities No changes were made in the rates of contributions or benefit or in the general conditions. Benefits for men and women were the same, 7s. a week for adults.

Out of Work Donations Act and Doles.—The British plan has been basically an *insurance* plan throughout its history. Employers and employees have both paid specified contributions for the purchase of definite benefit rights for insured workers Down to Nov. 1918, it followed this insurance principle strictly Then, in order to cope with the serious unemployment of ex-servicemen and former war-industries workers, the Out of Work Donations act was passed, under which more than £40,000,000 was paid to ex-service people and more than £21,000,000 to civilians These funds were not raised through insurance They were provided by vote of parliament. But they were disbursed through the machinery of the unemployment insurance system and for a time the Donations act virtually superseded the Insurance act. After that time the policy of using the machinery of the act to distribute unemployment relief, supplementary to the insurance, was used almost continuously until the 1934 revision when a separate administrative agency was created, the Unemployment Assistance board, to handle the "dole," leaving to the ministry of labour the administration of unemployment insurance Thus, after 16 years of experimentation with mixed unemployment insurance and unemployment relief, the British separated them and went back to their insurance system, but not to as pure insurance as before 1918, since the dependents' benefits started in 1921 remained a part of the benefits structure.

The Act of 1920.—After the war the subject of unemployment insurance was examined by a number of committees, all of which reported in favour of the extension of the scheme. The problem faced in 1920 was that if the contributory features of the Insurance act were maintained and enforced, about 500,000 genuine unemployed would be forced either to become "paupers" and obtain support from the local poor law authorities or to find some other means of existence, with the added probability that the financial structure of many local governments would break down. The institution of the out-of-work donation scheme and the need for awaiting the resettlement of industry into its peacetime occupations postponed for a time the extension that was generally anticipated and desired, but in Dec 1919 a bill for this purpose was introduced and was passed into law in Aug. 1920

The Unemployment Insurance act, 1920, repealed all earlier enactments and, with amendments, remained the foundation of the scheme until 1934.

It came into force on Nov. 8, 1920, and brought into insurance an additional 8,000,000 persons, making, with those insured under the earlier acts, a total of about 11,750,000 persons insured against the risk of unemployment. The scheme as extended by the act of 1920 applied to all persons of 16 years of age and upward employed under a contract of service or apprenticeship (except apprentices without a money payment), save those in certain excepted employments, the chief of which were agriculture and private domestic service.

The permanent employees of government departments, local authorities, railways and general utility companies were also excepted.

Nonmanual workers in receipt of remuneration exceeding £250 a year were also excepted. Contributions ceased to be payable by the employed person, and he ceased to be entitled to benefit, on reaching the age of 65, but the employer remained liable for his share of the contributions.

About half the unemployed were unable to qualify for benefits under the existing rules; *i.e.*, 1916 act rules The new act extended to all covered by it benefit rights on substantially the same terms as to contributors who had been paying for their benefits In addition, the weekly benefit rate was increased to approximate the cost of livelihood and in 1921 dependents' benefits were added, which incorporated relief allowances into the insurance scheme This union of insurance and relief continued until the scheme was reorganized in 1934. **Moreover, no test of means or needs was set** up for the insured class. The waiting period was reduced from six days to three days. Thus was the most costly alteration made during the passage of the bill through parliament

Because of these changes made during the passage of the bill, changes which increased the cost of the scheme, the contributions of employer and employed were increased and, instead of being, as intended, in the case of adult male contributors, 3*d* from employer, 3*d*. from employed and 2*d* from the exchequer, the amounts became 4*d*., 4*d*. and 2*d*. respectively. Thus, instead of paying one-fourth of the total contribution, the exchequer paid one-fifth. Benefit was payable in proportion to the number of contributions previously made and subject to a maximum of 15 weeks' benefits in a year as in 1911, but instead of one week of benefit for every five contributions, the rule was one week's benefit for six contributions, hence the "1 in 6 rule" The weekly rate of benefit was increased and the act of 1920, following the precedent of the out-of-work donation scheme, prescribed different rates for men and women, the former being entitled to 15s. and the latter to 12s. Boys of 16 to 18 received 7s. 6d. and girls of the same age 6s. a week. The reserves which the fund had in 1920 were quickly dissipated and the fund ran far into debt. The whole conception of a contributory insurance scheme bid fair to be extinguished

Statistical Basis of the Scheme.—Upon the data available when the act was being framed, it was assumed that over a period or cycle of good, bad and average years of trade the rate of unemployment among workers in the trades to be insured would be 4% The act of 1920 contained, as explained later, provisions enabling industries to contract out of the general scheme It was estimated that after allowing for the withdrawal of those industries that might be expected to contract out, the industries that remained in the general scheme would have an unemployment experience of 5.32% over a cycle. It was upon this basis that the finance of the scheme was founded There was no real opportunity to test the soundness of these assumptions up to the start of World War II because of the much greater severity of unemployment (1930–39) than the actuaries had anticipated. Material alterations in the contributions and benefits had changed the act so much that the original calculations were not applicable. The conditions and disqualifications for benefit were almost identical in 1930 with those under the act of 1911 and need not, therefore, be repeated The machinery of adjudication upon claims (viz., the insurance officer, court of referees and the umpire) was maintained.

The act of 1920 contained two provisions for enabling persons who would not otherwise have been qualified to draw benefit under the scheme. The first was that men discharged from the forces should be given a free credit of contributions to enable them to receive up to the maximum period payable during 12 months; this was at first 15 weeks and later 26 weeks in a year. The other special qualifying condition was temporary. It was that during the first 12 months of the scheme benefit might be paid up to a maximum of eight weeks as soon as an insured person had paid four contributions. This was to provide for new entrants who had had no opportunity to satisfy the statutory condition of the payment of 12 contributions. Even this relaxation of the normal condition did not prove adequate to meet the situation which arose. The act of 1920 began to operate just when the severe industrial depression began. To meet this situation an act was passed enabling eight weeks of benefit to be paid to persons who had been engaged in insurable employment during ten weeks from Dec. 1919 or during four weeks after July 1920. Even this proved insufficient, as will be shown.

The right of employers to receive a refund of a part of the contributions paid in respect of workmen in their regular employment was not continued, but the practice of refunding to workmen their share of the contributions paid in respect of them, less any benefit they had received, was retained. This right of the workmen was, however, abolished in 1924.

An important new feature was included in the extended scheme of 1920. Power was given to an industry to set up a special scheme of unemployment insurance for itself and so contract out of the general scheme. Such a scheme when approved had statutory force and effect and was binding on all employers and workers

in the industry. The chief conditions which applied to a special scheme were that it must cover all persons employed in the industry; the benefits must be, on the whole, not less favourable than those provided under the general scheme; the state contribution would be on a reduced scale; and the scheme would be administered, not by a government department, but by a joint body of employers and employed in the industry.

It was expected that several industries with low rates of employment would contract out of the general scheme and a number prepared to do so, but because of the severe trade depression which began in the autumn of 1930 only two industries formed special schemes; viz, the insurance and banking industries. The power of contracting out was suspended as from July 1931 and was abolished by the act of 1927.

Twenty Acts (1920–30).—After the principal act of 1920, no less than 20 acts of parliament dealing with unemployment insurance were passed down to June 1930, while contributions under the scheme were dealt with in two other measures. The need for this mass of legislation was in the wholly exceptional mass unemployment which began in the autumn of 1920, just when the scheme commenced, and continued until World War II. These several acts had one main purpose; viz., to enable benefit to be paid to those persons normally employed in the insured trades who were unable to satisfy the usual requirement of the prior payment of contributions The general trend was toward more generosity in dealing with the needs of the unemployed. The act of 1930 marked the extreme relaxation of the benefit rules. It opened the door to claimants who had no moral right to benefits, especially married women and seasonal and casual workers who merely "signed on" at the labour exchanges because there was a chance for benefits. The legislation which followed the principal act brought into existence a system of additional benefit which was first called "uncovenanted" and later "extended" benefit. The most important and serious effect of these extensions of rights of benefits to persons who had not earned them through previous contributions was that British workers came to regard the employment exchanges as banks where they always had a balance upon which, subject to the rules, they always had a legal right to draw without query into their need for the benefits. This sense of rights became a part of British social life.

Uncovenanted Benefit.—Persons who desired to obtain the advantage of this extended system of benefits although they had exhausted all their contributory rights, or even although they had paid no contributions at all, were required not only to fulfil all the usual conditions for covenanted benefit (except those relating to contributions), but also to satisfy certain additional conditions. These extra conditions varied somewhat from time to time, but in the main they required the claimant to show that he was normally employed in an insured trade, that he had done what, in the circumstances of his case, could be regarded as a reasonable amount of work in a recent period, and that he was making every reasonable effort to obtain work suited to his capacities

The various measures dealing with uncovenanted benefit proceeded for some time on the basis of allowing it to be drawn for a stated number of weeks during certain periods which were termed special periods. It was found that the provision so made did not meet the needs of the case and that many insured persons were obliged to apply to the poor law authorities for relief, during the intervals, or "gaps" as they were termed, between the periods for which benefit was payable. From time to time the number of weeks for which benefit might be drawn during the special periods was extended and increased and the gaps were reduced in length and finally abolished.

The additional conditions which had to be fulfilled by recipients of extended benefit were in general of such a character that they did not readily lend themselves to precise adjudication or determination by the authorities set up to give decisions on the normal conditions. Partly for this reason, partly in order to ease the burden which would otherwise have fallen on the ordinary machinery, the work of advising whether or not extended benefit should be allowed in individual cases was given to the local employment committees, bodies which had been appointed by the minister of labour to advise him on the employment position in the areas of the employment exchanges and generally on the work of the exchanges. These committees were representative of the employers and employed in each district and had additional members nominated by other bodies such as boards of guardians and ex-servicemen's associations.

As a further means of meeting the need for exceptional assistance to the unemployed a measure which, in its title, was described as a temporary provision, was passed in Nov. 1921, by which an insured person in receipt of unemployment benefit became entitled to receive in addition 5*s.* a week for his dependent wife and 1*s* a week for each dependent child. This act was intended to operate for six months only, but the provision made under it for adult and juvenile dependents was made part of the general unemployment insurance scheme early in 1922. The classes of persons in respect of whom the 5*s.* allowance might be paid were also extended and the rate for children was increased to 2*s.* a week

Cost of the Depression.—In order to meet the increased expenditure due to the long continued depression and to the grant of extended and dependents' benefit the contributions of all three parties—employers, employed and the exchequer—were raised and power was given to borrow up to £30,000,000. The contribution in respect of a man became 2*s.* 1½*d.*, borne as to 10*d* by the employer, as to 9*d.* by the employed and as to 6½*d.* by the exchequer. This was, later, reduced to 1*s.* 9*d* , the three parties paying 8*d.*, 7*d.*, and 6*d.* respectively. There were variations also in the rates of benefit. Starting in 1920 with 15*s* for men and 12*s.* for women these rates were raised to 20*s.* and 16*s.* respectively in March 1921, but were reduced to 15*s.* and 12*s.*, again from the end of June 1921. As from Aug 1924 they were again increased to 18*s.* for men and 15*s.* for women. The changes in rates under the acts of 1927 and 1930 are mentioned later. It is right to say that the various acts of parliament passed from the end of 1920 to 1926 inclusive were all regarded as emergency measures and that the extended benefit paid under them was regarded as paid in advance of future contributions. No separate account was kept of the cost of extended benefit but for some time before April 1928 probably more than half the persons in receipt of benefit were drawing extended benefit. The amount of the debt varied considerably. The borrowing power was first exercised in July 1921. By the end of the year the debt was £7,000,000. It reached £17,060,000 in March 1923, but fell to £5,000,000 in 1924. It rose again to nearly £25,000,000 in March 1927 largely in consequence of the severe unemployment due to the coal dispute which lasted for six months or more in 1926.

During 1925 and 1926 the whole subject of unemployment insurance was examined by a committee under the chairmanship of Lord Blanesburgh. They made a number of important recommendations for the amendment of the scheme with a view to putting it on a sound and permanent basis. In particular they advised the abolition of the dual benefit system; *i.e.*, the concurrent existence of standard and extended benefit. The recommendations of the committee were accepted in principle by the government, and with one main exception were passed into law by the Unemployment Insurance act of 1927. That act made a number of changes in the scheme, dealing among other matters with the rates and conditions of benefit, the creation of a class of young persons between 18 and 21 years of age, the abolition of extended benefit and of contracting out.

During the years 1931–34 unemployment insurance became a menacing factor in British public finances and a major factor in political party struggles In 1931, expenditure for contributory and noncontributory benefits was at the rate of £125,000,000 a year, while the contributions of employers and workers were at the rate of less than £30,000,000 a year.

In addition, the government was spending approximately £30,000,000 on relief works.

On Nov. 12, 1931, benefit rates were cut 10% (adult males from 17*s.* to 15*s.* 3*d.* and females 15*s.* to 13*s.* 6*d.*, and adult dependents from 9*s.* to 8*s.*), and their duration to 26 weeks per year. These new rates remained in effect until the 1934 law went into effect on July 1, 1934, when the 1930 rates were restored, but every claim-

ant was made to prove 30 contributions in the two years preceding the date of his claim. These restrictions excluded over half of the current list of claimants from drawing insurance benefits as a right They cut off more than 1,000,000 persons. These were now offered a new relief called "transitional payments" *subject to a means test* These payments could not exceed what the person in question would have drawn under insurance, but they might be less. The exchequer footed the bill. In addition, stiff regulations were made to deter married women, seasonal and casual workers, and semi-retired persons from obtaining either insurance or transitional payments.

This purge, together with the means test, was deeply resented by many poor people. The rolls were reduced by approximately 200,000 persons, equivalent to a saving of £10,000,000 a year. Another effect was a substantial increase in private relief for the unemployed.

The constructive results produced by the new transitional payments scheme were that it reintroduced the giving of noncontributory relief according to needs instead of as a right, and that it kept thousands of people from making applications who could not apply on a basis of need but did apply when public "doles" were given as a right at fixed rates and without requiring previous insurance contributions.

The act of 1934 thus created, parallel to the unemployment insurance system, a national system of assistance for those unemployed who were without insurance rights, administered by a new national administrative agency, the Unemployment Assistance board.

Relief payable for other reasons than unemployment still remained a local function. The act also expanded the insurance scheme to the widest insurance coverage it had ever had and restored the 1931 cuts in rates. A steady contributor could now draw a maximum of 52 weeks' continuous benefits if necessary. Certain classes of agricultural workers and domestic servants were able to come under the act. As set up by the 1934 act, the administration of the unemployment insurance scheme remained in the ministry of labour, with a new body, the Unemployment Insurance Statutory committee, empowered to watch the operation of the scheme and act as official advisers both to the ministry and to parliament.

In 1936 coverage was expanded to include 600,000 agricultural workers in a separate scheme in which contribution and benefit rates were lower than in the general scheme

The separation of unemployment assistance from insurance, accompanied by the improved economic conditions in the late 1930s, resulted in a greatly strengthened financial position for the unemployment insurance fund. Whereas under the 1934 act the debt of the fund to the exchequer had been funded at £105,800,000, to be repaid at the rate of £5,000,000 annually, the insurance surpluses permitted a much faster rate of repayment. During World War II, the debt was paid in full and a large reserve accumulated (approximately £500,000,000 in 1948, when the fund was merged with the National Insurance fund). Coverage was expanded in 1940 to cover nonmanual workers earning up to £420 per year.

Benefit and contribution rates were increased periodically, so that by the time the national insurance program went into operation in 1948 the adult unemployed person (man or woman) was receiving 24*s.* per week. The adult dependent's benefit was 16*s.* weekly, and the rate for the first two children was 5*s.* each, plus 4*s.* each for any subsequent children. Contributions were 10*s.* each per week from employer and insured adult male worker; the government contributed at one-half the joint employer-employee rate.

Effect of the National Insurance Act of 1946.—As a result of the Beveridge report of 1942 and subsequent deliberations, all legal provisions respecting unemployment insurance were incorporated in the National Insurance act (9 & 10 Geo. 6, ch. 67, Aug. 1, 1946), which also governed cash benefits for sickness, maternity, retirement and death.

The effect on unemployment insurance was less pronounced than in the case of health or pensions, where the benefits had been lower but were now made uniform at the same rate for all risks.

Coverage was extended to all persons aged 16 to 65 (60 for women) employed under a contract of service. As a result, the number of covered workers in July 1948 under the National Insurance act was estimated at 20,500,000 in Great Britain, as compared with the 16,100,000 who had been covered immediately before the new program began to operate. The agricultural scheme as well as the separate schemes in insurance and banking were merged with the general system. Contributions were payable by the employer, the employed person and the exchequer, but were part of the total national insurance contribution.

The unemployment insurance contribution was not separate. In the actuarial calculations employed to determine the contribution, it was judged that unemployment would be on the average 8.5% of the total number of covered workers During the early years of the new program the rate of unemployment was much lower—generally from 1% to 2%.

Benefits became payable, after a three-day waiting period, at the rate of 26*s.* per week for persons over age 18, 20*s.* for married women; and 15*s.* for persons under age 18. In the case of a married woman or young person entitled to an increase for an adult dependent, or in the case of a married woman with a dependent child, the rate was set at 26*s.* An additional 10*s.* per week was payable for an adult dependent, and 7*s.* 6*d.* for the first child (the others being covered by the family allowance program). The conditions for receipt of benefit were the payment of 26 contributions between entry into the system and the day for which benefit was claimed, with an average of 50 contributions paid or credited (for periods of unemployment, sickness, etc.) in the last contribution year.

Standard maximum duration of benefit was 180 days; after five years' coverage this might be gradually increased for additional contributions (not offset by benefits) up to 130 days more. Extended benefit might then be awarded by local tribunals after taking into account the claimant's circumstances but without imposition of a means test. Extended benefit was payable by the local offices of the ministry of labour and national service in the same way as unemployment benefit.

The claimant was disqualified (except in special circumstances) during a work stoppage resulting from a labour dispute, and for a period no longer than six weeks in the following cases: (1) misconduct or voluntary leaving without just cause; (2) refusal without good cause to apply for employment after notification or to accept it when offered; (3) neglect to avail himself of a reasonable offer of suitable employment; (4) failure to carry out reasonable written instructions of the employment exchange to help him find employment; and (5) refusal of training.

Administration of the general national insurance scheme was placed in the hands of the ministry of national insurance. The employment exchanges, however, were operated by the ministry of labour and national service, and the office of the latter ministry also paid unemployment benefit. (J. F. G. P.; D. D. L.; X.)

UNITED STATES

The most important unemployment insurance events in the 1930s were the establishment of unemployment insurance in the U.S., 1932 *ff.*, and in Sweden in 1934, and the reorganization of the British system in 1934, already described. Futile efforts to enact unemployment insurance in Massachusetts in 1916 and in several other states in subsequent years were followed by the passage of the first U.S. unemployment insurance law in Wisconsin in Jan. 1932. Previous to that time, U.S. experiments with unemployment insurance were limited either to single plants or portions of an industry and probably covered fewer than 150,000 persons.

They were plans either initiated by employers or adopted by joint agreement between labour unions and employers. Systems of union benefits against unemployment, in which the benefit funds were raised and administered by the unions themselves had never been very extensive in the United States. In that respect U.S. labour history differed sharply from that of Europe.

The cornerstone of unemployment insurance in the United States was laid by the enactment in Aug. 1935 of the Social Secu-

rity act. This act followed the recommendations of the Committee on Economic Security, appointed by Pres. Franklin D. Roosevelt in 1934, for a co-operative federal-state system. But it contained very strong inducements to all states to adopt unemployment insurance laws.

Title III of the act provided for federal grants to the states for the total cost of administering unemployment insurance laws, if certain general statutory and administrative standards were met

Title IX (the tax features of which later became a chapter in the internal revenue code) imposed a pay-roll tax on all employers having eight or more employees in "covered" employment, 90% of which could be offset if the employer was liable for unemployment insurance taxes under a state law meeting certain general standards These inducements were strong enough to bring about enactment of unemployment insurance laws in every state, the District of Columbia, Alaska and Hawaii, before July 1, 1937. Later, in 1938, a special federal system was adopted for the railroad industry.

Generally speaking, the U.S. unemployment insurance laws had as their objective the protection of the regularly employed who became unemployed because of lack of work and were able and willing to accept suitable employment. A basic characteristic was that it provided income as a matter of right without inquiry into the needs and resources of individuals. The income provided was in the form of a weekly benefit related to prior wages, intended to be sufficiently large to cover the workers' nondeferrable expenses but not so large as to reduce work incentives.

The objective was to provide benefits for a period long enough to tide most workers over spells of unemployment between jobs, making it unnecessary for them to turn to other programs for aid, when unemployed. Another purpose was to accumulate funds during periods of high-level employment, for use during periods when benefit expenditures increase. Through continuous contact with public employment offices, speedy absorption of claimants into employment was facilitated.

The U.S unemployment insurance system involved close cooperation between the federal government and the states. Each had essential functions to perform. There was no national unemployment insurance law except for railroad workers; there were 51 state, territorial and district laws, each of which had been influenced by federal legislation, and the administration of which was subject in certain aspects to federal supervision.

Federal Responsibility.—The Social Security Act of 1935 created a Social Security board to administer the various provisions of the act including the federal government's responsibilities for unemployment insurance as defined in titles III and IX of the act. After June 1939 the Social Security board exercised its function under the direction and supervision of the administrator of the Federal Security agency.

Federal responsibilities in the federal-state unemployment insurance program were carried on through the bureau of employment security.

The United States employment service, created by the Wagner-Peyser Act of 1933, was transferred by congress from the U.S. department of labour to the Federal Security agency on July 1, 1948, and became a part of its then bureau of employment security.

On Aug. 20, 1949, Pres. Harry S. Truman transferred the bureau of employment security to the department of labour and vested in the secretary of labour responsibility for carrying out the provisions of the Wagner-Peyser act and titles III and IX of the Social Security act and certain provisions of the Federal Unemployment Tax act.

The bureau set up central units to service both the employment service and the unemployment insurance service. Regional offices maintained direct relations with state administrative agencies.

The responsibilities of the federal agency were primarily to determine that the state laws were in conformity with requirements of the federal act, both for the purpose of enabling employers subject to the federal tax to secure credit with respect to their liability under the state laws and for the purposes of federal grants for administration. In addition, the federal agency determined, within the amount authorized by congress, the amounts to be granted to the individual states for the proper and efficient administration of their laws.

The federal agency also served in clearing-house and service capacities to promote most efficient methods of administration and was also charged with the responsibility for making studies and recommendations to improve provisions for economic security.

Among the requirements that a state law had to meet to enable employers to secure credit against the federal tax were: that benefits be paid through public employment offices; that all taxes (usually called contributions) collected under the state law be deposited to the state's credit in the trust fund in the United States treasury from which they could be withdrawn only for the payment of benefits; that unemployment insurance not be denied "to any otherwise eligible individual for refusing to accept new work under any of the following conditions: (1) if the position offered was due directly to a strike, lock-out, or other labour dispute; (2) if the wages, hours or other conditions of the work offered were substantially less favourable to the individual than those prevailing for similar work in the locality; (3) if as a condition of being employed the individual would be required to join a company union or to resign from or refrain from joining any bona fide labour organization."

In determining whether a state was entitled to federal grants for the costs of administration, the secretary had to find in the state law methods of administration, including those relating to the establishment and maintenance of personnel standards on a merit basis, reasonably calculated to insure the full payment of benefits when due, and provisions for a fair hearing to anyone whose claim for benefits was denied. In addition he had to find that there had not, in a substantial number of cases, been a denial of benefits due under a state law. The states were also required to make such reports on their operations as the secretary found necessary.

Grants for the costs of administration were generally made quarterly or semiannually. At mid-century the total of such grants for the administration of unemployment insurance and of the employment service totalled more than $140,000,000 annually.

State Responsibilities.—The state administrative set-ups differed widely from state to state—at mid-century 19 were administered by independent boards or commissions, 13 by independent departments reporting directly to the governor, 17 in state departments of labour, and 2 in state workmen's compensation agencies. The state agency had to be equipped to collect and record contributions, receive and pass upon claims for benefits, pay benefits, adjudicate disputes over benefits, manage state budgetary functions connected with the administration of unemployment insurance, and allied responsibilities including furnishing to the secretary of labour such reports and in such form as he might require. A nation-wide system of public employment offices, affiliated with the United States employment service of the bureau of employment security, although financed wholly by federal funds, was administered by the same state agency.

The states were free to enact unemployment insurance laws with such coverage and benefit provisions as they desired. However, with respect to both coverage and the financial structure, state laws were strongly influenced by the provisions of the federal Unemployment Tax act.

Coverage.—Coverage of the federal act was restricted, as a temporary measure, to the larger employers—those employing eight or more workers in 20 weeks in a calendar year, and 28 of the state laws adopted the same restriction. By mid-century, the federal act had remained unchanged, but only 22 states restricted coverage to employers of eight workers, 17 covered employers of one or more, and in 12 states, there were variations from three to six workers.

Workers in agriculture, domestic service, nonprofit, religious, educational and charitable organizations, and in federal, state and local government employment were also excluded from the program's protection. Because of the growth in employment and the rise in the labour force, coverage under the unemployment insurance program had increased from 20,000,000 in 1938 to about 33,000,000. Approximately 13,500,000 wage and salary workers were still outside the program at mid-century.

Benefits.—The principle of basing a worker's rights to benefits on his employment and earnings during a preceding period was common to all state laws. The specific provisions of the different laws differed considerably in this particular. The qualifying requirements attempted to measure his attachment to the labour market by requiring that he had earned a minimum amount of wages or had worked a certain number of weeks within a late period; most laws attempted to assure that he had worked more than 13 weeks in the year preceding his employment.

Before drawing any benefits, all state laws required a one-week waiting period except four which required a 2-week period, and two which required none.

Weekly benefits payable for total unemployment were based, as in state accident compensation laws, upon a percentage of the worker's earnings rather than upon the flat benefit rate used in England. While the original objective was to provide 50% of wages, the rise in weekly wages immediately before and following World War II outstripped statutory maximums, with the result that weekly benefits fell below that ratio in all states

In 41 states, at mid-century, the benefit rate was a specified percentage of the total wages earned in the highest calendar quarter in a late period Average benefits were about $21, as compared with $11 in 1938 To assure that unemployed workers with dependents received a sufficiently high percentage of wages to be able to purchase nondeferrable necessities when out of work, 11 state laws provided additional allowances for dependents. Minimum weekly benefits were around $5 to $6, and maximums varied from $15 to $26 for states without dependents' allowances and from $20 to $40 for states with such allowances.

The maximum potential benefits available to a claimant during a year was not the same in all states. Fifteen states allowed potential benefits for the same number of weeks (calculated as a multiple of the weekly benefit amount) to all workers meeting the qualifying requirement. Thirty-six states limited the worker's total benefits to a fraction of his annual earnings or (in two states) limited the duration by a fraction of the number of weeks worked.

Since 1939, the potential duration of benefits had increased from an average of less than 13 weeks to about 21 weeks The largest number of states provided a maximum of 20 weeks; 22 states, however, provided a maximum of more than 20 weeks, in 13 of these it was 26 or more. Despite the increase in potential duration, about three out of ten claimants exhausted their benefits rights during the two years ended July 1, 1949, before finding new jobs or returning to their former jobs

Disqualifications.—Under all state laws benefits might be denied if the worker's unemployment was due to certain specified reasons; generally, if he had been discharged for misconduct connected with his work, had voluntarily left his work or refused an offer of suitable work without good cause, or if his unemployment was due to a labour dispute.

While all laws postponed eligibility for benefits for a specified period for the above reasons, many also cancelled benefit rights for the same or a shorter period.

Financing.—The idea that unemployment insurance taxes would stimulate employers to reduce unemployment greatly influenced U.S. legislation in this field The concept of merit or experience rating, as it was generally called, was based upon the assumption that if employers could reduce their taxes thereby, they would take steps to reduce unemployment.

Experience did not demonstrate that employers' rate reductions resulted from stabilized employment, induced by experience rating.

Beginning with the Wisconsin law, all state laws provided for modifying employers' contribution rates in accordance with their experience with unemployment "or other factors directly related to unemployment risk." While most state laws varied employers' contribution rates in accordance with the relation between benefits paid to their former workers and charged to their "accounts," contributions paid, and their average annual pay roll, other states used measures taking less direct account of such benefit payments. Later, five states adopted plans based upon pay-roll fluctuations and designed to avoid the undesirable effects of other plans in creating adverse employer interest in the payment of benefits to their former workers.

As a result of the high pay-roll and employment levels during most of the program's history, and especially after 1941, employer tax rates were sharply reduced from the 2.7% rate at which they began Average tax rates fell to about 1.2% by 1947 and were still about that level at mid-century.

State Administration.—Certain administrative arrangements involved in operation of the unemployment insurance program were common to all states. Every claimant for benefit had to file his application for benefits at a public employment office and at the same time apply for work Certification by the employment office of a registration for work was a prerequisite to the receipt of benefits.

A report from the employment service or an employer that an applicant had refused suitable employment offered him held up his right to benefits until it could be determined whether the refusal was justified. Each state law decided what constituted "suitable employment."

Machinery and procedure to investigate and settle disputed claims became a vital part of unemployment insurance administration.

Procedure was substantially the same in all states A deputy of the state administrative officer first passed upon the claim or, if it involved a question he could not resolve, referred it to an appeal tribunal.

Either the claimant or an interested employer might request a hearing before an appeal body on any decision denying or allowing benefits Decisions of the appeal tribunals might be appealed further either to the state administrative agency or an independent review board, according to state law Further appeal might also be made to the courts in the same manner and under the same limitations as other legal matters. (*See* also SOCIAL SECURITY.)

Temporary Disability Insurance Co-ordinated with Unemployment Insurance.—By mid-century, four unemployment insurance programs had been expanded to provide weekly cash benefits to workers whose unemployment was due to inability to work as well as to those unemployed because of lack of work These were the laws of Rhode Island, expanded in 1942, California, 1946, the federal Railroad act, 1947, and New Jersey, 1948. These four temporary disability insurance or cash sickness insurance laws covered the same workers and paid benefits according to the same schedule as the unemployment insurance laws with which they were jointly administered. In addition, New York in 1949 enacted a disability benefits law not co-ordinated with unemployment insurance.

About 5,300,000 workers, 16% of the U.S. workers covered by unemployment insurance, were covered by the programs co-ordinated with unemployment insurance. The Rhode Island and California programs were financed by a 1% worker contribution which had formerly been paid for unemployment insurance. In New Jersey, workers paid three-fourths of 1% and employers, one-fourth of 1%, while the railroad program was financed by an employer tax formerly paid for unemployment insurance alone

Temporary disability insurance benefits were paid under all the laws to workers unable to perform their usual work because of illness or accident. California and New Jersey excluded disability resulting from pregnancy; those two and the railroad program excluded disabilities covered under the workmen's compensation laws. All four required an unpaid waiting period of the first seven-day period of disability in a benefit year; California and New Jersey required similar periods with future spells of disability, while Rhode Island did not, although only disabilities lasting at least seven consecutive days were compensable. To draw benefits, claims filed by mail had to be supported by medical certificates.

The outstanding difference among the laws was the provision made by California and New Jersey permitting individual establishments to substitute private group insurance for the state plan More than one-third of the covered workers in California, and about two-thirds of those in New Jersey were under such private plans.

The New York law put primary emphasis on private insurance, state coverage was not automatic, but had to be purchased in the same manner as private coverage.

OTHER COUNTRIES

Unemployment insurance programs had been adopted by 23 nations at mid-20th century, including the cash benefit plans of Australia and New Zealand, and the limited-coverage programs in Chile (for salaried employees only), Greece (where operations were limited to certain areas), and Uruguay (with special schemes in the wool-and-hide and cold-storage industries, as well as pensions for unemployed persons with long coverage under the retirement system). Nineteen plans were compulsory and four (Denmark, Finland, Sweden and Switzerland) were government-subsidized trade-union plans

The European countries with programs in operation, with date of the first laws, were: Denmark (1907), Netherlands (1916, voluntary system which was discontinued during World War II; compulsory scheme, 1949), Finland (1917), Italy (1919), Austria (1920), Poland (1924), Switzerland (1924), Bulgaria (1925), Germany (1927), Belgium (1933), Sweden (1934), Norway (1938) and Greece (1945).

The Irish system went back to 1911, the date of the first British National Insurance act In France and Spain the voluntary plans dating from 1905 and 1919, respectively, had been replaced in France by unemployment assistance and in Spain by public works In the U S S.R unemployment insurance was discontinued in 1930; in Czechoslovakia, it was discontinued in 1948

Outside Europe, unemployment insurance had been adopted by the United States (1935), Chile (1937), the Union of South Africa (1937, expanded 1946), Canada (1940) and Japan (1947) New Zealand cash benefits dated from 1938, and the Australian scheme from 1944; both programs required an income test but were part of unified social security programs. Uruguay's first special program of unemployment insurance was established in 1944.

The scope of the several schemes naturally varied in the different countries since the need of insurance against the unemployment of classes of the population varied widely. The conditions to be satisfied under the various national systems differed in points of detail, but there were broad lines of resemblance in most of them. For instance, the unemployment against which the worker was insured was involuntary unemployment. Nor would he be paid benefits under the schemes if there was suitable employment which he could take up. In this connection it was worthy of note that in countries which had instituted compulsory systems the example of Great Britain had been followed by setting up systems of employment exchanges by means of which the existence of suitable employment might be known and jobs offered to the unemployed

The loss of work through a labour dispute in which the worker was involved was commonly a reason for disqualification although there were various refinements on this point; *e.g.*, the duration of the disqualification might be for the period of the dispute or for any period after it had ended until the worker was again employed. Voluntarily leaving work without good cause and dismissal for misconduct were also generally grounds for refusal of benefit.

The financing was variously accomplished, but in 11 of the 23 systems the insured, the employer, and the government all contributed. In 5 countries the employer was the only contributor and in 1 the employee was the sole support. In 3 systems the insured and the employer shared the cost; and in 3 (all subsidized trade-union plans) the insured and the government provided the funds.

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UNGAVA, originally the native name for the region south of Hudson strait and thus a part of the historic Rupert's Land (*q.v.*) The name was adopted officially by Canada by order in council Oct 2, 1895, as that of a district of the Northwest Territories. But the Boundaries Extension act of 1912 annexed Ungava to the province of Quebec. The northern portion of this province is bounded by Hudson bay on the west; Hudson strait and Ungava bay on the north; and the coast strip of Labrador on the east. The area is estimated at more than 300,000 sq.mi. and includes much of the lower portion of Labrador, with a rim of recent marine deposits along its western coast, but the interior has the usual character of low rocky hills of Archean rocks, especially granite and gneiss, with a long band of iron-bearing rocks, resembling the Animikie, or Upper Huronian of the Lake Superior region, near its eastern side. Along Hudson bay shore there is a strip of similar rocks, and a long row of small islands of the same age, with great sheets of trap or diabase forming the tops of the hills. In 1949 intensive development began on a proven initial reserve of 300,000,000 tons of high-grade iron ore located in roughly the centre of Ungava. Recovery involved creation of a seaport at Sept Iles, Que., on the Gulf of St. Lawrence, and building a 360-mi. railway to the ore field. Ungava, like the rest of Labrador. has risen several hundred feet since the Ice Age, marine beaches being found up to 700 ft on the Hudson bay side, and it is interesting to find seals like those of the adjoining sea coasts in the Seal lakes 100 mi inland and 800 ft. above the present sea level Because of its northerly position a large part of Ungava is treeless, and belongs to the barren grounds where caribou roam and feed on the so-called caribou moss, a grayish lichen. Until the mining development began, Ungava inhabitants were chiefly migratory Eskimos, wards of the government. Pop. (1951) 4,470. (C. Cv)

UNGER, FRANZ (JOSEPH ANDREAS NICOLAUS) (1800–1870), Austrian physician and botanist, was born at Amthof in Steiermark on Nov. 30, 1800. He studied medicine in Graz, Vienna and Prague He practised in Stockerau and Kitzbühel and in 1833 became professor of botany at the University of Graz. In 1849 he went to Vienna to occupy the chair of plant physiology. In 1866 he retired to live in the country near Graz where he died on Feb. 13, 1870. Unger made many contributions to the understanding of plant anatomy and physiology, and was also much interested in plant palaeontology. Among his published works were *Die Exantheme der Pflansen* (1833); *Ueber den Bau und das Wachstum des Dikotyledonenstammes* (1840); *Anatomie und Physiologie der Pflansen* (1855); *Chloris protogaea, Beiträge zur Flora der Vorwelt* (1841–47); *Sylloge plantarum fossilium* (1860–64); *Versuch einer Geschichte der Pflanzenwelt* (1852); *Botanische Streifzüge auf dem Gebiet der Kulturgeschichte* (1857–67).

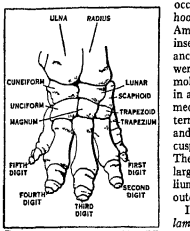
UNGER, RUDOLF (1876–1942), German writer and literary critic, born in Hildburghausen. He studied in the universities of Heidelberg, Munich and Berlin, and in 1911 became professor in literature at Munich. After 1921, he was professor of German literature at Gottingen. He was noted for his studies in the period of Goethe He edited *Obras de Goethe* (1910) and wrote *Philosophische Probleme in der neueren Literaturwissenschaft* (1908), *Weltanschauung und Dichtung* (1917), *Gesammelte Studien* (1929), etc. He died Feb. 5, 1942.

UNGULATA, an order or superorder of placental mammals including the hoofed herbivorous quadrupeds Aristotle in his work on *The Parts of Animals*, in describing the extremities of the viviparous quadrupeds, says that ". . . some are bifid and have hoofs instead of nails, as the sheep, the goat, the elephant, the hippopotamus; and some have undivided feet, as the solid-hoofed animals, the horse and the ass. . . ."

After the Renaissance, E. Wotton (1552), following Aristotle, divided the viviparous quadrupeds into the many-toed, double-hoofed and single-hoofed. In 1693 John Ray divided the viviparous quadrupeds into two grand divisions, the Ungulata, or hoofed, and the Unguiculata, or clawed, forms. The former were subdivided into: (1) the Monochela, or Solidipeda, with solid hoofs, including the horse, the ass and the zebra; (2) the Dichela, or Bisulca, with cloven hoofs; and (3) the Tetrachela or Quadrisulca, including the rhinoceros and hippopotamus. The Dichela were again subdivided into the Ruminantia, or ruminants, and the Non-ruminantia, or swine; the Ruminantia were finally divided into

those with permanent horns, namely the cattle, sheep and goats, and those with deciduous horns, of the deer kind. Here then was a usable and nearly correct classification of the ungulates before the beginning of the 18th century.

Subsequent discoveries have added to the Ungulata a great many extinct and some recent groups which were wholly unknown to Ray. Thus in Osborn's *Age of Mammals* (1910) the "Cohort Ungulata" includes no less than 13 "orders" of hoofed mammals. While each of these is a more or less natural group of animals related by descent from a common ancestral stock, the derivation and interrelationships of the orders themselves are still far from clear It is well established that the typical ungulates, namely the Perissodactyla (horses, tapirs, rhinoceroses, etc.) and the Artiodactyla (ruminants, swine, etc.) were wholly distinct from each other in the Lower Eocene, some 50 to 60 million years ago. It is indeed not improbable that the ungulate, or hoofed herbivorous type, was evolved several different times from different families of placental mammals of the Cretaceous period, or in other words, that many of the resemblances between ungulate orders are examples of either parallel or convergent evolution.



RIGHT FORE FOOT OF INDIAN ELEPHANT, SHOWING PARTS

Order Condylarthra.—In the Basal Eocene formations of New Mexico and in the Lower Eocene of Wyoming have been found the fragmentary jaws and teeth, and very rarely more or less entire skeletons, of small hoofed mammals which on the whole were *structurally* intermediate between the oldest creodonts or flesh-eaters, and the true ungulates. Of these the most primitive was the genus *Mioclaenus*, known chiefly from the conical-cusped upper molars, which recall those of such primitive carnivores (creodonts) as *Tricentes* and *Claenodon*. Somewhat higher in the scale was the group of species of the genus *Hyopsodus*; these little animals were about as large as a hedgehog, the skull being of remarkably generalized type. The dental formula, (Incisors $\frac{3}{3}$ Canines $\frac{1}{1}$ Premolars $\frac{4}{4}$ Molars $\frac{3}{3}$)$\times 2 = 44$, was that of other very primitive placental mammals. The crown-patterns of the molar teeth were advancing ever further away from the primitive tritubercular type toward the more typical condylarth types presently to be described.

By far the most famous condylarth was the Lower Eocene *Phenacodus primaevus*, an animal about as large as a Newfoundland dog, which has figured in many textbooks as the "five-toed ancestor of the horse." But W. D. Matthew has advanced decisive evidence against this view For in *Phenacodus* (*q.v.*) each quadrangular upper molar had four conical main cusps and two very small intermediate cusps or conules; whereas in the contemporary ancestors of the horse family the oblique crests of the molars were progressively developed Even in the Lower Eocene genus *Ectocion*, which was related to *Phenacodus*, the detailed patterns of the upper and lower molars were not quite right to be structurally ancestral to the molars of the primitive horses. Another Eocene condylarth, the genus *Meniscotherium*, had more complex upper molar patterns of the type known as buno-lopho-selenodont (*i.e.*, with cones, ridges and crescents), which in some respects foreshadow the general molar types of such later ungulates as the hyracoids, the chalicotheres and the litopterns.

The foot structure of the condylarths was likewise of interest. In the five-toed hind foot the ankle bones were much like those of a contemporary creodont, with a ball-and-socket joint at the lower end, an arrangement to which the name Condylarthra refers. In the fore foot of *Phenacodus* the two rows of carpal bones were placed directly above each other, "like unstruck bricks," whereas in typical ungulates a more displaced, or alternating arrangement, was the rule. E. D. Cope supposed that *Phenacodus* was in this respect also ancestral to later ungulates but Matthew showed that in both *Phenacodus* and the later ungulates the contrasting arrangements of the carpal elements above mentioned were probably both derived independently from the still older interlocking creodont type.

Amblypoda (*q.v.*).—In the basal Eocene of New Mexico occur the fragmentary remains of a diversified series of small hoofed mammals collectively known as Pantodonta or taligrade Amblypoda. Some of the smaller genera were hardly bigger than insectivores and with teeth suggestive of insectivore-creodont ancestry, while the larger taligrades (*Periptychus*, *Pantolambda*) were about the size and proportions of stocky badgers. The upper molar teeth in the smaller forms had three main cusps arranged in a triangle with the apex toward the inner side; the small intermediate cusps or conules were more or less circular; the main internal cusp was flanked by small cusps borne by the anterior and posterior ridges or cingula. In *Periptychus* the upper molar cusps were all subcircular and the enamel surface was pleated. The brain-cast indicates a brain of extremely primitive form with large olfactory lobes and a minimum development of the neopallium. In *Pantolambda* the upper molar crowns bore two sharp outer V's and a centrally placed conical internal cusp.

In all the taligrades the feet were short, especially so in *Pantolambda*. This feature becomes greatly emphasized in the later members of the order, the corypbodons and Dinocerata. *Coryphodon* is characteristic of the Lower Eocene of Wyoming and England. It was broad-headed and almost hippopotamus-like. Related forms have recently been found in the Eocene of Mongolia. *Uintatherium*, *Dinoceras* and their allies were characteristic of the later Eocene. Their bodies were gigantic, larger than modern rhinoceroses, with massive, post-like limbs and extremely short stubby toes. They had sabre-like upper tusks, six or more horn-like bony outgrowths on top of the skull and a brain of low type.

Notoungulata.—The condylarths and taligrades disappeared from the fossil record of the northern hemisphere in early Eocene, but there is some reason to believe that some of them reached South America and there gave rise to the amazingly varied series of herbivorous mammals which are often referred to collectively as notoungulates. These flourished for millions of years in Patagonia and adjacent regions, while the perissodactyls, artiodactyls and other ungulates held sway in the northern world. These notoungulates exemplified the law of adaptive radiation on a grand scale. Protected by geographical barriers from the deadly competition of their larger-brained northern analogues, they exploited all the economic possibilities for ungulates available in South America and gave rise to the wide diversity of forms that covered the ancient pampas. Some (the protypotheres) were small and swift-running like rabbits; others (the smaller litopterns) were like slender-limbed three-toed horses; some (*Macrauchenia*) paralleled the llamas and camels; others closely paralleled the rhinoceroses, while a few almost rivalled the elephants in bulk (*Pyrotherium*).

Litopterna (*q.v.*).—Among the most primitive of the entire series of notoungulates is the genus *Didolodus*, a small forerunner of the litopterns known only from the upper cheek-teeth, which in some ways recall those of the smaller taligrades. In the swift-footed proterotheres of the Miocene of Patagonia both cheek-teeth and feet suggest those of the Oligocene three-toed horses of the northern world. But in the upper molars the main inner cusp is central rather than anterior in position and the posterior cross-crests fail to meet the middle point of junction of the two main outer cusps, as they do in the three-toed horses, while the feet, although superficially horse-like, differ profoundly from the horses in the detailed arrangements and contacts of the tarsal elements. The larger litopterns (*Theosodon*, *Macrauchenia*), while in general appearance paralleling llamas and camels, yet are more nearly related to the horse-like proterotheres in their deeper characters.

Notioprogonia.—In the "*Notostylops* beds" of Lower Oligocene or Upper Eocene in Patagonia occur a strange group of ungulates, varying in size from a rabbit to a rhinoceros. Of these the most famous form, *Notostylops*, had a small skull in which the upper grinding teeth have oblique and flattened outer walls remotely

suggesting those of recent rhinoceros. The lower molars bore long obliquely-placed blades on the hinder part or talonid The skull as a whole suggests that of the recent *Hyrax*. In certain early members in which the feet are known there are five digits on the fore and hind feet, the terminal bones are cleft for the attachment of fairly large hoofs, the main ankle bone (astragalus) is more or less flattened. A single very small jaw, the genus *Arctostylops* of Matthew, found in the Lower Eocene of Wyoming, appears to be related to these South American Notioprogonia. Another apparently related type is found in the Eocene of Mongolia. These small jaws seem to increase the probability that the South American Notioprogonia, like other members of the notoungulate series, had been derived from some basal Eocene or Upper Cretaceous forerunners of the taligrades and condylarths of the northern world.

The *Astrapotheria*, gigantic Santa Cruzian (Lower Miocene) forms with long downwardly growing tusks, may be highly specialized derivatives of some early member of the Notoungulata.

Toxodontia (*q.v.*).—These were perhaps the most numerous in species of all the notoungulate series. One of the best known primitive toxodont is the Santa Cruzian (Lower Miocene) genus *Homalodontotherium*, a larger form in which all the teeth had become high-crowned and all the incisors, canines, premolars and molars were pressed together in a continuous series without break or interval. The Santa Cruzian (Lower Miocene) *Nesodon* was about the size of a rhinoceros but with the back curved and the limbs shorter. The front teeth were enlarged and flattened for cropping vegetation, the upper molar teeth had extremely long oblique outer walls and folded wearing surfaces. The three-toed feet, although rhinoceros-like in appearance, agreed with those of the litopterns in their fundamental characters. The Pampaean (Pleistocene) *Toxodon* was still larger, with a gigantic head and a huge curved back. This was one of the famous fossil South American mammals studied by C. Darwin (see *Voyage of the Beagle*).

Typotheria.—The smaller genera of this group, named protypotheres, included some that broadly resembled *Hyrax* and others that were rabbit-like. They were very abundant in the Lower Miocene of Patagonia. The extremely high-crowned molar teeth were much curved transversely, as in some rodents, and were adapted for grinding tough vegetation. The later form, *Typotherium*, from the Pampaean or Pleistocene of Argentina, had rodent-like incisors. It was about as large as a brown bear. This group is rather closely related to the toxodonts.

Pyrotheria.—In these curious animals the molars were bilophodont, that is they bore two cross-crests like those of tapirs and dinotheres. The skull in some ways resembled those of the Proboscidea (*q.v.*) and the same is true of the tusks, but on the whole it seems more likely that the pyrotheres are simply the South American analogues of the Proboscidea.

Hyracoidea (*q.v.*).—This characteristically African group is represented today by the "coneys" or dassies of southern and west Africa, Abyssinia, Arabia and Syria. These furry little animals have but slight external resemblance to ungulates but their jaws and teeth abound in resemblances to ungulates of many groups. The internal anatomy shows a curious mixture of resemblances to elephants and perissodactyls. There is no satisfactory evidence, however, of the relationship of *Hyrax* to any of the groups so far named. The hyracoids as a group must have been in Africa for many millions of years, since various forms of fossil hyracoids have been found in the Lower Oligocene of the Fayûm district in Egypt. In some of these very ancient hyracoids (*Megalohyrax*) the molar teeth recall those of Eocene titanotheres or of *Meniscotherium* among the condylarths. In its skull *Megalohyrax* was more or less swine-like.

Embrithopoda.—While the hyracoids played the part of the small ruminants in the ancient fauna of the Fayûm, the economic rôles of the rhinoceroses and elephants were assumed by gigantic beasts named *Arsinoitherium* (*q.v.*) in honour of an Egyptian queen. In these very strange animals the whole fore-part of the skull was surmounted by an enormous pair of bony horns, which in the front view rose to a great height. The folded surfaces of the molar teeth remotely recall those of the American Eocene amblypods, but the premolars rather suggest relationships with the hyracoids. The body was very massive and the skeleton shows a curious mingling of resemblances to elephants and amblypods, doubtless the results of similar adaptations to slow browsing movements and the support of the immense body weight. The existence of these highly specialized animals in Africa at such an early date as the Lower Oligocene and their apparent isolation, in spite of their adaptive resemblances to elephants and amblypods, all indicate a very long line of less and less specialized ancestors, traces of which may some day be discovered when still older fossil-bearing horizons are discovered elsewhere in Africa.

Barytherioidea.—Another strange type of extinct ungulate (named *Barytherium grave* by C. W. Andrews) was discovered in the Fayûm district of Egypt along with the fossil hyracoids, arsinotheres and ancestral elephants. The only parts of the animal found were a large lower jaw, a humerus and a radius, all of which show a curious mixture of resemblances on the one hand to the primitive proboscidean *Moeritherium* and on the other hand to *Dinoceras* of the Amblypoda. In a general way it also resembles the ancient South American *Pyrotherium*.

Proboscidea.—The evolution and structure of the elephants (*q.v.*) are considered in the article PROBOSCIDEA, and further information can be found in H. F. Osborn's *Monograph* of this group. As to the remote origin of the Proboscidea, the fact that *Arsinoitherium*, in spite of its wholly different skull and dentition, shows so many curiously detailed resemblances to the Proboscidea in its limbs and backbone, lends some support to a view that the Paenungulata, a superordinal group, consisting of the Proboscidea, Hyracoidea, Embrithopoda, Amblypoda, may after all be a more or less natural assemblage of ungulates. In fact we may even advance the tentative hypothesis that some such small Lower Eocene condylarth as *Hyopsodus wilcottanus* (described by Matthew and Granger), with short spreading feet, reduced canines, slightly procumbent incisors and bunodont molars, would have been an ideal starting-point for the entire subungulate series, including also the South American Pyrotheria and the Sirenia.

Sirenia (*q.v.*).—If "common sense" and superficial appearances were trustworthy, these surprisingly whale-like mammals would still be classified with the Cetacea (*q.v.*) as they were by all early naturalists. But De Blainville as far back as 1816 classified them as *"ongulogrades anomaux pour nager"*—anomalous ungulates adapted for swimming; in his later classification he brigaded them with the Proboscidea under the term "Gravigrades." Andrews in his description of *Eotheroides* (the oldest known sirenian, from the Upper Eocene of the Fayûm, Egypt) pointed out a number of significant features in which the skull of *Eotheroides* resembled that of *Moeritherium*, the oldest and most primitive known proboscidean from the same formation. He also cited a number of curious anatomical details in which even the modern Sirenia agree with the elephants in spite of the enormous difference in their external appearance and mode of life. On the other hand, R. Lydekker pointed out that the unworn molar teeth of certain extinct sirenians were curiously like those of certain extinct artiodactyls (*Merycopotamus*) and that this fact suggested the derivation of the Sirenia from very early Eocene artiodactyls; but one might equally say that the molar teeth of another extinct sirenian (*Miosiren*) suggest those of the Eocene rodent *Ischyromys* and that the order Sirenia had therefore been derived from primitive rodents. Either of these views would be hard, in the present meagre state of our knowledge of the subject, to disprove; but neither has nearly as much positive evidence in its favour as the view of De Blainville and Andrews that the Sirenia are an aquatic specialization from the Proboscidean stem.

Be that as it may, however, by the time of the Lower Oligocene *Eotheroides* was already definitely a sirenian in its dentition, skull and locomotor skeleton. Thereafter during the Oligocene, Miocene, Pliocene and Pleistocene epochs the changes in the skull and skeleton were comparatively slight and unimportant. The middle and late Tertiary sirenians (such as *Halitherium* and *Haliananassa*) were for the most part considerably larger than the modern manatees and dugongs (*qq.v.*) and had a large vertically-

placed pair of upper tusks, which have been retained by the dugongs but lost by the manatees.

The Sirenia are whale-like in their torpedo-like bodies and horizontal tail flukes, in the complete absence of external hind limbs and in their flipper-like forelimbs, which however still retain external nails or vestigial hoofs They differ markedly from typical cetaceans in their relatively small heads, truncate flattened snouts with transversely expanded upper lips covered with very large bristles The molar teeth are two-ridged,—wholly unlike the conical teeth of toothed cetaceans. Their tusks when present are situated at the end of the muzzle and directed downward They differ profoundly from cetaceans in their food and feeding habits, being the herbivores of the coasts and estuaries, whereas at least the typical cetaceans are essentially carnivores of the open seas. In their internal anatomy the sirenians likewise differ widely from cetaceans: the musculature of the forelimbs is less profoundly modified for aquatic life, the brain has a much less complexly convoluted surface and the digestive tract recalls that of the ruminants. The skeleton of sirenians is peculiarly massive and dense, the swollen, heavy ribs serving apparently as ballast to keep these voluminous, gas-filled bodies below the surface.

Most of the many known extinct types of sirenians conform in essentials to the dugong type, but one extinct family, the Miocene Desmostylidae, is widely different from the rest In these the large upper tusks almost suggest the earliest proboscidean types but the most remarkable peculiarity is found in the molar teeth, each of which consists of a closely packed cluster of cylindrical columns of circular cross-section.

Perissodactyla.—*See* PERISSODACTYLA.

Artiodactyla.—This order is chiefly dealt with in the article ARTIODACTYLA. Here it may be noted that attempts, as by Cope and others, to brigade the artiodactyls with the perissodactyls under the terms Taxeopoda or Ungulata Vera have in the long run only served to bring out the entirely artificial nature of such an assemblage and to throw into relief the significant differences which widely separated these two orders from each other as far back as Lower Eocene times There is indeed more to be said in favour of the view that the Artiodactyla may be an offshoot of some forerunner of the mesonychid family of the creodonts, while the Perissodactyla may be related remotely to the Cretaceous ancestors of the condylarths. Recent studies by Miss H. S. Pearson on the skull structure of the earliest artiodactyls have revealed that at a very early date the order was already subdivided into two series, one the amastoid series, in which the mastoid region of the periotic bone was completely covered by the squamosal and adjacent elements (as in the suines and their extinct relatives) and the other, or mastoid series, in which the mastoid was well exposed on the outer side, as in the Eocene Dichobunidae and all the ruminant artiodactyls.

In conclusion, much future palaeontologic exploration, in Africa, in Mongolia and many other parts of Asia, will doubtless be necessary before many of the problems touched upon in this article can be pushed forward nearer to solution.

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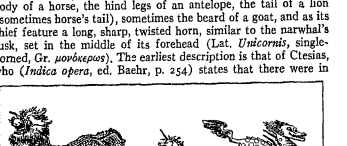
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(W. K. G.; X.)

UNICORN, a fabulous beast, usually having the head and body of a horse, the hind legs of an antelope, the tail of a lion (sometimes horse's tail), sometimes the beard of a goat, and as its chief feature a long, sharp, twisted horn, similar to the narwhal's tusk, set in the middle of its forehead (Lat. *Unicornis*, single-horned, Gr. *μονόκερως*). The earliest description is that of Ctesias, who (*Indica opera*, ed. Baehr, p. 254) states that there were in



FROM (LEFT AND RIGHT) GOULD, "MYTHICAL MONSTERS" (ALLEN & CO.), (CENTRE) FAIRBAIRN, "BOOK OF CRESTS" (T. C. & E. C. JACK)

THE UNICORN OF LEGEND AND HERALDRY

The centre illustration shows the heraldic unicorn, and those on the left and right, the Chinese and Japanese varieties respectively

India white wild asses celebrated for their fleetness of foot, having on the forehead a horn a cubit and a half in length, coloured white, red and black; from the horn were made drinking cups which were a preventive of poisoning. Aristotle mentions (*Hist. anim.*, ii. 1; *De part. anim.*, iii. 2) two-horned animals, the oryx, a kind of antelope, and "the so-called Indian ass." In Roman times Pliny (*N.H.*, viii. 30; xi. 106) mentions the oryx, the Indian ass, and an Indian ox as one-horned; Aelian (*De nat. anim.*, iii. 41; iv. 52), quoting Ctesias, adds that India produces also a one-horned horse, and says (xvi. 20) that the *Monoceros* was sometimes called *Carcazonon*, possibly a form of the Arabic *Carcadān*, rhinoceros

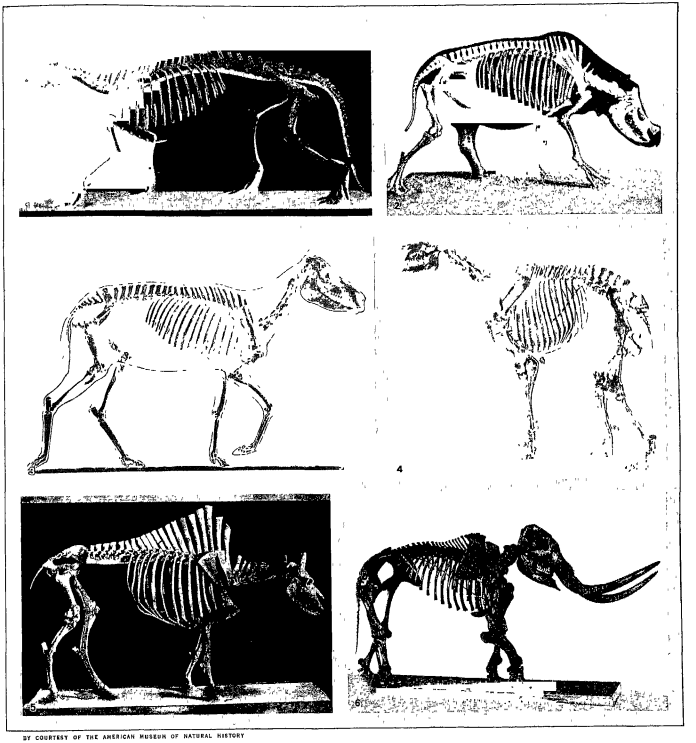
The mediaeval conception of the unicorn as possessing great strength and fierceness is perhaps due to the fact that in certain passages of the Old Testament (*e.g.*, Num. xxiii. 22; Deut xxxiii. 17; Job xxxix. 9–10) the Hebrew word *R'ēm*, now translated in the Revised Version "wild ox," was translated in the Septuagint *μονόκερως*, in the Vulgate *unicornis* or *rhinoceros*, and in the Authorised Version "unicorn," though in Deut. xxxiii. 17 it obviously refers to a two-horned animal. Isidore xii. 2, 12 tells how the unicorn has been known to worst the elephant in combat.

As a decoration on drinking-cups it symbolized the ancient belief in the efficacy of the unicorn's horn against poison, which in England remained, even in the time of Charles II, though Sir E. Ray Lankester (*Science from an Easy Chair*, 1910, p. 127) mentions that a cup made of rhinoceros horn was then handed over to the Royal Society for experiment, with the result of entirely disproving the superstition. In the court ceremonial of France as late as 1789 instruments of "unicorn's" horn were still used for testing the royal food for poison.

In heraldry the unicorn was sometimes used as a device (*see* HERALDRY), but oftener as a supporter, and subsists to the present day as the left-hand supporter of the royal arms This position it assumed at the Union, the Scottish royal arms having been supported by two unicorns. When the unicorn became a supporter of the royal arms both of England and Scotland, a royal crown was added on the head of the unicorn, in addition to the crown with chain and ring round its neck (*see* Great Seal of James I. and VI. in Anderson, Pl. xciii.), but this crown was removed after the Hanoverian succession In England after the Union the unicorn became the left-hand supporter, but in Scotland, as late as 1766, it was still put on the right (Seton, p. 442).

BIBLIOGRAPHY.—*See* Drexler *s.v. Monokeros*, in Roscher's *Lexicon;* and Rev W Haughton in *Annals and Magazine of Natural History* for 1862, p. 363; *see* Odell Shepard, *The Lore of the Unicorn.* (1930).

UNICORN-PLANT (*Proboscidea jussieui*), a North American plant of the family Martyniaceae, called also proboscis-flower and devil's-claw, native from Indiana to New Mexico and southward to Mexico, cultivated for its abundant foliage, peculiarly shaped flowers and oddly formed fruiting pods. It is a



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

EXTINCT MAMMALS OF TERTIARY AND QUATERNARY TIMES

1. Skeleton of Lower Eocene *Phenacodus primaevus*, believed to be a five-toed ancestor of the horse
2. Skeleton of Upper Oligocene *Diceratherium*, an extinct species of Rhinoceros
3. Skeleton of *Neohipparion whitneyi*, a horse of the Upper Miocene plains region of North America. The outline is restored
4. Skeleton of Lower Miocene *Moropus*. It stood about six feet high at the shoulders and resembled a large horse
5. Skeleton of *Bison occidentalis*, extinct North American mammal of the Quaternary period, inhabiting Kansas and Alaska Closest species to the existing bison
6. Pleistocene North American *Mastodon americanus*, forerunner of the elephant

coarse, sticky-hairy, half-prostrate annual, with thick, roundish leaves; large violet or purple flowers, ¾ in. long; and hanging, horn-like, woody pods, with a thick body, 3 in to 4 in. long, ending in a curved beak of equal or greater length When dry, the beak splits into two opposed hook-like or claw-like appendages.

UNIDIRECTIONAL RADIO DIRECTION FINDER, a radio device which permits determination of the direction (without 180 deg ambiguity) of waves as received from a transmitting station.

UNIFIED FIELD THEORY, a term widely applied, early in 1929, to represent the new theory which was then advanced by Dr Albert Einstein, according to which there is but a single background to all material activity—one unified field. A material object is commonly conceived of as existing in *space* and *time*. The scientist often adds that the object is in a *gravitational field* and in an *electro-magnetic field* These four terms seem to attribute four different backgrounds to the object But the special theory of relativity (*q v*) has amalgamated space and time into space-time and the general theory of relativity, with its Riemannian geometry, has absorbed the gravitational field into space-time Thus three of the four terms were already reduced to one. The unified field theory goes a step further by including the electro-magnetic field. A survey of Dr Einstein's announced solution of the problem of unification has been written by Professor A. S. Eddington and will be found at the end of Dr. Einstein's own article on SPACE-TIME in vol xxi , page 108.

UNIFORMS. The word "uniform" (Lat *unus*, one, and *forma*, form), meaning adjectively homogeneous, is specifically used as a substantive for the distinctive naval, military and air service dress, which serves, in its various styles, to give homogeneity to the several services, regiments and ranks Although in ancient history we occasionally meet with uniformed soldiers, such as those of Rome and the white and crimson Spanish regiments of Hannibal, it was not until the establishment of standing armies that uniforms were introduced in modern times. The absence of uniforms accounts very largely for the significance attached to the colours and standards, which alone formed rallying points. The beginnings of uniforms are therefore to be found in truly national armies, in the *Indelta* of Gustavus, and the English armies of the Great Rebellion In the earlier years of the latter, though the richer colonels uniformed their men (as, for instance, the marquess of Newcastle's "Whitecoats" and the king's own "Bluecoats"), the rustics and the citizens turned out for war in their ordinary rough clothes, donning armour and sword-belt. But in 1645 the parliament raised an army "all its own" for permanent service, and the colonels became officials rather than proprietors. The "new model" was clothed in the civilian costume of the date —ample coat, waistcoat, breeches, stockings and shoes (in the case of cavalry, boots)—but with the distinctive colour throughout the army of red and with regimental facings of various colours. The regiments were known as the Blue, Orange, Yellow, etc. Regiments—according to the colour of these facings. The breeches were grey Soon afterwards the helmet disappeared, and its place was taken by a grey broad-brimmed hat. From the coat was evolved the tunic of to-day, and the hat became the cocked hat of a later generation, which has never altogether disappeared, and has reverted to its original form in the familiar "slouch-hat "

For service in Ireland the red coat was exchanged for one of russet colour. The cavalry, however, wore buff leather coats and armour long after the infantry had abandoned them; the Austrians on account of their Turkish wars, retained them longer than any

Thus the principle ever since followed—uniform coat and variegated facings—was established. In France, as in England and Austria, the cavalry, as yet rather led by the wealthy classes than officered by the professional, was not uniformed upon an army system until after the infantry. But in 1688 six-sevenths of the French cavalry was uniformed in light grey with red facings; and about half the dragoon regiments had red uniforms and blue facings. Louvois, in creating a standing army, had introduced an infantry uniform as a necessary consequence. The native French regiments had light grey coats, the Swiss red, the German black and the Italian blue, with various facings.

The hat and the long coat and breeches remained the uniform of line infantry almost everywhere up to the advent of the shako and the coatee about 1790–1820. The gradual evolution of these two garments, from the comfortable civilian clothes of 1690 to the stiff, precise military garments of 1790, can be traced in a few words. The brim of the felt hat was first looped up on one side for convenience, then, for appearance' sake, on the other, and so became the three-cornered cocked hat, fringed with feathers, lace or braid, of Marlborough's wars Then came the fashion of looping up before and behind, which produced the hat called the "Khevenhuller," or the broadside-on cocked hat Lastly, came the purely decorative, lace-looped "fore-and-aft" pattern. Though the long skirts that rendered great coats unnecessary were looped back and the ample cuffs of Marlborough's time became narrower until they were at last sewn down to the sleeve, yet the military costume was in all essentials the civil costume of the time—long coat, hat, sleeved waistcoat, breeches and gaiters.

The introduction into armies of Slavonic irregulars, tended to restrict line infantry and cavalry to parade drill and to pitched battles in parade order. This stiffened their costume until it became "soldierly." The flapped cuffs became plain round cuffs, above which were embroidery stripes and buttons which at one time laced the flaps of the cuff together and now survive as the "guard-stripe." This may be called the first instance of the dummy adornments, which are so marked in modern full-dress uniforms. Similarly the former cloth turnback on the front of the coat was cut off, even in 1756, the buttons and embroidered loops that retained it being kept as decorations.

During the 18th century the cocked hat was by far the most common type. The grenadier cap was its first successful rival. This form of headdress grew out of the limp, conical fatigue caps of the irregular forces, and was adopted by grenadiers in the days when they actually hurled grenades. These caps lacked a brim and thus permitted a greater freedom in throwing. As grenadiers grew into picked companies of tall men, their caps were heightened to create an even more imposing effect. From these developed the towering bearskins of the British grenadiers, and the mitre-caps of the Russian and German guard corps. From this same beginning came a smaller cap, round and of jacked leather, with a plate in front This was worn by light troops, horse and foot, who were next in importance to the grenadiers.

The Hungarian hussars introduced the jacket and the busby. The latter was originally a conical cap with fur edge, but the fur became higher until there was nothing left of the cap but the ornamental "busby-bag" of today. The lancer cap, originally the Polish *czapka*, was a cylindrical cap with a square top, the upper part of which could be pushed up or down after the fashion of a bellows or accordion. The line infantry and cavalry coat, fulk-larted in the first instance, retained its original length until about 1780, but from that time onwards it became, little by little, shorter and scantier until at last it was a "coatee," not as long as the present-day tunic or a swallow-tailed coat. This did away with the protection afforded by the full skirt, and necessitated the introduction of the great coat. The white breeches and gaiters, retained to the last, gradually gave way to trousers and ankle boots in 1800–1820. About 1800 the shako was introduced, apparently from civilian origins. By the end of the Napoleonic wars it was almost universally worn by foot troops and by many other branches as well. Since then it has taken many forms, the latest of which is the modern peaked cap.

Another form of headdress came into vogue—the helmet, which had disappeared from the infantry about 1650–1670, and the cavalry thirty years afterwards. It took two forms, a small helmet with sausage-shaped ornament from front to back, worn chiefly by British light dragoons and artillery, and the towering crested helmet worn by the French, British and Austrians. The French cuirassiers and dragoons had long horsehair tails dependent from the crest.

At the beginning of the 19th century gaitered breeches were replaced by trousers and cavalry uniforms were increasing in brilliance. After Waterloo, indeed, all traces of the old-fashioned coat disappeared, and, the soldier was more showy and worse off in comfort and convenience than previously The hussar furred

pelisse, originally worn over a jacket, had become a magnificently embroidered and laced garment, always slung and never worn, and the old plain under-jacket had been loaded with buttons and lace and differed from the pelisse only in the absence of fur. British regulations of 1855 introduced the low "Albert" shako and the tunic, and abolished the epaulette.

The tunic, accompanied by a spiked helmet of burgonet shape, had been introduced in Prussia and Russia about 1835. The French adopted the tunic in 1853, the Austrians in 1856, and in both countries the shako became smaller and lighter. From about 1880, when the spiked helmet replaced the low shako in England, no radical changes were made in full dress uniforms, except that the Russian army, abandoning the German pattern uniforms formerly in vogue, adopted a national uniform. In 1906–09, however, this attempt to combine handsomeness and comfort was given up, full dresses being made more decorative and light green-grey service dresses being introduced.

The most significant development of this period was the introduction of the drab-coloured field uniform as distinct from other forms of dress. Bright clothing had been of decided moral value on the battlefield, and the limited range of older weapons rendered the extreme visibility of such dress of little consequence. The rapid development, however, of the more accurate, long-range magazine rifle, during the last quarter of the 19th century, placed a premium on low visibility and the need for "protective colouring" in the field.

During the Spanish-American War (1898) the United States adopted a cotton "khaki" uniform for some of its units serving in the tropics. This "dust coloured" cloth had been used in the Indian army for 50 yr.; other types of neutral clothing were of even greater antiquity. As a result of experience gained during the Boer War (1899–1902) a service dress of khaki serge was introduced in the British army about 1903. Experimentation was undertaken in other countries which led up to the issue of a greenish grey uniform in Sweden (1906), Turkey (1909), Germany (1910) and several other states about the same time. Italy had adopted a bluish grey field uniform in 1908 and Austria-Hungary a somewhat similar shade in 1912.

At the outbreak of World War I (1914–18) the issue of these field uniforms was general in all the belligerent nations except France and Belgium. Both hastened to repair this defect, and by 1915 the French army was garbed in a light or "horizon" blue and the Belgian forces were in British khaki. By this time the United States had adopted a darker and greener shade of brown called "olive drab." The exigencies of trench warfare necessitated looser, more comfortable clothing. Caps were softened, collars were lowered and enlarged and pockets became more plentiful. As a protection against shell fragments the combatant armies had by 1917 adopted the steel helmet for all branches. Various attempts were made to provide multi-coloured or "camouflage" clothing which would blend more readily with the landscape, but the results were not found to be worth the cost and effort except in special instances.

Needless to say, dress uniforms were set aside during the period of hostilities and for some years thereafter. In time, however, the need for more inspiriting apparel made itself felt and was solved by various countries in two general ways. The first and most general method was to enliven the field uniform by the addition, in times of peace, of coloured patches, bright metal parts and special insignia which could be removed for field service. The second method entailed the adoption of a very plain and serviceable field uniform and one or more dress kits which were worn off duty or on parade. The German and American armies tried the first method, the British the second and the French adopted somewhat of a compromise between the two. No state returned in the entirety to its 1914 dress uniforms.

Several general trends may be observed in uniform development from 1918 to 1940. To accustom soldiers to the weight and employment of the steel helmet and gas mask, most armies required them worn during all field exercises. The shirt gained popularity as an outer garment in warmer weather, and trousers continued to become longer and more full. Distinctive uniforms were widely adopted for tank, motorized and air units, parachute troops and other special services. Details of the uniforms worn in the principal states at the beginning of 1940 are given in the sections below. (F. P. T.)

Party Uniforms.—A dress of a particular style has often been used to distinguish members of political parties. Sometimes it was merely an armband; in other cases (for instance, when certain insignia were prohibited) civilian clothes, from tie to tophat, had to serve this purpose. The most popular political uniform was probably the shirt. Red Shirts were worn by the volunteers who followed Giuseppe Garibaldi (*q.v.*) and later members of the family. The legions of Gabriele d'Annunzio (*q.v.*) and those of Benito Mussolini (*q.v.*) adopted the Black Shirt, which was also selected by the leader of British fascists, Oswald Mosley (*q.v.*). American fascists wore Silver Shirts, fascists in the Irish Free State and in the Philippines had Blue Shirts, while Gray Shirts were to be found in Cuba and Green Shirts in Brazil. Because of this garment veterans of Latin-American fascism were called "Old Shirts." The best-known political uniform is perhaps that of the Brown Shirts. In 1924 the Brown Shirt was first introduced by the Munich S.A. (*Sturm Abteilung*). Later it was taken over by all S.A and S.S. (*Schutz Staffel*) men and the political leaders of the National Socialist party. Brown Shirts then became the general term for the adherents of the National Socialist movement (*See* NATIONAL SOCIALISM (X)).

GREAT BRITAIN

General Service Uniforms.—The British Army wore the khaki service uniform issued about 1903. The coat was single-breasted, had four outer pockets, a high collar for men and peak lapels for officers. With this was worn a peaked khaki cap, long trousers for foot units and breeches for mounted corps. The khaki overcoat was single-breasted.

Special Service Uniforms.—Tank units wore black overalls and berets. Scottish regiments continued to wear their traditional tartan kilts with a special cut of khaki coat, while units of the Indian Army and other Empire troops introduced many variations into the service uniform. In tropical service cotton shirts and shorts were worn with sun helmets.

In 1938 a drab-coloured "battle dress" was introduced for all combat units. It consisted of a short jacket with a wide collar and two full pockets; long, full trousers with large pockets over the thighs, and short gaiters. A simple fatigue cap or the 1916 pattern steel helmet was worn with this kit, together with web equipment of a new design.

Dress Uniforms.—In 1921 the traditional scarlet or blue dress uniforms were reintroduced for Household troops and regimental bands. Officers were permitted to wear special dress and mess kits. In 1937 a dark blue walking-out dress was issued for enlisted men of all arms, consisting of a single-breasted coat with four outer pockets, long trousers and a peaked cap. Minor modifications in hat and trousers and variations in trimming were permitted.

Insignia.—Regimental and branch distinctions were indicated by means of metal badges bearing traditional coats-of-arms and by numerous minor variations throughout the different uniforms. Rank was shown for officers by metal devices on the shoulder strap, for enlisted men by chevrons and other insignia on the sleeve.

UNITED STATES OF AMERICA

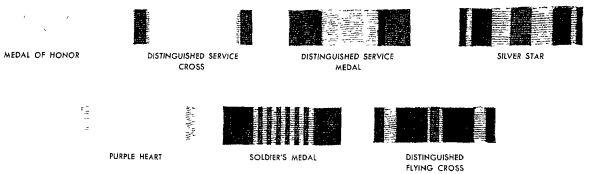
General Service Uniforms.—The service uniform for all branches and components of the Army was olive drab in colour, wool for winter and cotton for summer. The coat was single-breasted, with four outer pockets and a peak lapel collar for all ranks. Trousers of a slightly lighter shade were issued to foot troops, and were tucked into laced canvas leggings, while breeches and laced leather boots were worn by mounted units. Breeches and trousers for officers were of a definitely lighter shade than the coat. An olive drab shirt and black tie were worn under the woollen coat. Usually the cotton uniform did not include a coat, the shirt being worn with a tie of similar colour.

A peaked service or "barracks" cap was worn for walking-out or formal parades by all branches, that of the officer being of a slightly different design and of better material. For field service all branches except the Air Corps, tank and mechanized cavalry units wore a full-brimmed hat with the crown shaped by four indentations (called the "Montana Peak"). The other units used a fatigue or "overseas" cap. All branches and ranks wore the steel helmet of World War (1917) pattern. All forms of headdress were olive drab in colour.

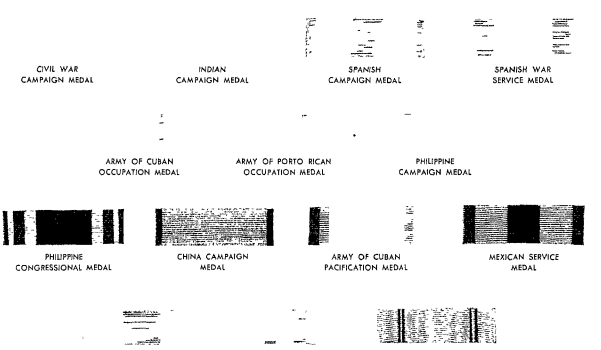
Special Service Uniforms.—Cadets of the Military Academy wore a special service uniform of "cadet grey," consisting of a shirt, breeches and service hat. Flying cadets were issued a slate-blue uniform of the same general pattern as the Army, single-breasted coat or shirt, trousers and "overseas" cap.

Dress Uniforms.—The blue and white dress uniforms of 1917 were not reissued to enlisted men. While the blue uniform was worn later by a few officers on special occasions, the officer's white dress uniform and white mess jacket were used frequently in warm weather. The former consisted of a single-breasted linen or cotton coat with four outer pockets and a peak lapel collar, white shirt and black tie, white trousers and a white peaked cap of regular pattern.

DECORATIONS



SERVICE RIBBONS

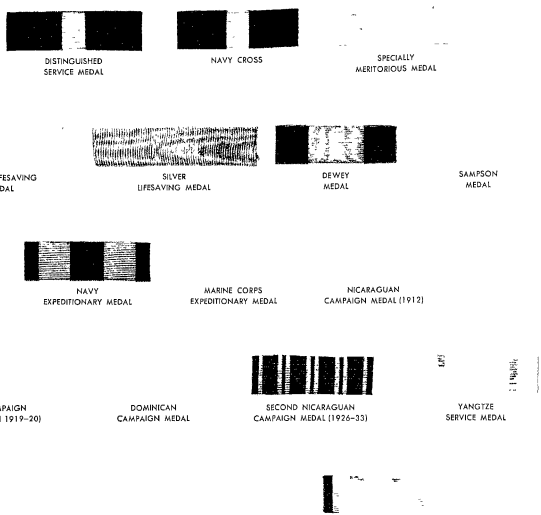


LOFMAN PIX

U.S. ARMY DECORATION AND SERVICE RIBBONS

DECORATIONS IN ORDER OF PRECEDENCE.—(First row) *Medal of Honor* For conspicuous gallantry and intrepidity at the risk of life, above and beyond the call of duty, in action involving actual conflict with an enemy, while an officer or enlisted man *Distinguished Service Cross* For extraordinary heroism in connection with military operations against an armed enemy. *Distinguished Service Medal* For exceptionally meritorious service in a duty of great responsibility. *Silver Star* For gallantry in action in situations not warranting the award of either the Medal of Honor or the Distinguished Service Cross. (Second row) *Purple Heart* For singularly meritorious service or extraordinary fidelity, and for wounds received in battle *Soldier's Medal* For heroism not involving actual conflict with an enemy *Distinguished Flying Cross* For heroism or extraordinary achievement in aerial flights. SERVICE RIBBONS.—(Third row) *Civil War Campaign Medal*, 1861–66. *Indian Campaign Medal*, 1865–91 *Spanish Campaign Medal*· Cuba, Porto (Puerto) Rico, Philippines, 1898 *Spanish War Service Medal*, 1898–99, to those not eligible for Spanish Campaign Medal (Fourth row) *Army of Cuban Occupation Medal*, 1898–1902. *Army of Porto Rican Occupation Medal*, 1898. *Philippine Campaign Medal*, 1899–1913. (Fifth row) *Philippine Congressional Medal* For serving beyond date of normal discharge from Spanish-American War service. *China Campaign Medal* Relief expedition to Peking, 1900–01. *Army of Cuban Pacification Medal*, 1906–09. *Mexican Service Medal* Mexican border and in Mexico, 1914–19. (Sixth row) *Mexican Border Service Medal*· Mexican Border Patrol, 1916–17. *Victory Medal* World War I, 1917–18; Siberia and European Russia subsequent to Nov. 11, 1918 *Defense Service Ribbon*: Awarded to all service men of World War II on active duty in the armed services prior to Dec 7, 1941

UNIFORMS



LOFMAN PIX

U.S. NAVY DECORATION AND SERVICE RIBBONS

(Ribbons for the Medal of Honor, Distinguished Flying Cross, Purple Heart, Civil War Campaign Medal, Spanish Campaign Medal, Philippine Campaign Medal, China Campaign Medal, Cuban Pacification Medal, Mexican Service Medal, Victory Medal and National Defense Medal are the same as in the U S Army, and are illustrated in Plate I)

(First row) *Distinguished Service Medal* For exceptionally meritorious service in a duty of great responsibility, combat or noncombat *Navy Cross* For extraordinary heroism in combat action against an armed enemy *Specially Meritorious Medal* For specially meritorious non-combat service in War with Spain, 1898. (Second row) *Gold Lifesaving Medal* For heroic daring in saving or endeavouring to save lives at sea. *Silver Lifesaving Medal.* For acts of heroism not sufficiently distinguished to deserve the Gold Lifesaving Medal. *Dewey Medal·* For officers and men of the Asiatic squadron under the command of Commodore George Dewey May 1, 1898 *Sampson Medal* For officers and men of the Navy and Marine Corps in naval and other engagements off the West Indies and in Cuba during the War with Spain, 1898.

(Third row) *Navy Expeditionary Medal* For landing on foreign territory and engaging in operations against armed opposition *Marine Corps Expeditionary Medal* Same as preceding, awarded to Marines. *Nicaraguan Campaign Medal*, 1912 (Fourth row) *Haitian Campaign Medal*, 1915 and 1919–20 *Dominican Campaign Medal*, 1916 *Second Nicaraguan Campaign Medal*, 1926–33 *Yangtze Service Medal*, 1926–27 and 1930–32 (Fifth row) *Navy Good Conduct Medal* For clear records, proficiency in rating, enlistment, time of service, etc *Naval Reserve Medal* For officers and men who complete ten years' honourable service *Marine Corps Reserve Medal* For specified periods of service with the Marine Corps Reserve



AMERICAN REVOLUTION | FRENCH REVOLUTION | NAPOLEONIC WARS



WAR OF 1812 | MEXICAN WAR | CRIMEAN WAR | AMERICAN CIVIL WAR

UNIFORMS OF THE 18TH AND 19TH CENTURIES

American Revolution Grenadier regiment von Rall Hessian; British 17th regiment of foot, French Gatinois regiment; U S Patrick Henry rifleman *French Revolution* Revolutionary Infantry *Napoleonic Wars* French 7th regiment hussar (1807); Prussian grenadier (1806). Russian Cossack type *War of 1812* U S Infantry (1813–15); British 44th (East Essex) regiment *Mexican War* Mexican lancer, Active cavalry regiments, U S infantry *Crimean War* Russian infantry; British lancer, 17th regiment *American Civil War* Northern infantry; Southern infantry

UNIFORMS



UNIFORMS OF THE 19TH AND 20TH CENTURIES

Franco-Prussian War: French infantry; Prussian infantry. *Spanish-American War*: Spanish regular infantry, U.S. infantry. *World War I* (infantry): German, 1916–18; U.S., 1917–18, French, 1916–18; British, 1916–18; Italian, 1916–18. *World War II* (infantry): Polish, Italian, Russian, Finnish, German, Japanese, U.S., British

Enlisted men off duty or on parade were permitted a white shirt under the coat. The use of bright metal buttons and colourful insignia was permitted in peace times, which rendered the general service uniform suitable for dress purposes. Special dress uniforms were worn by some bands, cadets of the Military Academy, and many units of the National Guard.

Insignia.—Branch was indicated by various coloured cords on the service hat, piping on the "overseas" cap, and metal devices on the collar or lapel. Unit designations were also shown on these metal devices, as well as by special unit coats-of-arms, worn on the hat, lapels or shoulder straps. Division, corps or army patches were sewn to the upper left sleeve of the coat and overcoat. Rank was indicated by metal devices on the shoulder strap for commissioned officers, and by chevrons on both sleeves for non-commissioned officers. Specialist insignia and service stripes were worn on the arm of the coat and overcoat.

FRANCE

General Service Uniforms.—Since 1935 both the Metropolitan and Colonial Armies have worn khaki. The drill or fatigue dress consisted of a shirt, breeches, roll puttees and a wide sash of various colours. A short, single-breasted coat with wide collar was added to make the walking-out dress. The traditional overcoat, looped back for marching, was worn for field service. Mounted troops wore leather gaiters over the infantry ankle boot instead of puttees; motorized and tank units used long trousers, strapped under the instep, as their only leg covering.

A khaki-coloured steel helmet, quite similar to the World War (1915) model, was worn by most arms. Anti-aircraft and motorized units were issued more compact types, both lacking a front visor. For undress most arms wore the round *kepi*, or peaked cap, of dark or light blue. Fortress and tank units wore a beret, and African units, different forms of the fez or turban. Most arms used a simple cloth cap (*bonnet de police*) for fatigue wear.

Special Service Uniforms.—The *Chasseurs Alpins* and *Chasseurs à Pied* retained their traditional dark blue uniforms and berets. When operating in the snow, the former were equipped with a white outer garment. African units wore the full oriental trousers of khaki colour in place of breeches; while troops of the Colonial Army, serving in the tropics, were outfitted in cotton khaki shirts, shorts and sun helmets.

Dress Uniforms.—All African units continued to wear their traditional dress uniforms of various colours when off duty as late as 1939. Regiments of the Foreign Legion retained the blue sash, red epaulettes, and green trimmings on their khaki clothing. Officers of different branches presented a wide variety of dress clothing: combinations of dark and light blue, red, black and khaki, with a white uniform for tropical wear. Special dress uniforms were provided for military schools and units of the *Garde Republicaine*.

Insignia.—Branch was indicated by various coloured collar patches, hat devices, buttons and other means. Unit numbers were shown on the collar patches and *kepis*. Rank was indicated on the sleeve and hat by stars for general officers and by horizontal stripes for other commissioned grades; for non-commissioned rank, by chevrons and slanting stripes on the sleeve. Many specialist insignias were worn on the coat, and honours were designated by ribbons and *fourragères*.

GERMANY

General Service Uniforms.—The general uniform was derived from the field service dress of 1910, modified by subsequent experience. The coat was of a green-grey colour, single-breasted, with four outer pockets and a wide collar which could be worn open at the neck. The trousers were of a somewhat greyer shade, loose, and fitting into high leather boots, laced in front and buckled on the side. The steel helmet was still chiefly the pattern introduced in 1916, painted green-grey and weighing 2½ pounds, although a lighter form was adopted about 1925. In walking-out order a peaked cap was worn, while a soft cloth cap (*Feldmütze*) was employed for fatigues and drills. The overcoat was of green-grey cloth.

Special Service Uniforms.—Tank units wore a distinctive black uniform with rose-coloured trimmings and white death's-head insignia. The jacket was short, double-breasted, with open collar; the trousers, full and long, were strapped around high shoes. A black beret or leather crash-helmet was used for head-dress.

Dress and Special Uniforms.—Officers and some non-commissioned ranks wore a single-breasted, pocketless tunic for undress (*Gesellschaftsanzug*), with long trousers or riding breeches and high black boots With this uniform, in some orders, a dress belt of metal lace was worn. Officers when off duty in summer were allowed a white coat with a peak lapel collar.

Permanent units of the National Militia wore uniforms of the same general cut as the infantry, only of black for *Schutz-Staffeln* and brown for *Sturm-Abteilungen*.

Insignia.—Branch was indicated by various coloured piping and patches on the collar, shoulder strap and cap. Unit numbers were found on the shoulder strap, and rank was indicated by piping or patches on the collar and by the design and markings of the shoulder strap Various specialist insignias appeared on the arm, and ratings in marksmanship were indicated by short *aiguillettes*.

On the right side of the steel helmet was a seal bearing the German colours and on the left another having the army eagle and swastika. All ranks wore the German eagle and swastika emblem (*Hoheitszeichen*) over the right breast and on the peaked cap.

POLAND

During the 1920s the Polish Army adopted a universal pattern uniform of khaki, for both dress and field service. The coat was single-breasted, with upright collar and with four outer pockets for officers and two for men On each side of the collar opening was a patch of coloured cloth varying with the arm. Trousers or breeches were of plain khaki serge or cord. General officers wore a double dark blue stripe down both breeches and trousers. A modified form of the national headdress or *czapka*, was adopted and made into the headgear for all ranks of the Polish Army. A band of coloured cloth, varying with the regiment, was worn round the cap, on the front of which appeared the badge of rank. A fatigue cap was worn by mounted units. The usual steel helmet was of French pattern, although a deeper model was adopted about 1936. The soldier's greatcoat was of khaki cloth, single-breasted, with broad collar, belt and shoulder straps. The officer's was similar to the double-breasted British pattern.

BELGIUM

The Belgian Army was clothed in khaki for general service, of a pattern similar to the British. Officers' coats had peak lapels, those of the men, high collars. A peaked cap generally was worn by officers, a dark blue beret by *jagers* and *carabiniers*, and a tasselled fatigue cap by other arms. All troops used a steel helmet of French model, with a lion's-head device. Air corps officers wore a blue-grey undress uniform of standard cut, and in 1930 a dark blue dress uniform was authorized for all officers.

THE NETHERLANDS

The general service uniform of the Dutch Army was of green-grey, consisting of a single-breasted coat and fatigue cap, with roll puttees and full trousers for foot troops, and breeches and black leather leggings for mounted units. The overcoat was double-breasted The steel helmet was of a distinctive pattern resembling that of the Swiss Army, carrying on its front the royal arms.

SWITZERLAND

In 1917, a green-grey field uniform was adopted for all arms, and shortly thereafter a distinctive type of steel helmet was issued, being high-crowned and coming low over the ears and brow. At first the different arms were distinguished by coloured tabs on the collar and cuffs, pipings, etc., but these were omitted on the later field uniforms. Officers wore a peaked cap of distinctive design, high and full at the back of the head. Men used two gen-

eral forms of fatigue cap, both buttoned in front. Foot troops wore long trousers and high shoes; mounted units wore breeches

YUGOSLAVIA

The Yugoslavian Army retained essentially the same service uniform as that adopted in 1912 It was light khaki in colour; the coat was cut somewhat on the old Austrian pattern with concealed buttons Breeches were full, and both foot and mounted troops wore high black boots. Infantry were also issued roll puttees Enlisted men wore a soft fatigue cap, while officers used a stiffer type with a visor. The French steel helmet was worn by all arms Special dress uniforms were provided for Household units, whose officers were allowed a distinctive undress uniform.

RUMANIA

The general service uniform was khaki in colour, the coat having peak lapels for officers and a standing collar for men. A peaked cap was introduced in 1931, but the distinctive Rumanian fatigue cap, high in the front and rear, was retained in many units A new steel helmet on the Swiss pattern gradually replaced the older French type. Special dress uniforms of traditional pattern were allowed Household troops and other officers. Chasseurs wore a distinctive "hunter's" hat, and in winter units were issued fur caps and long overcoats.

JAPAN

The general service uniform was of khaki, of a darker and greener shade for officers. The coat was single-breasted with a high collar, the breeches were full and buttoned below the knee. Roll puttees were worn by foot troops, leather leggings by mounted units. The soft cloth cap had a visor, but no fullness in the crown The steel helmet was similar to the British pattern, only deeper. Branch was indicated by coloured patches on the collar In summer the uniform was cotton drill; in winter it was wool, usually supplemented by armless, fleece-lined jackets and by helmet covers having fur ear tabs.

CHINA

Since the Revolution of 1912 numerous styles and colours of uniforms have been worn by the troops of the different Chinese states, blue-grey and khaki being the predominant shades. Troops in the south usually wore cheap cotton clothing, whereas those in colder regions used heavily padded uniforms and fur-lined hats. Due to the shortage of clothing in the 1930s, most of the Chinese armies adopted a simple blue denim coat, breeches, plain round cap and blue roll puttees. Southern troops frequently carried wide straw hats suspended over their backs. All enlisted men wore a tag sewn to the breast giving their name, rank and organization. Nationalist officers wore olive drab in the field and black uniforms for dress.

SPAIN

About 1927 a universal general service uniform of an olive drab shade was adopted. The coat was single-breasted or double-breasted, the breeches were full and worn with roll puttees or boots The usual hat was a beret, with a peaked cap or tasselled fatigue cap for officers and some services. During the Civil War (1936–39) a steel helmet of German pattern, only smaller, was introduced The Moorish body guards wore wide white trousers, white turbans and capes By 1939 dress uniforms had been reissued to certain mounted units.

ITALY

General Service Uniforms.—The standard uniform colour for all arms was grey of a somewhat bluer shade than that of Germany. The woollen coat was single-breasted with four outer pockets and peak lapels for all ranks; the breeches were full Foot troops wore roll puttees, while mounted units and most officers had high black boots. The steel helmet was of distinctive design, fitting low over the head, while a stiff peaked cap was worn for dress and a special cloth cap for fatigue. In warm weather a grey cotton drill was used, often in the form of shorts and shirt. Shirts were grey and neckties were of various colours.

Special Service Uniforms.—*Bersaglieri* cyclists retained their traditional wide-brimmed hat with cock's feathers, or, in the field, wore these feathers on the helmet. Mountain units also wore their older type Alpine caps Native *askari* troops were issued high red fezzes with blue tassels and red sashes.

Troops of the Fascist Militia were issued uniforms like those of the Regular Army, but with numerous minor variations in design Shirts were black, as were certain forms of their fatigue caps. Mounted men wore grey double-breasted overcoats and dismounted, large grey capes (*mantellina*)

Dress Uniforms.—A few special units retained traditional dress uniforms and traces thereof existed elsewhere in the form of sashes, epaulettes and distinctive headdresses In tropical service, a white uniform was permitted officers Dark blue dress coats, overcoats and wide-crowned, peaked caps were worn by Fascist officers of higher rank.

Insignia.—Branch and organization were shown by coloured collar tabs and hat devices. Rank was indicated by devices on the shoulder straps, sleeves and sometimes on the cap When in command of troops higher officers wore an aigrette on the hat.

UNION OF SOCIALIST SOVIET REPUBLICS

General Service Uniforms.—The Soviet Army wore a uniform of varying shades of olive drab. The winter dress of wool comprised a single-breasted coat with two outer pockets, breeches and high black boots, and a very long, double-breasted overcoat In summer a loose cotton blouse of Russian cut and cotton breeches replaced the wool. Most troops wore a peaked cap, although it was replaced in some branches by a simple fatigue cap for summer or by a distinctive cloth helmet with ear flaps, of Tartar origin, for winter. The steel helmet was of French pattern, although in 1937 a new type was issued somewhat similar to that used by Switzerland

Special Service Uniforms.—Tank units wore blue-grey blouses and caps with olive drab breeches Cossack units were permitted black astrakhan caps and full, dark blue trousers. The units of the Political Department (G P.U.) wore the regular uniform with a blue peaked cap, piped with red.

Insignia.—All arms and ranks wore the Soviet five-pointed star on their headdress. Branch was indicated by the colour of collar patches and cap piping, while rank was shown by devices on the lower part of both sleeves. Metal specialist insignia was carried on the collar

AIR FORCES

France.—In 1934–35 a distinctive uniform was authorized for the Air Corps It consisted of a dark blue, belted coat with four outer pockets, dark blue, long trousers and peaked cap, similar to that worn in the Navy A cotton uniform of khaki colour was prescribed for wear in the tropics, where officers were also permitted white uniforms off duty.

Germany.—The uniform was blue-grey in colour, the coat single-breasted with four outer pockets and peak lapel. An undress uniform was provided, consisting of a short buttonless jacket and fatigue cap. The uniform, otherwise, was essentially the same as that of the Army, save for colour For walking-out in summer officers were authorized to wear a white dress coat

Parachute troops used in the field green-grey overalls of special design, fastened by zippers, with deep bomb pockets let into the full trousers The shoes were high and had rubber soles These troops wore a helmet without front or rear visors

Great Britain.—The service uniform of the Royal Air Force was light blue, the coat being single-breasted and belted with four outer pockets. Breeches and roll puttees were worn, with a peaked cap for dress and a fatigue cap for ordinary wear. For foreign service all ranks wore a khaki drill uniform including a Wolseley helmet on which was worn a "flash" bearing in silk the R.A.F. colours.

A full dress uniform was allowed officers, made of light blue material, the coat single-breasted with plain cuffs and trimmed with gold lace The headdress, of distinctive design, was of black chrome leather, trimmed with seal dyed nutria, and had a gold

and blue plaited cord across the front and an ostrich feather plume dyed blue Officers were also permitted a mess dress of the same light blue colour, and white uniforms were authorized for tropical wear.

Italy.—The uniform was similar in colour to that worn by the Army, having a peak lapel coat, belted at the waist, and long trousers. A peaked cap was worn for dress, and a white uniform was permitted in warm weather

Japan.—As part of the Army the air service wore the universal khaki uniform with distinctive badges Aviation pilots wore, on the right breast, an oval device of wings, propeller and sun's rays; members of aviation battalions wore a propeller across a steering wheel in the form of a gilt badge on the right collar patch, the number of the battalion being on the left patch.

Poland.—As part of the Army the members of the aviation arm wore the universal khaki uniform with yellow collar patches

Rumania.—The air corps wore a khaki uniform similar in cut to that worn by the Army, with a peaked cap. White uniforms were permitted in summer.

Switzerland.—The flying corps wore the universal grey-green uniform with two wings and a propeller in light-brown thread as a distinguishing badge.

Union of Socialist Soviet Republics.—The 'Russian Air Corps wore an undress uniform of dark blue, consisting of a coat with four outer pockets and peak lapels, breeches and high black boots, and a fatigue cap. Parachute units were equipped with grey overalls and flying helmets, and rubber soled shoes

United States of America.—The Army air service being an integral part of the Army, the members wore the uniform laid down for the Army with particular distinctions Aviators and observers wore a pair of wings and a vertical propeller in silver on the left breast; enlisted men wore the same on the sleeve; flying instructors a pair of wings only. Flying cadets wore a slate blue dress

Yugoslavia.—As part of the Army the air service wore the universal olive-yellow service dress with horizon blue collar patches. (F P. T.)

NAVAL

Great Britain.—The dress of seafarers in the British Isles had attained a certain uniformity, principally brought about by the conditions and hazards of their calling, long before any regulations were made on the subject. Chaucer's description of the attire of the Shipman depicts a figure he had doubtless seen many times at Dartmouth, or in the streets of London in the neighbourhood of Bankside and the Pool. A sea gown of "falding," reaching to the knee, a homely garment of rusty blue or brown, intended to stand hard usage, was long worn by seamen In a book on costume by Caesare Vecellio, published in Venice in 1598, a full-length figure of an English mariner is shown, and the legend states that they wore short coats, sky blue, white or some other colour, wide baggy breeches with many folds, and ruffs round their necks. Their caps were hairy, like those that pilgrims wore. Such expressions as a "sea gown," a "pitch'd jacket," and a "canvas shrowd," as synonyms for sailors' wear, are common in Tudor and Stuart literature.

An important step leading to uniformity in the dress of the seaman was taken in 1628, when an order for the provision of ready-made clothing was given. Certain articles of attire were placed on board his Majesty's ships and hired vessels for issue to the officers and men, the cost to be charged against their wages. In 1638, an order for the prevention of over-charging was hung up in the steerage of every ship, and a list of the articles to be sold, with their prices. In 1663, the slop clothing included canvas suits, red caps, blue shirts, red or striped breeches and blue neck-cloths, among the articles for sale. From 1706 until about 1750, the slop clothing consisted of grey kersey jackets, waistcoats of striped ticking or Welsh red, breeches of red kersey or striped shag, blue and white check shirts, grey stockings, shoes and leather caps, faced with red cotton, or flat-topped three-cornered hats.

From the middle of the 18th century, when blue and white became the colours of the officers' uniform, the dress of the seamen gradually conformed to the same combination. It comprised usually a blue jacket, a scarlet or buff waistcoat, a check or striped shirt, white or striped trousers "long in the legs and taut at the hips and ankles," a kerchief, black or brightly coloured, tied loosely round the neck with two corners hanging down outside the jacket behind to protect it from the chafe of the pigtail, the vogue of which was only from about 1780 to 1830. The round hat was made of straw, leather or tarred canvas, turned up at the sides with a coloured lining, and a ribbon with the name of the ship painted on it The strips of canvas sometimes sewn on the seams of the jacket were only to repair and strengthen old and used garments, as Jonas Hanway wrote in 1759, and not as ornamentation After the first quarter of the 19th century, nearly all colours except blue had disappeared for all articles but waistcoats and kerchiefs.

In 1787, a uniform for all officers was established, and remained in force until 1795, when, to commemorate Lord Howe's victory of June 1, 1794, gold epaulettes hanging down like tassels, with marks on them to indicate rank, were introduced At the same time, the white facings were abolished, with one exception, the patch on the midshipman's collar. Nearly all the later portraits of Nelson and those of his band of brothers are in the full or undress of these regulations. In 1812, white facings were reintroduced, and this dress was worn during the War with the United States. New regulations were issued on January 1, 1825, with plans, which may be seen in the Admiralty Library. Since this date, regulations have been published in the Navy List, where the changes to the present time may be traced The most important was made by William IV, who in 1832 altered the facings from white to red, and so they remained until June 30, 1843. Queen Victoria then restored white, and so it has remained ever since Illustrated manuals of current naval uniforms were published by the Admiralty on May 7, 1879, and October 10, 1891.

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Other Countries.—The development of naval dress in other states has, to a great extent, followed that of Great Britain. As a result, there was little difference between the naval uniforms of the various modern countries Almost all of them authorized blue kits for winter and white for summer or tropical wear, as well as various overgarments for combat or rough weather Only in the seamen's caps was any marked difference to be found. American sailors wore a distinctive white "shell" cap. French sailors carried a red pom-pon on top of their hats, and German seamen a long trailing ribbon German naval officers could be distinguished by the peak lapels and high wing collars worn with most uniforms, and the seamen by a jacket which replaced the blouse for dress. Japanese officers retained the older, high-collared uniforms. (X)

United States.—The uniform, with its various insignia and devices, is designed primarily to indicate on sight those men belonging to the naval service, to show at a glance their rank, corps, or rating, and is required to be worn at all times by officers and enlisted men while on duty.

The United States naval officers' uniform in general corresponds to those worn by officers of the various navies of the world, and officers of different ranks are most readily distinguished by the sleeve markings, or sleeve stripes of gold lace which completely encircle the sleeve In addition to these insignia of rank, officers of the several corps and warrants are indicated by individual corps devices embroidered above the sleeve stripes. Sleeve markings (stripes) for the various ranks follow:

Admiral .	One 2-inch stripe with three ½-inch stripes above it.
Vice-Admiral	One 2-inch stripe with two ½-inch stripes above it.
Rear-Admiral	One 2-inch stripe with one ½-inch stripe above it.
Captain . .	Four ½-inch stripes.

Commander	Three ½-inch stripes.
Lieut. Com.	Two ½-inch stripes with one ¼-inch stripe between the other two.
Lieutenant	Two ½-inch stripes.
Lieut.(jr. grade)	One ½-inch stripe with one ¼-inch stripe above it.
Ensign	One ½-inch stripe.
Chief warrant officer	One ½-inch stripe (the gold lace to be woven at intervals of 2 inches with dark-blue silk thread in widths of ½-inch.
Warrant officer	One ½-inch stripe (the gold lace to be woven at intervals of 2 inches with dark-blue silk thread in widths of ½-inch.

Sleeve markings (corps devices) of the commissioned grades and line warrants are listed as follows.

Line officers	Five-pointed gold star.
Medical officers	A spread oak leaf, embroidered in gold, surcharged with acorn, embroidered in sliver.
Supply officers	A sprig of three oak leaves and three acorns.
Chaplains	A Latin cross.
Naval constructors	A sprig of two live-oak leaves, spreading with an acron on the stem between the leaves.
Civil engineers	Two sprigs of two live-oak leaves embroidered in gold and an acorn embroidered in silver in each sprig.
Chief boatswain and boatswain	Two crossed foul anchors.
Chief gunner and gunner	Flaming spherical gold shell.
Chief machinist and machinist	A three-bladed gold propeller.

Uniforms worn by enlisted men of the United States navy consist in general of the conventional seaman's overshirt or jumper, with trousers that flare slightly at the bottom. The various enlisted ratings are indicated by rating badges worn on the sleeve midway between shoulder and elbow, consisting of an eagle, chevrons, and speciality marks. The chevrons indicate the rank or class of the petty or non-commissioned officer, while the speciality marks indicate, as the name implies, the branch in which the individual has been rated. Enlisted men, other than petty officers, wear what is known as a branch mark, consisting of a stripe of braid, white for the seaman branch and red for the engineer branch.

Detailed description, accompanied by photographic plates of the various naval uniforms of the United States may be found in a publication known as the *Uniform Regulations, United States Navy*, issued to members of the naval service and sold by the government printing office, Washington, D.C. (R. H. Le.)

UNION, a town of South Carolina, U.S., the county seat of Union county; 65 mi. N.W. of Columbia, on federal highway 176, and served by the Buffalo, Union-Carolina and the Southern railways. The population was 9,730 in 1950 and 8,478 in 1940 by the federal census.

It is in the beautiful Piedmont region, near the foot of the Blue Ridge, and is one of the important textile-manufacturing centres of the state, with large cotton mills.

UNION CITY, a city of Hudson county, New Jersey, U.S., 1 mi. W. of the Hudson river, opposite New York city, on high ground above Weehawken, between Hoboken and West New York. Railroad facilities are provided through Hoboken, Weehawken and Jersey City.

Pop. (1950) 55,537; (1940) 56,173. Manufactures include silk, cosmetics, paper and incandescent light bulbs.

Union City was formed in 1925 by the consolidation of Town of Union (incorporated 1864) and West Hoboken (incorporated as a town in 1884), which in 1920 had populations of 20,651 and 40,074 respectively.

UNIONIST PARTY: *see* CONSERVATIVE PARTY, BRITISH.

UNION LEAGUE OF AMERICA, THE, sometimes called the Loyal league, was an organization for political purposes of northern whites, later of southern Negroes, which originated in Ohio in 1862 when the Confederate military successes and political disaffection in the northern states made the outlook for the north seem doubtful. Within one year it had spread over 18 northern states and among the Unionists of the south. The order raised troops, paid their expenses, sent supplies to the field and distributed political literature. At the close of the war it worked for radical reconstruction of the southern states, punishment of the southern leaders, confiscation of property and Negro suffrage. The southern Unionists hoped to make it the nucleus of a new political party, but this was frustrated by the admission of the blacks for political purposes, after which the southern whites generally deserted the league.

After the Freedmen's bureau agents and other northern whites obtained command of the league in the south it became simply a machine to control the Negro vote. The league ceased to be important in the north, though headquarters were in New York city. Each southern state had its grand council and each county one or more councils.

A constitution and an elaborate ritual were adopted, making it an oath-bound secret order, whose members were sworn to support one another on all occasions, to vote in elections only for Negroes or northern men, and to overthrow the southern "white oligarchy." No ex-Confederate and few southern Unionists were permitted to join.

At each meeting the members were taught that they must beware of their white neighbours as their worst enemies, that the Democratic party, to which the southern whites belonged, had opposed emancipation and was still opposed to any rights for the Negro. To prevent moral control of the Negroes by former masters, the league, by an "exodus order," required all Negroes who were still living with their former masters to find other homes. The Negroes were taught the equality of men and the right of the Negro to his master's property.

The Negro vote during reconstruction was controlled by the few white Radical leaders and Negroes who voted with the mass of the southern whites were persecuted, beaten, or even, in a few cases, killed. The league died out about 1870 but not before it had succeeded, with the Freedmen's bureau and other forces, in permanently arraying the Negroes and the whites into opposing political parties.

UNION OF SOVIET SOCIALIST REPUBLICS, THE: *see* RUSSIA.

UNION PACIFIC RAILROAD extends from the Missouri river at Council Bluffs, Omaha, St. Joseph, and Kansas City, via Denver, Cheyenne, Ogden and Salt Lake City, to Los Angeles, to Portland, Ore., and to Seattle on Puget sound (and in connection with the Southern Pacific, to San Francisco and central and northern California). The railroad, a Utah corporation, at mid-20th century operated 9,756 mi. in 13 states. Including sidings, the total trackage was nearly 16,000 mi. The main line between Council Bluffs and Salt Lake City, 1,027 mi., is double tracked, as are several of the branch sections. The railroad owned, in 1950, about 1,500 locomotives, including 530 diesel-electrics ("A" and "B" units) and 1 experimental gas turbine-electric. In addition there were approximately 1,200 passenger cars and 55,000 freight cars.

The original company was incorporated in 1862 under an act of congress providing for the construction of a continuous line of railroad from the Missouri river to the Pacific ocean, as a measure of military protection, and for the preservation of the union. The connection of the line with the Central Pacific at Promontory, Utah, approximately 53 mi. west of Ogden, May 10, 1869, completed this first transcontinental railroad. The occasion was marked by ceremonies during which a golden spike was driven into the joining tie.

Although the company expanded rapidly to a route length of more than 7,000 mi. by 1893, it was struck by the business depression of that year and went into receivership. The government and other mortgages were foreclosed.

In the reorganization by E. H. Harriman and associates, the full amount of principal and interest of the government mortgage was repaid, and the other outstanding mortgages refunded. The present company, incorporated July 1, 1897, assumed operation Feb. 1, 1898. (W. M. Je.; X.)

UNIONTOWN, a city of southwestern Pennsylvania, U.S., 50 mi. S. by E. of Pittsburgh, the county seat of Fayette county; on federal highway 40, at an altitude of 1,020 ft. It is served by the Baltimore and Ohio and the Pennsylvania railways. Pop. 20,471 in 1950, 1940, 21,819 by the federal census.

A government airport and a commercial landing field are near by. A village was laid out there in 1776 on land belonging to Henry Beeson. It was incorporated as a borough in 1796, as a city in 1916 and has a commission form of government. On federal highway 40, 8 mi. E. of Uniontown, a monument marks the

spot where General Braddock died and was buried after his defeat by the French and Indians in 1755 Two miles farther east is the site of Ft. Necessity, built by Washington in 1754.

UNITARIANISM, a system of Christian thought and religious observance, deriving its name from its doctrine of the single personality of God the Father, in contrast with the Trinitarian conception of His threefold being as Father, Son and Holy Spirit. But the significance of the movement is imperfectly indicated by its name Its real importance lies in its teachings concerning mankind and the nature and work of Jesus Christ.

Free Study of the Bible.—The movement cannot be traced to any single teacher or any specific date; it had its sources in the thoughts of many minds in many lands

During the 17th century separate religious communities arose in Poland (now extinct) and in Hungary (Transylvania, now part of Rumania), standing for Unitarian Christianity, though not under that name; and afterward in England and in America, when the name came into general use. These societies took seriously the rule of "the Bible and the Bible only." And at the end of the following century we find the English Unitarians, in the petition presented to parliament in 1792, explaining their position by saying that they conceived it to be "their duty to examine into and interpret the Holy Scriptures for themselves, and their right publicly to declare the result of their enquiries."

A Twofold Tradition.—In the history of the movement two factors stand out as equally characteristic, distinctive and essential the demand for personal religious freedom, and the demand for clear, distinct and coherent religious thought and teaching.

(1) The demand for personal religious freedom, so far as England is concerned, can be traced directly to the Act of Uniformity (1662), under which 2,000 clergymen were deprived of their livings Richard Baxter (*q.v.*) represents the spirit of the ejected ministers at its best. He had no idea of complete toleration; but he stood for the endeavour to find a basis of agreement by reducing the number of the essentials and fundamentals. The influence of this endeavour, with its implied comprehensiveness and recognition of degrees of certainty, went on working after his death, and led to results undreamed of in his day. This history of a large number of churches in England, whose members now profess Unitarianism, begins with the ejection of 1662.

(2) Some of the ejected clergy, in the exercise of their freedom, arrived at the conviction that "the Trinitarian scheme" (by which they meant the whole scheme of salvation, with its doctrines of inherited guilt, eternal punishment, and vicarious atonement) was no part of essential Christianity. The advocacy of Joseph Priestley (*q.v.*), and the withdrawal of Theophilus Lindsey (1723–1808) from the Church of England to establish a Unitarian church in London (Essex street, Strand, 1774) aroused the liberal dissenters to consider their position, and to a large extent they found that they had grown into Unitarian Christianity.

There were also various interests which they had in common, in which they were threatened with serious injury. The penal laws against deniers of the Trinity were not repealed until 1813, and the Corporation and Test Acts (against all dissenters from the National Church) not until 1828. The general desire for more united and effective action led to the formation of the British and Foreign Unitarian association in 1825, by the amalgamation of three older societies for literature (1791), mission work (1806), and civil rights (1818).

Changing Bases of Belief.—At the beginning of the 19th century Unitarian Christianity was, broadly speaking, a biblical religion, accepting miracles, and rejecting creeds, not as incredible but as nonbiblical, resting its hopes on an external revelation, and attaching little importance to what it regarded as the uncertain influences and promises of "natural religion." Then this system in its turn gave way to a revised theology which was part of the changed outlook on the world and human history, due to the development of scientific and historical knowledge during the 19th century. A steady movement of doctrine can be traced among English Unitarian ministers and laymen, influenced by the personality and teaching of William Ellery Channing (1780–1842) and Theodore Parker (1810–60) from New England, and J. J Tayler (1797–1869), J. Hamilton Thom (1808–94), and above all, James Martineau (1805–1900), in England. The result of that movement has been that Unitarians no longer find the seat of authority only within the pages even of the best and broadest of books, but in religious history and experience, interpreted by the reason and conscience of mankind.

The past history of the Unitarian movement has stamped certain characteristics on its life. Many of its founders were forced into exile by exclusion from the larger historic Churches of Christendom; and this, together with its subsequent denominational history, has infused a certain habit of mind—of independent judgment, of bringing opinions to the bar of strong commonsense, of proving all things and holding fast that which is good But the need of more effective corporate union was deeply felt, and led to the union of the principal denominational organizations in a new and representative body, the "General Assembly of Unitarian and Free Christian Churches" (1928).

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UNITED STATES

Unitarianism in the United States followed essentially the same development as in England, and passed through the stages of Arminianism, Arianism, antitrinitarian, to rationalism and a modernism based on a large-minded acceptance of the results of the scientific and comparative study of all religions. As early as the middle of the 18th century Harvard college represented the most advanced thought of the time, and a score or more of clergymen in New England were preaching what was essentially Unitarianism. The most prominent of these men was Jonathan Mayhew (1720–66), pastor of the West church in Boston from 1747 to 1766.

The first official acceptance of the Unitarian faith on the part of a congregation was by King's chapel in Boston, which settled James Freeman (1759–1853) in 1782, and revised the Book of Common Prayer into a mild Unitarian liturgy in 1785. Unitarian congregations were organized at Portland and Saco in 1792 by Thomas Oxnard; in 1800 the First church in Plymouth accepted the more liberal faith Joseph Priestley came to the United States in 1794, and organized a Unitarian church at Northumberland, Pa., in the same year, and one at Philadelphia in 1796. His writings had a considerable influence. Thus from 1725 to 1825 a more tolerant belief was developing in New England, and to some extent elsewhere.

William Ellery Channing was settled over the Federal Street Congregational church, Boston, 1803, and in a few years he became the leader of the Unitarian movement. At first mystical rather than rationalistic in his theology, he took part with the "Catholic Christians," as they called themselves, who aimed at bringing Christianity into harmony with the progressive spirit of the time. His essays, *The System of Exclusion and Denunciation in Religon* (1815) and *Objections to Unitarian Christianity Considered* (1819), make him a defender of Unitarianism. The Unitarian movement has grown slowly; and its influence has been chiefly exercised through general culture and the better literature of the country. Many of its clergymen have been trained in other denominations; but the Harvard divinity school was distinctly Unitarian from its formation in 1816, to 1870, when it became an unsectarian department of the university. By 1950 there were four colleges and seminaries and two preparatory schools associated with the Unitarian denomination. One of the oldest Unitarian schools is Meadville Theological school, founded in Meadville, Pa., in 1844 and moved to Chicago, Ill, in 1926.

Periods of Unitarian Thought.—By mid-20th century Unitarian thought in the United States had passed through three periods. The first, from 1800 to 1835, was formative, mainly influenced by English philosophy, semisupernatural, imperfectly rationalistic, devoted to philanthropy and practical Christianity. Channing was its distinguished exponent. The second, from 1835 to 1885, profoundly influenced by German idealism, was increasingly rationalistic, though its theology was largely flavoured by mysticism. The leaders of this second period were Emerson and Theodore Parker.

The third period, beginning about 1885, was one of rationalism, recognition of universal religion, large acceptance of the scientific method and ideas and an ethical attempt to realize the higher affirmations of Christianity It was marked by harmony and unity to a degree found in perhaps no other religious body, by steady growth in the number of churches and by a widening fellowship with all other progressive phases of modern religion During this period the influence of Emerson became predominant.

An International Council of Unitarian and Other Liberal Religious Thinkers and Workers was organized at Boston, Mass., on May 25, 1900, "to open communication with those in all lands who are striving to unite pure religion and perfect liberty, and to increase fellowship and co-operation among them" In 1910 this organization became the International Congress of Free Christians and Other Religious Liberals. Foreign work of the Unitarians is carried on through the auspices of the International Association for Liberal Christianity and Religious Freedom. This organization by mid-20th century had correspondents in 22 countries

Beyond its own borders the body has obtained recognition through the public work of such men as Henry Whitney Bellows and Edward Everett Hale, the remarkable influence of James Freeman Clarke and the popular power of Robert Collyer By mid-20th century the number of Unitarian churches in the United States was more than 350, with more than 450 ordained clergy, among whom were 10 women. Church membership exceeded 75,000. Of this number 50,000 were 13 years of age or over

The periodicals of the sect are *The Christian Register* and the *Wayside Community Pulpit.*

See Joseph Henry Allen, *Our Liberal Movement in Theology* (1882), *Sequel to our Liberal Movement* (1897); John White Chadwick, *Old and New Unitarian Belief* (1894) *See* especially Chadwick's *William Ellery Channing* (1903), *Unitarianism: its Origin and History, a course of Sixteen Lectures* (1895); also George Willis Cooke, *Unitarianism in America: a History of its Origin and Development* (1902); Ephraim Emerton, *Unitarian Thought* (1911), Earl M Wilbur, *Our Unitarian Heritage* (Boston, 1925); Francis A Christie, "Unitarianism" in the *American Journal of Theology*, Oct., 1917, reprinted in *Freedom and Truth* (1925), and *Unitarian Year Book*, annual (J. H. L ; X.)

UNITED BRETHREN IN CHRIST, a U.S. religious sect which originated in the last part of the 18th century under the leadership of Philip William Otterbein (1726–1813), pastor of the Second Reformed church in Baltimore, and Martin Boehm (1725–1812), a Pennsylvanian Mennonite of Swiss descent. Otterbein and Boehm licensed some of their followers to preach and did a great work, especially through class meetings of a Wesleyan type; in 1789 they held a formal conference at Baltimore, and in 1800, at a conference near Frederick City, Md , the Church was organized and Otterbein and Boehm were chosen its first bishops or superintendents. In 1946 the United Brethren in Christ merged with the Evangelical Church to form the Evangelical United Brethren Church. The articles of the new church were derived principally from the Methodist Church and in turn from the Thirty-Nine articles of the Church of England. Baptism was required for membership. In organization the church was composed of a general conference with final authority in all church matters, 52 annual conferences and quarterly conferences presided over by local officials. General church officers are elected every four years at the meeting of the general conference.

At mid-20th century the combined church had more than 700,000 members affiliated to nearly 4,500 churches. It supported 11 colleges and seminaries, 2 children's homes and 7 homes for the aged.

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UNITED FREE CHURCH OF SCOTLAND, a religious organization, representing the union made in 1900 between the Free Church of Scotland (except a dissentient section who separated off and retained the name of Free Church) and the United Presbyterian Church. (*See* FREE CHURCH OF SCOTLAND and UNITED PRESBYTERIAN CHURCH)

The first moderator was Dr. Robert Rainy. The Free Church brought into the union 1,077 congregations, the United Presbyterians 599; the revenue of the former amounted to £706,546, of the latter to £361,743

The minority of the Free Church who had refused to join the union lost no time in testing the legality of the act of the majority in entering it Their summons, dated Dec 14, 1900, claimed that in uniting with the United Presbyterian Church, which did not hold the principles of the Free Church, the majority had forfeited the right to the property of the Free Church, which must be judged to belong to the minority who remained faithful to the principles of the Free Church and were that Church. In the Scottish courts the case was decided in favour of the union on Aug. 9, 1901, and on July 4, 1902, but, on appeal, the house of lords, on Aug 1, 1904, by a majority of five to two, reversed these decisions, and found the minority entitled to the funds and property of the Free Church.

Few legal decisions have occasioned so great consternation or such serious practical difficulties. At first sight it deprived the majority of the Free Church section of the United Church of all its material goods—churches, manses, colleges and missions, even of the provision for the old age of the clergy, and handed them over to a body which could have little prospect of making effective use of them Nothing remained but to invoke the intervention of parliament to put an end to an impossible situation. In December a commission was appointed, consisting of Lord Elgin, Lord Kinnear and Sir Ralph Anstruther, to inquire into matters connected with the two churches, while the question of interim possession was referred to Sir John Cheyne, as commissioner, for inquiry and action.

The commission sat in public, and after hearing evidence on both sides, issued their report in April 1905. They reported that the state of feeling on one side and on the other had made their work difficult. They had concluded however that the Free Church was unable in many respects to carry out the purposes of the trusts, which, under the verdict of the house of lords, was a condition of their holding the property, and that there was a case for parliamentary interference. They recommended that an executive commission should be set up by act of parliament, in which the whole property of the Free Church, as at the date of the union, should be vested, and which should allocate it to the United Free Church, where the Free Church was unable to carry out the trust purposes. The Churches (Scotland) act, which gave effect to these recommendations, was passed on Aug. 11, 1905.

The allocation of churches and manses was a slow business, and involved litigation; but at length was carried through. (*See* FREE CHURCH OF SCOTLAND.)

In Oct. 1929 the United Free Church reunited with the Church of Scotland. The joint group was renamed the Church of Scotland. At mid-20th century the combined organization was composed of a general assembly, 12 synods and 66 presbyteries in Scotland, 1 presbytery in England and 3 in continental Europe. There were 2,360 congregations with 1,300,000 members, exclusive of adherents. Sunday schools numbered 2,900 with more than 300,000 scholars and teachers.

Including natives, there were about 13,000 agents in the church's foreign missions. These missions had an annual income of more than £1,000,000.

The Church is affiliated with four Scottish universities: Edinburgh, Glasgow, Aberdeen and St. Andrews. These are served by 28 professors and lecturers. (*See* also SCOTLAND, CHURCH OF)

UNITED KINGDOM OF GREAT BRITAIN AND IRELAND, the title of the former political unity composed of

England, Wales, Scotland and Ireland, officially adopted on Jan. 1, 1801, when the Act of Union between Great Britain and Ireland came into force. The name Great Britain has been used since the union of the kingdoms of England and Scotland in 1707 as the official designation of the united countries.

When, in 1922, 26 Irish counties were severed from the United Kingdom and erected into a dominion of the British empire under the name of the Irish Free State (later Eire), no provision was made in the act for any change in the royal style or in the title of the imperial parliament. It even seems to have been assumed that the Free State was to remain technically part of the United Kingdom, for in sec. 2 (1) of the Free State Constitution Act we read that "Goods transported during the current year from or to the Irish Free State or from *any other part of the United Kingdom* or the Isle of Man shall not . . ." From 1922 onward, however, the title of United Kingdom of Great Britain and Northern Ireland was frequently used in official documents to designate those parts of the British Isles represented in the imperial parliament, meeting at Westminster.

In the report of the interimperial relations committee of the Imperial Conference of 1926 it was suggested that, in view of new constitutional developments, the words "United Kingdom" should be omitted from the royal style, which should run: "George V., by the Grace of God, of Great Britain, Ireland, and the British Dominions beyond the Seas King, Defender of the Faith, Emperor of India."

By the Royal and Parliamentary Titles Act, 1927 (17 Geo. 5. ch. 4), accordingly, the king was authorized to change the style and titles of the crown by royal proclamation. This was done, on May 13, 1927, by a proclamation adopting the recommendation of "the representatives of our Governments in Conference," and declaring that in the Latin style "Magnae Britanniae, Hibernae" should henceforth be used, and in the English style "Great Britain, Ireland and . . ." instead of "the United Kingdom of Great Britain and Ireland."

By the same act of parliament (2, 1) it was enacted that "Parliament shall hereafter be known as and styled the parliament of the United Kingdom of Great Britain and Northern Ireland." (*See* also ENGLAND; GREAT BRITAIN; IRELAND; IRELAND, NORTHERN; IRELAND, REPUBLIC OF; SCOTLAND; WALES.)

UNITED METHODIST CHURCH, or UNITED METHODISTS, an English Nonconformist community formed in 1907 by the union of the Methodist New Connection (1797), the Bible Christians (1815) and the United Methodist Free Churches (1857). The act of parliament which enabled this amalgamation received the royal assent on July 26, 1907. The union was completed on Sept. 16, 1907, in Wesley's chapel, City road, London. (For recent statistics *see* METHODISM.)

UNITED METHODIST FREE CHURCHES, an English Nonconformist community merged since 1907 in the United Methodist Church (*q.v.*).

UNITED NATIONS. On Jan. 1, 1942, 26 nations signed the declaration by the United Nations which affirmed their union against the axis powers. At Moscow in Oct. 1943 the United Kingdom, the Union of Soviet Socialist Republics and the United States, joined by the Republic of China, agreed to establish a general international organization for the maintenance of international peace and security "at the earliest practicable date." In the late summer and fall of 1944, representatives of these four powers met at Dumbarton Oaks (Washington, D.C.) to draw up a series of proposals for the new organization. These proposals were circulated among all states at war with the axis powers for comment and suggested amendment. An agreement on the voting procedure in the Security council was reached by Franklin D. Roosevelt, Winston Churchill and Joseph Stalin at the Yalta conference in Feb. 1945.

Forty-six states sent delegates to the conference which convened at San Francisco, Calif., on April 25, 1945, to draw up the charter of the United Nations. After the conference opened, four more states were admitted. The charter was signed on June 26 by representatives of 50 states; Poland signed on Oct 15. It entered into force on Oct. 24, 1945, when China, France, the U.S.S.R., the United Kingdom and the United States and a majority of other signatories had deposited their ratifications

Purposes and Membership.—The first article of the charter outlines the purposes of the organization The primary objective is the maintenance of international peace and security. The organization also dedicated itself to the development of friendly relations among nations, based on the principle of equal rights and self-determination of peoples; to the achievement of international co-operation in solving international problems of an economic, social, cultural or humanitarian character; and to serving as a centre for harmonizing the actions of nations in the attainment of these common ends.

Some of the basic principles of the United Nations, as outlined in article 2 of the charter, are as follows· the United Nations is based on the sovereign equality of its members, disputes are to be settled by peaceful means; members undertake not to use force or the threat of force in contravention of the purposes of the United Nations; each member must assist the organization in any action it takes under the charter; and states not members of the United Nations are required to act in accordance with these principles so far as may be necessary for the maintenance of international peace and security. Article 2 also stipulates that the organization shall not intervene in matters which are essentially within the domestic jurisdiction of any state, except to take enforcement measures

The original members of the United Nations were as follows· Argentina, Australia, Belgium, Bolivia, Brazil, Byelorussian S.S.R., Canada, Chile, China, Colombia, Costa Rica, Cuba, Czechoslovakia, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, France, Greece, Guatemala, Haiti, Honduras, India, Iran, Iraq, Lebanon, Liberia, Luxembourg, Mexico, the Netherlands, New Zealand, Nicaragua, Norway, Panamá, Paraguay, Peru, Philippines, Poland, Saudi Arabia, Syria, Turkey, Ukrainian S.S.R., Union of South Africa, Union of Soviet Socialist Republics, United Kingdom, United States, Uruguay, Venezuela and Yugoslavia.

Other states were later admitted to membership in the United Nations: Afganistan (Nov. 19, 1946), Burma (April 19, 1948), Iceland (Nov. 19, 1946), Indonesia (Sept. 28, 1950), Israel (May 11, 1949), Pakistan (Sept. 30, 1947), Sweden (Nov. 19, 1946), Thailand (Siam) (Dec. 16, 1946) and Yemen (Sept. 30, 1947).

A favourable recommendation by the Security council, requiring the unanimous vote of the five permanent members of the council, and a two-thirds vote of the general assembly are necessary to the admission of a state to membership. Furthermore, the charter stipulated that a candidate to be admitted must be a peace-loving state, accept the obligations contained in the charter and be able and willing to carry out these obligations. Because of lack of agreement among the permanent members of the Security council, the following states had failed of admission to the organization by mid-1953. Albania, Austria, Bulgaria, Cambodia, Ceylon, Finland, Hungary, Ireland, Italy, Japan, Jordan, Laos, Libya, Mongolia, Nepal, Portugal, Republic of Korea, Rumania and Vietnam. The subject of admission of new members to the United Nations was the source of considerable debate in both the general assembly and the Security council and resulted in advisory opinions by the International Court of Justice

PRINCIPAL ORGANS

The United Nations has six principal organs: the general assembly, the Security council, the Economic and Social council, the Trusteeship council, the International Court of Justice and the secretariat.

General Assembly.—This is the only body on which all members are represented. Although a member may send five representatives to the general assembly, each member has only one vote. Decisions on substantive questions are taken by a majority or two-thirds vote, depending on the importance of the matters involved. Procedural questions are decided by a majority vote

Through its deliberative, supervisory, financial and elective functions, the general assembly occupies a key position in the functioning of the United Nations. Its role as a deliberative

organ finds its basis in articles 10 to 14 of the charter. Article 10, the most inclusive in its provisions, states that the general assembly may discuss and make recommendations on "any questions or any matters within the scope of the Charter or relating to the powers and functions of any organs provided for in the present Charter." The general assembly is expressly authorized to deal with specific disputes and situations brought before it and to undertake studies and make recommendations for promoting international co-operation in political, social, economic, cultural and educational matters, for encouraging the development of international law and for assisting in the realization of human rights and fundamental freedoms

In performing its supervisory functions, the general assembly exercises general control over the activities of United Nations organs in the economic and social fields and in dealing with the problems of non-self-governing territories. The general assembly receives annual reports from the secretary-general and the Security, Economic and Social and Trusteeship councils, and may make recommendations to these organs. The Economic and Social council and the Trusteeship council operate under the authority of the general assembly. The assembly approves trust agreements and through the Trusteeship council supervises the administration of trust territories. It exercises general supervision and control over the operations of the secretariat.

The financial power of the assembly is exercised through its control over the budget of the United Nations and the scale of assessments levied on members. In its elective capacity, the general assembly chooses all members of the Economic and Social council and the elective members of the Security and Trusteeship councils. Along with the Security council, it also participates in the election of judges of the International Court of Justice and the appointment of the secretary-general. The assembly shares with the council the power to initiate amendments to the charter as well as the right to convene a conference for the purpose of revising the charter.

Like other representative bodies, the assembly performs most of its work in committees. At each session, the assembly organizes six main committees (Political and Security; Economic and Financial; Social, Humanitarian and Cultural; Trusteeship and Non-Self-Governing Territories; Administrative and Budgetary; and Legal) to which agenda items are referred for consideration before coming to the plenary session of the assembly for final decision. Each member of the United Nations is represented on all the main committees.

The assembly has two procedural committees (the General committee and the Credentials committee), two standing committees (Advisory Committee on Administrative and Budgetary Questions and the Committee on Contributions) and a series of subsidiary organs such as the United Nations Commission for the Unification and Rehabilitation of Korea, the Peace Observation commission and the Collective Measures committee. Furthermore, in 1947 the assembly established the Interim committee to perform certain of its functions when the assembly is not in session. All members of the organization were to be represented on this committee; however, since the members of the Soviet bloc challenged the committee's legality and refused to sit on it, its utility proved to be limited.

The assembly convenes annually; it elects a president for each annual session and establishes its own rules of procedure. The first part of the first session of the assembly convened in London in Jan. 1946. Sessions of the assembly thereafter met in New York city, with the exception of the third and sixth sessions which convened in Paris in 1948 and 1951, respectively.

Security Council.—The charter places on the Security council the primary responsibility for maintenance of international peace and security. Eleven members of the United Nations are members of the council, the five permanent members (China, France, the United Kingdom, the U.S.S.R. and the United States) and six nonpermanent members, which are elected by the assembly and serve two-year terms. In selecting nonpermanent members, the assembly must strive for an equitable geographical distribution as well as consider their contribution to the maintenance of international peace and security. From the beginning, nonpermanent members of the Security council were elected with a view to giving representation to certain regions or groups of states. Thus one member was chosen from western Europe, one from eastern Europe, one from the Arab league, one from the British Commonwealth and two from Latin America. The Soviet Union asserted the right of a caucus of states from the group or region to nominate the member to be elected. This claim was challenged in 1949 when the general assembly elected Yugoslavia in the face of strong opposition by the Soviet bloc, whose candidate was Czechoslovakia, and again in 1951 when Greece was chosen instead of Byelorussia.

Under the charter, all members of the United Nations agreed to carry out the decisions of the Security council. This was interpreted to refer primarily to decisions under chapter VII of the charter. The council is authorized to investigate any dispute which might threaten international peace and security, and to make recommendations for its peaceful settlement. The council may also call on members of the United Nations to apply economic and diplomatic sanctions against any state which the council found guilty of breach of the peace or act of aggression. It may also decide what military measures are to be taken by members, but this power did not become operative because of the failure to conclude agreements specifying the armed forces and facilities to be placed at the disposal of the Security council by members. The council may also make recommendations on the regulation of national armaments.

On procedural matters, decisions by the council are made by an affirmative vote of any seven of its members; on substantive matters, which include the investigation of any dispute and the application of sanctions, seven affirmative votes including the concurrence of the five permanent members are required. A vote as to whether a matter is procedural or substantive is itself a substantive question.

The council is required to be so organized as to be able to function continuously. Each member is represented at all times at the seat of the organization. Like the general assembly, the council functions through subsidiary organs. The United Nations Commission for Indonesia and the United Nations Commission for India and Pakistan are examples of bodies established to assist in carrying out the council's resolutions. The presidency of the council rotates monthly.

The Military Staff committee, provided for in the charter, is responsible for the strategic direction and deployment of any armed forces placed at the disposal of the council.

Economic and Social Council.—The Economic and Social council is charged with directing and co-ordinating the complex system of economic, social, humanitarian and cultural activities of the United Nations. It comprises 18 members, elected by the assembly for three-year terms with the possibility of re-election. Although the council, unlike the Security council, has no permanent members, certain states, such as the permanent members of the Security council, were continually re-elected. The assembly endeavoured to keep the membership of the council representative of the world's economic, cultural and religious systems.

The Economic and Social council meets at least twice a year; it is directed by the charter to make or initiate studies and make recommendations with respect to the promotion of international co-operation in economic and social matters. It may prepare draft conventions for submission to the assembly and call international conferences for specific purposes.

The council is assisted in its work by functional and geographical commissions. The functional commissions carry out studies in the economic and social field and otherwise assist the council in the performance of its functions. They formulate resolutions, recommendations and international conventions on which the council and general assembly take action. The functional commissions initially established consisted of the following: Economic and Employment commission (with two subcommissions), Transport and Communications commission, Fiscal commission, Statistical commission (with one subcommission), Population commission, Social commission, Commission on Human Rights (with

two subcommissions on Freedom of Information and of the Press, and Prevention of Discrimination and Protection of Minorities). Commission on the Status of Women and Commission on Narcotic Drugs. The council organized three regional economic commissions on Europe, Asia and the Far East and Latin America which are designed to deal with specific regional economic problems. It also established several standing committees The *Ad Hoc* Committee on the Organization and Operation of the Council and Its Commissions, established in 1950 to review the commission structure of the council, proposed to dissolve two commissions and three subcommissions, and the council accepted and carried out these proposals.

Trusteeship Council.—Acting under the authority of the general assembly, the Trusteeship council supervises the administration of trust territories by the states which are administering authorities. The composition of the council ensures that membership is equally divided between members which administer trust territories and those which do not. Furthermore, the permanent members of the Security council are assured membership. The six members of the council who are administering authorities are: Australia, Belgium, France, New Zealand, the United Kingdom and the United States. China and the Soviet Union are members by virtue of permanent membership on the Security council. The remaining four nonadministering members are elected by the assembly for three-year terms.

The Trusteeship council is authorized to send visiting missions of inspection into the trust territories to receive and examine petitions, to consider reports submitted to it annually by the administering authorities and to make recommendations with respect to all matters coming within its purview. The council is required to submit annual reports on its activities to the general assembly.

International Court of Justice.—The court is the principal judicial organ of the United Nations. Its statute is an integral part of the charter of the United Nations.

The 15 judges of the court are elected by the general assembly and the Security council voting independently. No two judges may be nationals of the same state. Representation of the main forms of civilization and of the major legal systems of the world is to be assured. Judges serve for nine years and are eligible for re-election.

The jurisdiction of the court comprises all cases which parties submit to it, and all matters specially provided for in the charter or in other treaties. States, by formal declaration, may accept the compulsory jurisdiction of the court in specified categories of disputes. The court may give advisory opinions at the request of the general assembly or the Security council, or at the request of other organs and specialized agencies authorized by the general assembly.

The Secretariat.—The secretariat is headed by the secretary-general and consists of such staff as the organization may require. The secretary-general is appointed by the general assembly upon the recommendation of the Security council. At the beginning of its first session in 1946, the general assembly chose Trygve Lie (Norway) for a term of five years. His term was extended for three years in 1951, following failure of the Security council to recommend a person for the full five-year appointment. The secretary-general is the chief administrative officer of the United Nations. He also has important political functions, being specially charged with bringing before the organization any matter that threatens or violates international peace and security. He and his staff perform secretarial functions for the general assembly, the councils and the various subsidiary organs. He submits an annual report to the general assembly on the work of the organization during the preceding year.

The secretariat is divided into eight departments and the executive office of the secretary-general. These departments are as follows: Security Council Affairs; Economic Affairs; Social Affairs; Trusteeship and Information from Non-Self-Governing Territories; Public Information; Legal; Conference and General Services; Administrative and Financial Services. Each is headed by an assistant secretary general. The Technical Assistance administration is an independent agency headed by a director-general.

MAINTENANCE OF INTERNATIONAL PEACE AND SECURITY

By the terms of the charter, the members of the United Nations conferred upon the Security council primary responsibility for the maintenance of international peace and security. At the San Francisco conference, the basic assumption underlining the United Nations as an international security organization was that there would be agreement among the five permanent members of the Security council on important questions. In fact, it was made a charter requirement that substantive decisions of the council could be taken only with the concurrence of the permanent members. It was realized that should the Big Five fail to agree, the council would be unable to perform its functions. The growing rift between the Soviet Union and the western powers after 1945 resulted in frequent use of the veto, which seriously reduced the effectiveness of the Security council in the discharge of its primary responsibility. As a result, there was an increasing tendency to look to the general assembly to assume responsibilities in this field.

As early as 1946 the assembly was asked to deal with a situation originally brought before the Security council. In June 1946 the U.S.S.R. vetoed a council proposal dealing with Spain on the ground that it should have been more strongly worded. The council on Nov. 4 removed the question from its agenda to permit Poland to bring the question before the assembly, which finally adopted a resolution on Dec. 12, 1946. In the summer of 1947 a Soviet veto prevented the adoption by the Security council of a resolution approving the findings of a commission which had been set up to investigate the disorders on the northern borders of Greece. The question was removed from the council's agenda, and the United States brought the question before the assembly, where action was taken on the matter in Oct. 1947. The Palestine and Korean questions were brought directly to the assembly in 1947, although both constituted situations endangering international peace.

In the Korean case, an accidental set of circumstances (absence of the U.S.S.R. from the council, the availability of United States troops in Japan and the presence of a United Nations commission in Korea) enabled the council in June 1950 to take prompt action against the North Korean forces attacking the Republic of Korea. Realizing that such conditions would not be repeated in the future, the general assembly in Nov. 1950, on United States initiative, adopted the Uniting for Peace resolution by which the assembly assumed additional responsibilities for the maintenance of international peace and security. This resolution provided that the assembly should take action with reference to a threat or breach of the peace or act of aggression should the Security council fail to exercise its primary responsibility in that field. The assembly may be convened for the purpose by the secretary-general, if requested by the Security council or by a majority of the members of the United Nations, in an emergency session within 24 hours. The resolution requested United Nations members to set aside contingents in their national armed forces to be made available to the United Nations should the assembly recommend the use of armed force under this resolution.

The resolution also established the Peace Observation commission to observe and report on areas of the world where existing tension might impair international peace and security. The commission was directed to be at the disposal of the Security council or the assembly if the council was not exercising its functions It also established the Collective Measures committee to study and report on methods which the assembly might use in strengthening international peace and security.

Iran.—The first situation to be brought before the United Nations was Iran's complaint to the Security council of Jan. 19, 1946, that the Soviet Union was interfering with Iran's internal affairs by not withdrawing its troops from northern Iran. The council called on both parties to negotiate their differences. However, on March 18 Iran reported that the Soviet Union had not withdrawn its troops. On April 4, 1946, the council requested both parties to report to it by May 6 on progress made in the withdrawal

of the Soviet forces. Two days later, the U S S R requested the council to remove the matter from its agenda since Iran had sought to withdraw the original complaint, but the council rejected the Soviet proposal The Soviet representative withdrew in protest On May 6 Iran reported the withdrawal of Soviet troops from all provinces except Azerbaijan where facts were not known.

Greece.—The Greek question proved to be a more difficult issue for the United Nations to handle, requiring the attention of the general assembly as well as the Security council In Dec 1946 Greece charged that Albania, Bulgaria and Yugoslavia were aiding communist guerrillas in northern Greece, and asked the council to investigate this situation The council established the Commission of Investigation, which, after an on-the-spot examination of the alleged disorders, supported the Greek accusations A minority report submitted by Poland and the U S S R dissented. The council, unable to agree on proposals to remedy the situation because of the opposition of the U S.S.R , removed the question from its agenda on Sept. 15, 1947. The matter was brought before the general assembly by the United States In its resolution of Oct 21, 1947, the assembly requested all parties concerned to negotiate their differences, and established the United Nations Special Committee on the Balkans (U.N.S C O B.) to facilitate peaceful settlement of the dispute. The Soviet Union and the satellite states refused to co-operate. In its first report to the assembly in 1948 the committee reported the continuation of aggressive interventionist activity by Greece's northern neighbours. The general assembly in Nov 1948 called on Albania, Bulgaria and Yugoslavia to terminate their support of the communist guerrillas in Greece. It authorized the committee to continue its mediatory efforts. The situation had markedly improved by the end of 1948, not only because of United Nations action but also because of United States aid to Greece and Yugoslavia's break with Moscow. However, the problem of repatriating an estimated 28,000 Greek children continued to concern the United Nations. By 1952 this matter had decreased in importance, mainly through the work of the International Committee of the Red Cross and the League of Red Cross Societies. The sixth session of the assembly terminated the Special Committee on the Balkans, and the task of observing and reporting conditions along Greece's northern frontier was delegated to the Peace Observation commission.

Indonesia.—In July 1947 Australia and India called the Security council's attention to hostilities which had broken out between the Republic of Indonesia and the Netherlands After a debate in which the Netherlands unsuccessfully argued that the United Nations should not interfere since the matter was within the "domestic jurisdiction" of the Netherlands, the council called on the parties to cease hostilities and settle the dispute peacefully. It then appointed the Committee of Good Offices to facilitate a peaceful settlement In Jan 1948 both parties signed the "Renville" agreement, providing for a truce and setting forth the political principles to govern a truce settlement. However, after alleged violations of the agreement by both sides, and after the council repeatedly urged the parties to adhere to the truce, the Netherlands renounced the agreement in Dec. 1948 and resumed hostilities. In Jan. 1949 the Security council again called on both sides to terminate armed action, recommended the establishment of a federal, independent and sovereign United States of Indonesia at the earliest possible date, and changed the United Nations Commission for Indonesia (which replaced the Committee of Good Offices) to assist the parties in implementing this resolution. With the assistance of the commission, the parties involved finally reached agreement on the transfer of sovereignty from the Netherlands to the Republic of Indonesia at a round-table conference which met at The Hague from Aug. 23 to Nov 2, 1949. The formal transfer of sovereignty took place on Dec. 27, 1949.

Palestine.—The future of Palestine was one of the most difficult and complicated questions that the United Nations was called upon to handle. After World War II, because of the increased activity on the part of the Jews for a national home and place of refuge and the deterioration of relations between the Jews and Arabs, Great Britain requested that the secretary-general summon a special session of the assembly to deal with the matter. This session, meeting from April 28 to May 15, 1947, established the United Nations Special Committee on Palestine (U N.S C.O P) to investigate possible solutions of this problem. After inspecting conditions in Palestine, the special committee submitted majority and minority reports to the general assembly in Nov. 1947 The majority report, violently opposed by the Arab states, proposed the partition of Palestine into an Arab and Jewish state and the establishment of an international regime for Jerusalem, the three areas to be joined by an economic union. The minority plan called for an independent federal state The general assembly finally accepted the majority plan and called on the Security council to take enforcement action should any interested party attempt to use force to alter the proposed partition Great Britain announced its intention to terminate the mandate on May 15, 1948.

The increase in fighting between Arabs and Jews following the assembly's resolution indicated the extreme difficulty that the United Nations would encounter in implementing the partition plan. The assembly, meeting in special session in April and May 1948, decided to invite the permanent members of the Security council to appoint a United Nations mediator. Count Folke Bernadotte of Sweden was subsequently appointed He was directed to use his good offices to promote cessation of hostilities and a peaceful settlement of the dispute and also to assist the Security council's Truce commission which had been established previously

On May 15, 1948, Britain terminated its mandate over Palestine, and the new state of Israel was proclaimed. The Arab states immediately had recourse to armed force. In a series of resolutions, progressively more insistent, the Security council called on the parties to cease hostilities. On July 15 the council passed its strongest resolution, warning the parties that, unless they desisted from military action, enforcement measures by the United Nations would be undertaken. Through the efforts of Count Bernadotte, agreements for a truce were finally reached on July 16 and July 18

In its third session in the fall of 1948, the assembly established the United Nations Conciliation commission to assist Israel and the Arab states to reach agreement on boundaries, repatriation of refugees and a general peaceful settlement. Following the assassination of Count Bernadotte by Jewish terrorists in Sept. 1948, Ralph Bunche of the United States was appointed acting mediator During 1949 he was successful in negotiating armistice agreements between Israel and all the Arab states, with the exception of Iraq

The disposition of thousands of Arab refugees who fled their homes in Palestine during the period of hostilities and were widely scattered in camps in the Arab states remained a serious obstacle to a political settlement Israel refused repatriation of these refugees, while the Arab states insisted that a solution of this problem was a prerequisite to any political settlement. Efforts of the United Nations and of certain specialized agencies and non-governmental organizations, such as the Quakers and the Red Cross, ameliorated the situation, without however providing a solution of the problem. In 1951 the United Nations Conciliation commission attempted without success to achieve a political settlement

India-Pakistan Question.—The state of Jammu and Kashmir, located in the northern part of the Indian subcontinent between India and Pakistan, was given its choice, under the British Indian Independence act of 1947, to accede to either of its neighbours. Both India and Pakistan pressed their claims. In the fall of 1947 Moslem tribal groups invaded Kashmir, and Indian forces were sent in at the request of the Kashmir government after it had elected to accede to India. India brought the situation before the Security council on Jan. 1, 1948, and demanded that the council order Pakistan to desist from encouraging and supporting hostilities in Kashmir. Pakistan, however, denied India's accusation and requested the council to appoint a commission to assist in ending hostilities in Kashmir and to facilitate the withdrawal of Indian and Pakistan troops so that a plebiscite

could be held On Jan. 20, 1948, the Commission on India and Pakistan was established by the council and was directed to place its good offices and mediatory services at the disposal of the two states.

The situation in Kashmir showed little improvement, although a cease-fire agreement became effective on Jan. 1, 1949 Sir Owen Dixon of Australia was appointed by the Security council in April 1950 as United Nations representative for India and Pakistan to replace the commission; however, he was unable to bring the parties to agreement on the two basic issues, the demilitarization of Kashmir and the conduct of a free and impartial plebiscite Although both parties were in accord on the principle of having a plebiscite in Kashmir, neither could agree on the conditions for its conduct In April 1951 Frank Graham of the United States replaced Dixon as United Nations representative.

Korea.—The end of World War II found the northern half of the peninsula of Korea occupied by the U S S R. while the area south of the 38th parallel was held by United States forces. In conjunction with Great Britain and the Republic of China, both powers agreed at the Moscow conference in Dec 1945 that a unified and independent Korea was their eventual goal and that a joint commission should be established to constitute a provisional government in Korea and make proposals for a four-power trusteeship. When the Soviet Union and the United States reached an impasse in their negotiations to implement the Moscow agreements, the United States requested the general assembly in Sept. 1947 to consider the question. The U.S.S R strongly objected to United Nations consideration The assembly passed a United States-sponsored resolution which called for elections to be held in Korea preparatory to constituting a government for that country The Temporary Commission on Korea was appointed to prepare for the elections and to assist in the establishment of the government of a unified and independent Korea. It arrived in Korea early in 1948 The United States military command in South Korea wished to hold national elections, but the U.N commission was unable to gain admittance to North Korea to prepare for elections there. After consulting the Interim committee of the assembly in February, the commission decided to proceed with elections in South Korea alone On May 10, 1948, elections were held, and a government of the Republic of Korea was established The general assembly in Dec. 1948 declared that this was the only legal government in Korea. The assembly reiterated its determination to achieve the goal of a unified and independent Korea; however, in its subsequent efforts, the Korean commission met with little success.

Meanwhile, Soviet authorities assisted in the establishment of a government in North Korea, known as the People's Republic of Korea, which, like the Republic of Korea, also claimed to be the only legal government in Korea. During 1948–49 both the United States and Soviet troops were withdrawn from Korea Relations between the two governments in Korea indicated no possibility of agreement on a common government, and there were armed outbreaks around the 38th parallel during 1949 and early 1950

On June 25, 1950, the armed forces of North Korea invaded South Korea On the same day, the Security council, after deciding that this action constituted a breach of the peace, called on North Korean authorities to withdraw their armed forces behind the 38th parallel and demanded an immediate cessation of hostilities When the North Korean authorities disregarded this resolution, the council on June 27 called on members of the United Nations to "furnish such assistance to the Republic of Korea as may be necessary to repel the armed attack and to restore international peace and security in the area" Led by the United States, many U N. members gave material assistance to the Republic of Korea, and the great majority of the organization's members expressed strong support of these measures On July 7 the council requested the United States to appoint a supreme commander for United Nations forces in Korea, and Gen. Douglas MacArthur was so designated.

The United Nations forces in Korea met with many initial military reverses and were compelled to retreat to a small bridgehead around the town of Pusan in southeast Korea. The Inchon landing in mid-Sept 1950, however, led to the expulsion of the Communist forces from South Korea. Faced with the necessity of deciding whether to stop at the 38th parallel or to seek to drive the Communists from all of Korea, the general assembly in Oct. 1950 implicitly approved the latter course of action The assembly established the United Nations Commission for the Unification and Rehabilitation of Korea to carry out the original unification goal of the United Nations. The Soviet bloc violently opposed this action, and the Indian delegate to the United Nations, in expressing disapproval of the resolution, feared that it would endanger international peace in that part of the world The Communist government of China also warned that it would not permit armed action in North Korea When, in Nov 1950, the United Nations forces approached the Yalu river, which separates Korea from Manchuria, contingents from the Communist Chinese army assisted North Korean forces in repelling the United Nations troops and drove them back below the 38th parallel.

After failing to achieve a cease-fire and the peaceful settlement of the dispute, the assembly, on Feb 1, 1951, labelled Communist China an aggressor and established an Additional Measures committee to consider the application of sanctions against that government. On May 18 the assembly recommended that members apply an embargo on arms, munitions and other implements of war against areas controlled by the Communist government of China Many states were already applying such measures

In June 1951 the Soviet delegate to the United Nations, Jacob Malik, suggested that cease-fire talks be undertaken in Korea. Upon the initiative of the United Nations supreme commander, Gen. Matthew Ridgway, who had replaced General MacArthur in April 1951, cease-fire talks commenced on July 10 at Kaesong Marked by many interruptions, accusations and counteraccusations and some success, the negotiations continued into 1952.

Corfu Channel.—In Jan. 1947 Britain called the Security council's attention to a dispute with Albania concerning damage incurred by British warships and naval personnel as a result of the detonation of mines in the Corfu channel The U.S.S.R. vetoed a resolution which placed the blame on Albania, and the council recommended that Britain and Albania submit the dispute to the International Court of Justice Both parties eventually accepted the court's jurisdiction, and the court disposed of the matter

Berlin.—In Sept. 1948 the Security council considered the question of the Soviet blockade of west Berlin which severed contact between the western powers and their zones in the German capital. The U.S S.R. argued that the council had no authority to deal with this matter, and when the council, in Oct 1948, voted to place the question on its agenda, the Soviet Union refused to participate in the council's discussions of the blockade Although the council was unable to work out an acceptable solution to the question after several attempts, the United States and Soviet representatives on the council reached an understanding which permitted a settlement to be subsequently reached

Italian Colonies.—After the Council of Foreign Ministers was unable to agree on the disposal of the former Italian colonies of Libya, Somaliland and Eritrea following World War II, a clause was inserted in the Italian peace treaty of 1947 to the effect that, in the event of continued disagreement, the matter would be referred to the general assembly for a final determination. When agreement was again found impossible, the matter was placed before the assembly in April 1949 In Nov. 1949 the assembly decided that by Jan 1, 1952, Libya should become an independent state and that until then it should be administered by a United Nations commissioner, advised by a council of representatives consisting of six United Nations members and four local inhabitants. Under the guidance of Adrian Pelt, United Nations administrator, Libya was prepared for statehood, and on Dec. 24, 1951, became the first formerly dependent area to become an independent state under the aegis of the United Nations. Somaliland was placed under U.N. trusteeship, with Italy serving as the administering authority. The assembly declared that this former colony should receive its independence ten years after the as-

sembly approved of the trusteeship agreement, which it did in Dec. 1950. The assembly decided in 1950 that Eritrea should be federated with Ethiopia, although it should retain as much local autonomy as possible. The United Kingdom was selected as the administering authority to prepare for federation, which was to take place by Sept 1952.

Anglo-Iranian Oil Dispute.—After Iran disregarded the jurisdiction of the International Court of Justice over its dispute with the United Kingdom in the matter of oil nationalization, the Security council on Oct 1, 1951, took note of Great Britain's complaint that the Iranian action was tantamount to a confiscation of British property. Premier Mohammed Mossadegh of Iran argued before the council that the matter was wholly within Iran's domestic jurisdiction, and after six meetings devoted to discussion the council adjourned debate until the court had ruled on its own competence in the matter It subsequently decided in July 1952 that it did not have jurisdiction.

Other Disputes and Situations.—The United Nations during this period also considered the presence of British and French troops in Syria and Lebanon, the Spanish situation, treatment of Indian nationals in the Union of South Africa, and the alleged violation of civil-rights provisions of peace treaties with Hungary, Bulgaria and Rumania.

GENERAL QUESTIONS

Control of Atomic Energy.—The United Nations met with little success in the control of atomic energy, largely because of the deterioration in relations between the Soviet Union and the United States after 1945. The Atomic Energy commission was established by resolution of the general assembly in 1946 to assist the Security council in preparing plans for the control of atomic energy. The commission submitted reports to the Security council in 1946, 1947 and 1948. The majority of the commission called for international managerial control or ownership of atomic energy activities, international inspection by a proposed international atomic development authority and the elimination of the veto from enforcement provisions of the agreement. The majority also insisted that the control system should be in operation before the existing stock pile of atomic bombs was destroyed The Soviet Union, however, took an opposite view It refused to agree to international ownership and to the kind of international inspection demanded by the majority, it demanded that the veto be applicable to enforcement measures under the plan and that the destruction of atomic stock piles should accompany the establishment of a system of control. The commission recorded an impasse in negotiations in its 1948 report, though some agreement had been reached on matters of detail.

Reduction of Conventional Armaments.—The Security council organized the Commission for Conventional Armaments in Feb. 1947, following an assembly resolution of Dec. 1946 that general regulation and reduction of armaments should be undertaken by the council. A Working committee of the whole was constituted by the commission in July 1947, and that committee was charged with working out an adequate program of armament reduction. Progress in this field was likewise obstructed by the distrust between the Soviet bloc and the western powers. The commission in Aug. 1949 approved the Working committee's proposal that a census of national armaments should be taken. Although the assembly in Dec. 1949 approved a plan whereby each state would submit full information to the commission on its conventional armaments and armed forces, little progress was made in implementing the proposal.

The assembly established a Committee of Twelve in Nov 1950 to study a U.S.-sponsored resolution to combine the Atomic Energy and Conventional Armaments commissions, and in Jan. 1952 the assembly adopted a resolution merging the two commissions into a new Disarmament commission.

Relations between the Great Powers.—The general assembly made numerous appeals to the great powers to settle matters of international concern on a peaceful basis. In Dec. 1949 the assembly laid down a series of principles which it considered essential for an enduring peace. The assembly also exhorted the permanent members of the Security council to reach agreement on such matters as the admission of new members to the United Nations and to be more moderate in the use of the veto.

DEVELOPMENT OF INTERNATIONAL LAW

In Nov 1947 the general assembly established the International Law commission of 15 members to make recommendations for the progressive development of international law and its codification. In setting up the commission, the assembly directed it to formulate the principles of international law recognized at the Nuremberg trial of nazi war criminals and to prepare a draft code of offenses against the peace and security of mankind.

In 1950 the commission submitted its formulation of the Nuremberg principles, which covered crimes against the peace, war crimes and crimes against humanity. The assembly circulated these principles to member governments for comment. The commission presented to the assembly in 1951 draft articles on offenses against the peace and security of mankind, which enumerated 12 crimes against international law, including any act of aggression, threat of or preparation for aggression, annexation of territory and genocide The assembly also circulated this draft code among its members for comment and suggestions. While the commission did not include a definition of aggression in the draft code, the assembly in 1951 adopted a resolution to the effect that a legal definition of aggression was possible and desirable and recommended that the seventh session of the assembly attempt to define this term.

The commission prepared a draft declaration on the rights and duties of states which it submitted to the assembly in 1949. It was decided to be among the basic duties of a state to conduct international relations in accordance with international law and to observe legal obligations; to settle disputes peacefully and not by the use of force, and to refrain from recognizing any territorial acquisition resulting from war or other illegal use of force. Included among the rights of states were the rights to independence, to equality in law and to individual and collective self-defense in cases of armed attack.

The commission made studies of the possibility of codifying certain branches of international law, giving priority to the law of treaties. Also, it prepared a study on the legal aspects of reservations to multilateral conventions.

ECONOMIC AND SOCIAL CO-OPERATION; SPECIALIZED AGENCIES

A major purpose of the United Nations is "to achieve international co-operation in solving international problems of an economic, social, cultural, or humanitarian character, and in promoting and encouraging respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion." The general assembly, the Economic and Social council, along with the council's commissions, the secretariat and the specialized agencies are the organs primarily responsible for action in this field. An important part of the United Nations activity consists of research, publication and the rendering of technical assistance to governments. The United Nations has no authority to legislate or to enforce measures of economic and social co-operation; it can only make recommendations which the member governments may or may not follow.

It was believed by those who drafted the United Nations charter that many areas of economic and social co-operation, while requiring an intergovernmental approach, could be more effectively covered by relatively autonomous functional organizations. Consequently, it was assumed that international co-operation in this field would find expression in a great variety of intergovernmental organizations Of these, those with "wide international responsibilities" were to be brought into relation with the United Nations as specialized agencies. This relationship might initially be defined by an agreement concluded with the specialized agency by the Economic and Social council subject to general assembly approval. The charter provided that the general assembly and the Economic and Social council should undertake to co-ordinate the policies and activities of the specialized agencies. The general as-

sembly may review and make recommendations subject to the administrative budget of an agency; both the assembly and the Economic and Social council may make recommendations with respect to program

Each specialized agency in fact concluded an agreement with the United Nations defining in general terms its relation to the latter. These agreements contain provisions regarding such matters as reciprocal representation, exchange of information and documents, administrative co-operation, annual reports and action to be taken on general assembly recommendations. An Administrative Committee on Co-ordination, composed of the secretary-general and the executive heads of the specialized agencies, was established by the Economic and Social council to assist in co-ordinating and harmonizing the relations between the agencies and the United Nations.

The general structure of each specialized agency follows a common pattern. There is provision for a general conference in which all members are represented The conference elects an executive body which is charged with initiating proposals and carrying out decisions of the general conference. Each agency has a permanent secretariat, headed by a director Many agencies have regional subcommissions operating in various parts of the world Some of the specialized agencies were in existence before the United Nations was organized, some were in process of establishment during World War II and some agencies were organized under the auspices of the U.N One agency, the International Refugee organization (I R O), terminated its activities at the end of Jan. 1952. Those in operation after that date are the following:

International Labour Organization (I.L.O.).—The I.L O. was established at the end of World War I as an international organization to improve labour conditions. Its constitution was incorporated in the peace treaties, along with the covenant of the League. It survived World War II and was accepted by the United Nations as a specialized agency. An agreement with the U.N. was approved by the general assembly on Dec. 14, 1946.

The main function of the I.L.O. is the improvement of labour conditions throughout the world. The conclusion of international conventions is one of the principal methods by which the I.L.O. seeks to achieve this purpose. The organization is unique in that its constitution provides for the representation of private organizations (employer and labour) as well as governments in its conference and governing body. Its headquarters are in Geneva, Switz At the beginning of 1952 the I L O. had 65 members.

Food and Agriculture Organization of the United Nations (F.A.O.).—The F.A.O came into being on Oct. 16, 1945, with the signing of the constitution. An agreement between the F.A.O. and the United Nations was approved by the general assembly on Dec. 14, 1946. The main functions of the F.A.O. are to raise the nutritional levels and living standards of the world's peoples, to secure improvements in production and distribution of food and agricultural products and to better the conditions of country dwellers. The headquarters of the F.A O are in Rome, It. The F.A O had 70 members at the beginning of 1952.

United Nations Educational, Scientific and Cultural Organization (U.N.E.S.C.O.).—U.N.E S.C O. came into being on Nov. 4, 1946, on the basis of a constitution drafted and signed at London in Nov. 1945. An agreement between U N E S.C.O and the United Nations was approved by the general assembly on Dec. 14, 1946. The central aim of U.N.E.S.C O. is to achieve international peace through the diffusion and interchange of education, science and culture among all the peoples of the world. Its headquarters are in Paris, Fr., and at the beginning of 1952 it had 64 members.

International Civil Aviation Organization (I.C.A.O.).—The I C.A.O. came into being on April 4, 1947, on the basis of a convention drafted at Chicago, Ill., in 1944. During the intervening period a provisional organization operated. An agreement between I.C.A.O. and the United Nations was approved by the general assembly on Dec. 14, 1946. The main functions of the I.C A O. are the development of principles and techniques of international air navigation and the planning and development of international air transport. Its headquarters are in Montreal, Que.; at the beginning of 1952 it had 57 members.

International Bank for Reconstruction and Development.—The bank came into being Dec 27, 1945, on the basis of articles of agreement drafted and signed at Bretton Woods, N.H., in July 1944. An agreement between the bank and the United Nations was approved by the assembly on Nov 15, 1947. The main functions of the bank are to assist in the reconstruction and development of member countries by facilitating the investment of capital for productive purposes, to promote the flow of private capital toward international investment and to contribute toward the goal of balanced international trade. The headquarters of the bank are in Washington, D C. At the beginning of 1952 it had 50 members.

International Monetary Fund.—The fund came into being Dec. 27, 1945, on the basis of articles of agreement drafted and signed at Bretton Woods in July 1944. An agreement between the fund and the United Nations was approved by the assembly on Nov. 15, 1947 The main functions of the fund are to promote stability in the exchange rates of the world's currencies and to assist in the curtailment of competitive practices in exchange depreciation. Its headquarters are in Washington, D.C.; at the beginning of 1952 the fund had 50 members.

World Health Organization (W.H.O.).—The W H O came into being on April 7, 1948, on the basis of a constitution signed in New York city July 22, 1946 An interim commission functioned during the intervening period An agreement between W H O. and the United Nations was approved by the assembly on Nov. 15, 1947. The main functions of W H O. are the eradication of epidemic, endemic and other diseases, the improvement of nutrition, housing, sanitation and other aspects of environmental hygiene, the promotion of maternal and child health and research in the field of private and public health. Its headquarters are in Geneva. At the beginning of 1952 it had 68 members

Universal Postal Union (U.P.U.).—The agreement between the U P.U. originally established in 1874, and the United Nations was approved by the assembly on Nov. 15, 1947. The main function of the U.P U. is to promote international postal co-operation with a view to improving international postal service. Its headquarters are in Berne, Switz. At the beginning of 1952 the U.P.U had 89 members (including colonial areas)

International Telecommunication Union (I.T.U.).—The I.T.U. came into being Jan. 1, 1934, on the basis of a convention signed Dec. 9, 1932, merging the International Telegraph union (established in 1865) and the International Radio-telegraph union (established in 1906) An agreement between the I.T U. and the United Nations was approved by the general assembly on Nov. 15, 1947. The purpose of the I T U is to establish international regulations for radio, telegraph and telephone services. Its headquarters are in Geneva. At the beginning of 1952 it had 85 members (including colonial areas).

World Meteorological Organization (W.M.O.).—The W.M.O. came into being March 23, 1950, replacing the International Meteorological organization which was established in 1878. An agreement between the W.M.O. and the United Nations was approved by the general assembly in Dec 1951 The purposes of W.M.O. are to co-ordinate, standardize and improve world meteorological activities and to encourage exchange of meteorological information among its members. Its headquarters are in Geneva; at the beginning of 1952 it had 74 members.

Two other specialized agencies were envisaged in agreements which had been signed but had not yet come into force at the beginning of 1952. They are the International Trade organization (I T O), the charter of which was signed at Havana, Cuba, March 24, 1948, and the Inter-Governmental Maritime Consultative organization (I.M.C O.), the convention for which was drafted at a conference held in Geneva in February and March 1948. The purpose of I T O. is to encourage the expansion of international trade by establishing a code of fair dealing in international trade and by encouraging the reduction of trade barriers and the elimination of discriminatory practices. The purpose of I.M C.O. is to facilitate intergovernmental co-operation in the shipping field with a view to improving shipping services.

Economic Reconstruction and Development.—The devastation of large areas during World War II, as well as the substandard existence of almost two-thirds of the world's population, became of vital concern to the United Nations. The United Nations Relief and Rehabilitation administration, established in 1943, did much to alleviate the results of the war's devastation and dislocation, and the International bank extended numerous loans to dislocated and underdeveloped areas. Since the bank can make loans only for self-liquidating projects, however, the long-range needs of many states, such as construction of roads and dams, educational and welfare programs and land reform, require long-term investment. The assembly and the Economic and Social council undertook studies and made recommendations on the necessity of land reform and the establishment of an international fund to finance economic development and reconstruction

The Economic and Social council, realizing that many problems of an economic nature demand treatment and solution on a regional level, established three economic commissions The Economic Commission for Europe and the Economic Commission for Asia and the Far East were established in 1946, and the Economic Commission for Latin America was set up in 1948. The Economic Commission for Europe made an important contribution to the economic reconstruction of that area. Its work, particularly after 1947, was handicapped by the developing east-west conflict. The Economic Commission for Asia and the Far East was active in considering the special economic problems of that area, largely problems of underdeveloped economies.

Technical Assistance.—Closely related to the problem of economic development is technical assistance to underdeveloped areas of the world. A modest program of technical assistance was undertaken at an early stage. World attention became centred on the problem with the announcement of Pres Harry S. Truman's Point Four program. The expanded program for technical assistance was approved by the general assembly in 1949 It was undertaken with a view to raising the standard of living and promoting economic assistance to underdeveloped areas

Aside from the Technical Assistance administration, a branch of the secretariat, there are two other United Nations agencies with responsibilities in connection with the implementation of this program. The Technical Assistance board, composed of the secretary-general of the United Nations and the executive heads of the five participating specialized agencies (I L O., F A O, U N E S C O, W.H O and I.C A.O.), surveys all requests to the Technical Assistance committee, which is composed of representatives of the 18 members of the Economic and Social council. To finance the assistance projects, a Technical Assistance conference was convened in June 1950, and $20,000,000 was pledged by member states. This procedure was repeated in Feb 1952

Refugees.—The International Refugee organization, a specialized agency which was established in 1946 and terminated its activities in 1952, took over the refugee functions of the United Nations Relief and Rehabilitation administration which expired in 1947. The I R O was successful in resettling, repatriating, transporting and maintaining more than 1,000,000 European refugees. Since the I.R.O. was conceived as a short-term emergency organization, a new refugee structure was devised in 1951. A United Nations high commissioner for refugees was appointed and was directed to act under the Convention Relating to the Status of Refugees, which was drawn up by the Economic and Social council and approved by the general assembly in 1951. An Advisory Committee on Refugees was appointed by the council in 1951 to assist the high commissioner.

Human Rights.—The general assembly in 1948 adopted the Universal Declaration of Human Rights, which was prepared by the Commission on Human Rights. In 1948 the commission began attempts to draft a Covenant of Human Rights which, upon ratification by governments, would become legally binding upon them However, in view of differences of economic and social philosophy, often reflecting differences of economic and social conditions within states, great difficulty was encountered in efforts to achieve agreement on a common text Some members insisted on the inclusion of economic and social rights, while others insisted that only political and civil rights should be protected. In the general field of human rights, the assembly also concerned itself with discrimination against Indian nationals in the Union of South Africa and the violations of civil-rights provisions of peace treatres by Hungary, Rumania and Bulgaria.

Control of Narcotics.—The Commission on Narcotic Drugs was authorized by the assembly in 1946 to carry out the functions entrusted by international conventions to the League of Nations Advisory Committee on Traffic in Opium and Other Dangerous Drugs. The agreements, conventions and protocols on the control of narcotic drugs concluded in 1912, 1925, 1931 and 1936 were amended in a draft protocol which was approved by the assembly in Nov. 1946 and which subsequently came into force among its signatories. In addition to re-establishing the pre-World War II system of narcotics control, which had suffered from the dislocations of the war, the United Nations concerned itself with new problems resulting from the development of synthetic drugs. Efforts were made to simplify the system of control by drafting one convention incorporating the provisions of all agreements in force

Other Economic and Social Activities.—The United Nations also concerned itself with the rights of women in matters such as employment, educational opportunities and property rights Among its more important publications are the *Statistical Yearbook*, the *Demographic Yearbook* and the *Yearbook on Human Rights*

The general assembly established the United Nations International Children's Emergency fund in Dec. 1946 to provide for the emergency needs of children in devastated areas. Financed by contributions from member states, U.N I.C.E F. has been effective in sustaining basic nutritional requirements for destitute children in more than 50 countries, preventing such communicable diseases as tuberculosis, whooping cough and diphtheria and providing for children's clothing and other needs U N I C.E.F. has trained child welfare workers, laid emphasis on milk-conservation programs, and worked effectively with the Arab refugees in the middle east.

In 1946 the assembly requested the Economic and Social council to formulate a genocide convention for adoption by member states. The assembly unanimously approved the Convention on the Prevention and Punishment of the Crime of Genocide in Dec. 1948. The convention makes genocide a crime under international law whether committed in time of peace or war.

DEPENDENT AREAS

On two different levels, the United Nations maintains concern for people residing in non-self-governing territories· (1) under principles and procedures developed for making administering states internationally accountable for the treatment of their non-self-governing territories; and (2) under the United Nations trusteeship system applicable to certain territories placed under it.

Non-Self-Governing Territories.—Under article 73 of the charter, members of the United Nations with responsibilities for the administration of non-self-governing territories agreed to grant the people of such territories political, economic, social and educational advancement, just treatment and protection against abuses, to develop self-government, to further international peace and security; to promote constructive measures of development; and to transmit to the secretary-general information of a technical nature concerning the economic, social and educational conditions in their territories. In 1947 the general assembly created the Special Committee on Information Transmitted under Article 73e of the Charter to receive and analyze information on these territories and to make recommendations to the administering authorities on the basis of information received Although originally established as an *ad hoc* organ, the special committee became a permanent unit of the U.N.

The general assembly placed emphasis on economic development, raising standards of nutrition and health, and land reform in non-self-governing territories. Furthermore, the assembly encouraged the administering authorites to co-operate with non-governmental organizations and the specialized agencies in meeting the United Nations' objectives under article 73. A notable

achievement in this respect was the conclusion of an agreement in 1951 between the United Kingdom and the United Nations Technical Assistance board which provided for the application of the technical assistance program to dependent areas under British administration.

The Trusteeship System.—The United Nations trusteeship system, successor to the League mandate system, made provision for bringing the administration of certain non-self-governing territories under international guarantees that certain standards would be observed The trusteeship system is applicable to former League of Nations mandated territories, territories detached from axis states as a result of World War II and territories voluntarily placed under the system by the states responsible for their administration. In order for a territory to be under trusteeship, it is necessary for an agreement to be concluded between the states "directly concerned," subject to general assembly approval. In practice the administering state has proposed the terms of the agreement which have become operative upon general assembly approval.

At the beginning of 1952 the following territories were under trusteeship with the administering authorities as indicated the Cameroons (United Kingdom); Cameroun (France); New Guinea (Australia); Nauru (Australia); Ruanda-Urundi (Belgium); Somaliland (Italy); Tanganyika (United Kingdom); Togoland (United Kingdom); Togoland (France), Western Samoa (New Zealand); and the strategic Trust Territory of the Pacific Islands, including the Marianas, Marshalls and Carolines (United States).

Each trusteeship agreement delineates the authority and obligations of the administering state in the trust territory and provides for the implementation of the powers vested in the organs of the United Nations by provisions of the charter. Strategic areas may be placed under a special regime which vests responsibility for supervision in the Security council and gives the administering authority greater discretionary powers. Each administering authority is required to submit an annual report based on a questionnaire prepared by the Trusteeship council. A representative of the administering state is required to be present when the council examines the report and is interrogated by members of the council after he submits an oral statement Persons residing in the trust territories or outside may petition to the council with respect to any grievances, complaints or suggestions they may have regarding the administration of the territory.

The Trusteeship council sends visiting missions to each of the trust territories, to investigate and report on conditions and the extent to which the administering authority is carrying out its obligations. Missions were thus dispatched to the trust territories in the Pacific, to Western Samoa and to East and West Africa On the basis of full discussion, the Trusteeship council prepares its report to the general assembly, incorporating recommendations with respect to the administration of the trust territory in question. The general assembly customarily accepts the recommendations of the council If the administering authority refuses to conform, the organs of the United Nations can do little more than publicize the facts. The United Nations does not have the power to terminate the authority of an administering state for failure to discharge its obligations under the charter. Experience indicated, however, that the administering authorities had taken seriously the constructive criticism and suggestions of the Trusteeship council and general assembly.

ADMINISTRATION AND FINANCE

Personnel.—The secretariat of the United Nations, serving under the secretary-general, is part of the United Nations machinery influencing the day-to-day work of the organization to a degree which the words of the charter would not indicate The extent of this influence is in large measure a result of the fact that the secretariat members are permanent expert officials. The secretariat staff is recruited on a merit basis but with regard to equitable geographical distribution. In the first two years of the organization's existence, the preponderance of United States nationals on the staff caused considerable concern among many delegations. Consequently, the assembly in 1947 adopted a resolution calling on the secretary-general to study the recruitment policy with a view to improving the geographical distribution of the staff. Members of the organization are required to take an oath of loyalty to the United Nations and are not permitted to receive instruction from member governments The staff of United Nations headquarters at the beginning of 1952 numbered approximately 3,500, with about 500 other members located in Geneva and other parts of the world.

In Nov 1949 the general assembly established a United Nations Administrative tribunal to hear and pass on alleged violations of staff contracts and other conditions of employment in the secretariat The tribunal is composed of seven members, no two of which may be nationals from the same state. In decisions handed down in 1951 the tribunal established the principle that staff members are entitled to due process when questions of contract renewal are being considered.

A United Nations Field service and a United Nations Panel of Field Observers were organized by the assembly in 1949 The Field service performs security functions for United Nations missions in many parts of the world, and the Panel of Field Observers assists the various missions in supervising truces and observing plebiscites. Both are under the secretary-general

Finance.—The secretary-general must submit an annual budget including estimated expenditures to the general assembly for approval After estimates have been made by each branch of the secretariat and submitted to the secretary-general, he compiles his annual budget estimates which he presents to the general assembly before each annual session. The assembly's Advisory Committee on Administrative and Budgetary Questions examines the estimates and makes recommendations on them to the fifth committee of the assembly (Administrative and Budgetary). This committee makes recommendations to the general assembly for final adoption The annual budget of the United Nations rose from $19,390,000 in 1946 to $48,096,780 in 1952.

The charter stipulates that the expenses of the organization shall be borne by members as apportioned by the general assembly. The Committee on Contributions prepares a scale of assessments for each member, based on the general economic level and capacity of each state, which is submitted to the general assembly for approval. The United States' contribution became the largest of any member, starting at about 49% of the total. The U S. argued that no one member should pay more than one-third in order that it should not have too great a financial interest in the organization, and its contribution was progressively reduced to the point where it approached that proportion.

Privileges and Immunities.—A General Convention on Privileges and Immunities of the United Nations approved by the general assembly in Feb 1946 asserted that the U N. possesses juridical personality. It provides for such matters as the immunity from legal process of the property and assets of the United Nations and for the privileges and immunities of the representatives of members, officials of the United Nations and experts on missions of the organization. A headquarters agreement between the U.N. and the United States was signed in June 1947, defining the privileges and immunities of the United Nations headquarters in New York city

Headquarters.—The general assembly decided during the second part of its first session in New York to locate its permanent headquarters in that city. John D. Rockefeller, Jr., made a gift of land for a building site in Manhattan, and a loan of $65,000,000 from the United States permitted plans to be initiated for the construction of permanent buildings Temporary headquarters were established at Lake Success. The Secretariat building was completed and occupied in 1951 The building providing accommodations for the general assembly and the councils was completed and occupied in early 1952.

In 1947 the assembly adopted a United Nations flag. Its design consists of the official emblem of the United Nations in white, centred on a light-blue background. The assembly also designated Oct. 24 as United Nations day. (L. M. Gh.)

UNITED PRESBYTERIAN CHURCH (of Scotland).

This Presbyterian organization, merged since 1900 in the United Free Church of Scotland (*q v*), was formed in 1847 by the union of the United Secession and Relief Churches.

The general causes which led to the first great secession from the Church of Scotland, as by law established in 1688, are indicated in the article SCOTLAND, CHURCH OF Its immediate occasion rose out of an act of assembly of 1732, which abolished the last remnant of popular election by enacting that, in cases where patrons might neglect or decline to exercise their right of presentation the minister was to be chosen, not by the congregation, but only by the elders and Protestant heritors The act itself had been passed by the assembly, although the presbyteries to which it had been previously submitted as an overture had disapproved of it by a large majority; and in accordance with a previous act (1730), which had taken away even the right of complaint, the protests of the dissentient majority were rejected. The protests however were vigorously renewed by Ebenezer Erskine, minister of Stirling He was soon joined by other ministers, who in Dec 1733 constituted themselves into a presbytery, disowning the authority of the general assembly The members of the Associate Presbytery and its adherents steadily increased, until in 1745 there were 45 congregations under its jurisdiction, and it was reconstituted into an associate synod. A violent controversy respecting the religious clause of the oath taken by burgesses in Edinburgh, Glasgow and Perth ("I profess and allow with my heart the true religion presently professed within this realm and authorized by the laws thereof"), resulted in April of 1747 in a breach, when two bodies were formed, each claiming to be the Associate Synod; those who condemned the swearing of the burgess oath as sinful came to be popularly known as "Anti-burghers," while the other party, who contended that abstinence from it should not be made a term of communion, were designated "Burghers." The Associate (Anti-burgher) Synod held its first meeting in Edinburgh on April 10, 1747 It grew with considerable rapidity, and for purposes of organization was formed into four provincial synods, and took the name of the General Associate Synod. The Associate (Burgher) Synod held its first meeting at Stirling on June 16, 1747. The number of congregations under its charge also increased, and in 1820 the General Associate or Anti-burgher Synod (to the number of 129 congregations) united with the 154 congregations of the Associate or Burgher Synod The body thus constituted, the United Secession Church, had increased by 1847 to 400 congregations

In 1847 a union was formed between all the congregations of the United Secession Church and 118 out of 136 of the Relief Churches, in what now became the United Presbyterian Church. Doctrinally there was little difference between the United Presbyterian Church and the Free Church of Scotland, and between 1863 and 1873 negotiations were carried on for a union, which however were fruitless In 1896 the United Presbyterian Church again made advances which were met, and on Oct 31, 1900 the United Free Church of Scotland came into existence.

UNITED PRESS ASSOCIATIONS, founded in 1907 through merger of Publishers' Press, Scripps-McRae Press association, and Scripps News, became one of the world's largest distributors of spot news By mid-20th century it supplied news dispatches daily to more than 4,000 clients in the United States and in 68 foreign countries Bureaus were maintained (79 in the U S, 78 in other nations) in every important world news centre, from which staff correspondents dispatched news by cable and radio. These offices abroad were joined by a network of radio transmission and by leased wires which in Europe alone amounted to a length of more than 10,000 mi

Serving as it does newspapers of all shades of editorial policy, U.P. does not take sides on any controversial subject. Its only function is reportorial, and the management insists on accuracy and impartiality.

The U.P also opened services for radio and television stations, supplying them with dispatches and scripts. News is distributed in Great Britain and the British dominions by British United Press, organized in 1922. United Feature syndicate, a U.P. subsidiary, by the 1950s supplied feature material to 2,000 papers in the U.S and abroad, handling the works of well-known columnists, feature writers and cartoonists. Ocean Press, another subsidiary, was organized to transmit world news by radio to passenger ships at sea, many of whom publish daily newspapers

The company was incorporated in New York with headquarters in New York city Regional officers and executives were stationed in other world news centres (H. BA.; X)

UNITED PROVINCES, the name by which the state of UTTAR PRADESH in the Republic of India was known under British administration from 1937 and until after the passing of the republican constitution The name North-Western Provinces was used by the British until 1902; United Provinces of Agra and Oudh from 1902 to 1937 The state includes the former states of Rampur, Tehri-Garhwal and Benares, merged with it under the scheme brought to completion by the government of India It is bounded on the north and northeast by Tibet and Nepal and comprises the whole of the upper part of the Gangetic basin, from the Himalaya and the Punjab border to the Vindhyan plateau and the rice lands of Bihar, an area roughly corresponding to the Hindustan of the old Moslem chroniclers. To this it adds the great semicircular tract, watered by the Gogra and the Gumti, which was formerly the kingdom of Oudh The total area is 112,523 sq mi.

The population (63,254,118 in 1951) is larger than that of any other state of the republic. In the census of 1941, 83.3% of the population were Hindus and 15.3% Moslems, but the movement of population caused by partition, added to the nonclassification of communities by religion, made it subsequently impossible to determine accurately whether this ratio was maintained. The number of displaced persons in the Uttar Pradesh was 475,822 in 1951. Hindustani or Urdu and Hindi (Eastern and Western) are the chief languages.

Physical Aspects.—At one end the state rises into the Himalaya and includes, at one extreme, some of the grandest of the peaks which look out upon upper Asia. At the other extreme, where it borders on central India, it has a fringe of rough, broken and picturesque country Apart from these, however, it is a level and somewhat monotonous expanse, well-drained, closely cultivated and studded with villages, the number of which (nearly 105,000) far exceeds that in any other state Many of them, standing high on the debris of older sites, have the air of fortified places; and the fine mango groves which often adjoin them redeem the bareness of the surrounding plain.

The flora of the forests is rich and varied. The sal tree yields the most important timber. The hard wood of the *shisham* is also valuable, and several other timber trees afford materials for furniture or roofing shingle Among the scattered jungles in various parts of the province, the mahua tree is prized alike for its edible flowers, its fruits and its timber. The fauna comprises most of the animals and birds common to the Gangetic plain; but the wild elephant is now practically unknown, except when a stray specimen loses its way at the foot of the hills. Tigers are found in any numbers in the *tarai* only Leopards haunt the canebrakes and thickets along the banks of the rivers; and nilgai and antelopes abound Game birds consist of teal and wild duck, snipe, jungle fowl and peacock.

The Ganges and its great affluents, the Jumna, the Ramganga and the Gogra, rise in the Himalaya and meet within the province. In addition there are the secondary streams the Kalinadi and the Hindan flow through the Doab; the Chambal intersects the trans-Jumna tract. In Bundelkhand the principal streams are the Betwa and the Ken. The Ramganga, rising in Garhwal, pursues a tortuous course through Rohilkhand; the Gumti flows past Lucknow and Jaunpur to join the Ganges and the trans-Gogra region is divided into two nearly equal parts by the Rapti. These rivers are constantly modifying the adjacent lands.

Climate.—The climate as a whole is hot and dry. The Himalayan districts of course are cool and have a much greater rainfall than the plains. They are succeeded by a broad submontane belt, the *tarai*, which bears the reputation of being the most unhealthy in all India; in many parts only the acclimatized aborigines can withstand its deadly malaria. The plain country is generally warm

and dry, the heat becoming more oppressive as the general level of the country sinks toward Allahabad and Benares (Banaras), or among the hills of Bundelkhand The rainfall varies from 30 to 44 in in the plains, increasing gradually toward the Himalaya The temperature in the hot season ranges from 86° to 115° F. and even higher in the shade. (E Ho ; X)

History.—If the present limits were slightly extended in either direction so as to include Delhi and Patna, the United Provinces would contain the area on which almost the whole drama of Indian history has been played. There lay the scene, known as Madhya Desa or "middle country," of the second period of Aryan colonization, when the two great epics, the "Mahabharata" and "Ramayana," were probably composed and when the religion of Brahmanism took form There Buddha was born, preached and died There arose the successive dynasties of Asoka, of the Guptas, and of Harsha. There ruled the Mogul for his most brilliant period at Agra and at Fatehpur Sikri There finally, at the crisis of the mutiny, British dominion was established in India.

The political vicissitudes through which this tract of country passed in earlier times are described under INDIA. *History* It will be sufficient here to trace the steps by which it passed under British rule. In 1765, after the battle of Buxar, when the nawab of Oudh had been decisively defeated and Shah Alam, the Mogul emperor, was a suppliant in the British camp, Lord Clive was content to claim no acquisition of territory Oudh was restored to the nawab with the exception of the two districts of Kora and Allahabad in the lower Doab which were handed over to the Mogul emperor for the upkeep of his dignity and expenses. Warren Hastings augmented the territory of Oudh by lending the nawab a British army to conquer Rohilkhand and by making over to him Allahabad and Kora on the ground that Shah Alam had placed himself in the power of the Marathas In 1775 he received from Oudh the sovereignty over the province of Benares Lord Wellesley in 1801 obtained from the nawab of Oudh the cession of Rohilkhand, the lower Doab and the Gorakhpur division, thus enclosing Oudh on all sides except the north In 1804, as the result of Lord Lake's victories in the Maratha War, the rest of the Doab and part of Bundelkhand, together with Agra, were secured from Sindia. In 1815 the Kumaon division was acquired after the Gurkha War, and a further portion of Bundelkhand from the peshwa in 1817. These new acquisitions, known as the ceded and conquered provinces, continued to be administered by the governor-general as part of Bengal. In 1833 an act of parliament authorized the appointment of a lieutenant-governor for the North-Western Provinces, as they were then styled. They included the Delhi territory (transferred after the mutiny to the Punjab) and also (after 1853) the Saugor and Narbada territories, which in 1861 became part of the Central Provinces. Meanwhile Oudh remained under its nawab, who was permitted to assume the title of king in 1819, until it was annexed in 1856 and constituted a separate chief-commissionership. Then followed the mutiny, when all signs of British rule were for a time swept away throughout the greater part of the two provinces. The lieutenant governor died when shut up in the fort at Agra, and Oudh was only reconquered after several campaigns lasting for 18 months. (*See* INDIAN MUTINY.)

In 1877 the offices of lieutenant governor of the North-Western Provinces and chief commissioner of Oudh were combined in the same person; and in 1902, when the name of United Provinces of Agra and Oudh was introduced, the title of chief commissioner was dropped. In 1920 the tract was created a governor's province. (X.)

Minerals and Agriculture.—Because of the loamy nature of the soil, few minerals of any kind are found, and the chief underground product is the abundant nodular limestone (*kankar*) which is used for road making. Iron and coal exist in the southern hills but not in paying quantities, and there are traces of old iron-workings in the lower Himalaya. The course of tillage comprises two principal harvests. the *kharif*, or autumn crops, sown in July and reaped in October or November; and the *rabi*, or spring crops, sown in October or November and reaped in March or April. The great agricultural staple is wheat, but millets, rice, barley and pulses are also largely cultivated. Speaking broadly, rice and oil-seeds predominate in the eastern and sub-Himalayan districts, millets and cotton in Bundelkhand and wheat in the greater part of the Gangetic plain. Sugar cane, condiments and tobacco are locally important, and a little tea is grown in the submontane districts of Almora Garhwal and Dehra Dun

Irrigation.—The Doab is intersected by canals drawn from the great rivers. The major productive works are the Upper and Lower Ganges, the Eastern Jumna and the Agra canals. The greatest work in the province and one of the greatest irrigation works in the world, is the Upper Ganges canal, which is taken from the river where it leaves the hills, some 2 mi above Hardwar In the first 20 mi. of its course this gigantic canal crosses four great torrents, which bring down immense volumes of water in the rainy season The total length of the main canal is 213 mi , navigable throughout and designed to irrigate 1,500,000 ac. The Lower Ganges canal is taken from the river at Narora, 149 mi below Hardwar After crossing four great drainage lines, it cuts into the Cawnpore and 7 mi lower down into the Etawah branches of the Upper Ganges canal. These branches are below the point of intersection, part of the Lower Ganges canal system. The irrigating capacity of this canal is 1,250,000 ac The Sarda canal, opened in 1928 to carry the waters of the Sarda into Oudh, was extended in 1941, making the total length of its main canals and branches 7,236 mi., one of the longest systems of its kind in the world, the area irrigated being more than 1,200,000 ac (including 200,000 ac of sugar cane).

Land Tenure.—Under British rule the system of land tenure was not uniform. In the Benares division, the land revenue was permanently fixed in 1795, on the principles that had been previously adopted in Bengal; and there a special class of tenants, as well as the landlords, enjoyed a privileged status. Throughout the rest of the province of Agra temporary settlements were in force, usually for a term of 30 years, the revenue being assessed at one-half the "assets" or estimated rental value. The settlement was made with the landholders or zamindars, who were frequently a group of persons holding distinct shares in the land and might be themselves petty cultivators. The privileged tenants were those possessing "occupancy" rights, defined by statute All other tenants were merely tenants-at-will. In Oudh, after the convulsion of the Indian mutiny, all rights in land were confiscated at a stroke; and the new system adopted was in the nature of grants to the talukdars, or great landlords, who were declared to possess permanent, heritable and transferable rights, with the special privilege of alienation, either in lifetime or by will, notwithstanding the limits imposed by Hindu or Mohammedan law.

On July 1, 1952, an act of 1951 abolishing zamindari took effect Compensation (eight times the annual income) went to 2,000,000 zamindars at a cost of £112,500,000, the 12,000,000 tenants holding their 60,200,000 ac. (83.3% of the total agricultural land) directly from the state

Manufactures and Trade.—The principal manufactures are those of sugar, metal and coarse cotton cloth. Ornamental metal-work is made at Benares. Among the factories on the English model are the Elgin and Muir cotton mills at Cawnpore (Kanpur), the Cawnpore wool mill, tanneries and leather factories, the Shahjahanpur rum distillery and the breweries at Mussoorie and Naini Tal There are also iron and brass foundries, lac factories and oil mills.

The export trade is chiefly confined to agricultural produce. The principal staples include wheat, oilseeds, raw cotton, sugar, molasses, timber and forest produce, dry stuffs, ghee and tobacco. The imports consist mainly of English piece goods, metalwork, manufactured wares, salt and European goods. The chief centres of trade are Cawnpore, Allahabad, Agra, Mirzapur, Benares, Meerut and Moradabad.

Railways.—The province is well supplied with railways. The main line of the East Indian traverses it from end to end, on both banks of the Ganges, connecting with Bengal on the one side and the Punjab on the other and linking up with the Great Indian Peninsula railway line at Allahabad, Agra and Cawnpore.

Besides this broad-gauge system, there is also a metre-gauge

nexus (the Bengal and North-Western, with its associate, the Rohilkhand & Kumaon), which serves the whole of the submontane tract and projects into Bengal, while it also joins with the Bombay Baroda & Central India railway at Muttra. The trade of the province thus has access to the sea at Bombay, Calcutta and Karachi.

Administration.—Under British rule the United Provinces were under the direction of a governor with an executive council and ministers The legislature had 118 members, to whom the ministers were responsible. After the transfer of power the legislature remained, pending the holding of elections under the constitution of the republic, which came into force on Jan 26, 1950. The first governor after the transfer of power was the poetess politician, Mrs Sarojini Nadu, who died in her term of office on March 2, 1949

The state has 48 districts, each under a collector and magistrate (called also deputy commissioner in Oudh and Kumaon) The supreme judicial tribunals are the high courts at Allahabad, with jurisdiction over the part of the state that was formerly Agra, and the chief court at Lucknow with jurisdiction over Oudh

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(E. Hd , X)

UNITED STATES (OF AMERICA), THE, the foremost nation of the western hemisphere in the number and wealth of its people, and the second largest in area. It is situated advantageously in the temperate zone of the North American continent (approximately 24° 30′ to 49° N. lat.), and extends in a broad belt from the Atlantic ocean on the east to the Pacific ocean on the west (approximately 66° 57′ to 124° 45′ W. long.). On the north it is bordered by Canada, the boundary in the west being an arbitrary line at the 49th parallel and in the east largely a natural one formed by the Great Lakes. The eastern half of the southern boundary is naturally defined by the Gulf of Mexico, but in the west the nation is separated from Mexico by an oblique line following first the Rio Grande river and continuing afterward generally west-northwest across the highlands to the Pacific ocean

The eastern coast is separated from Europe by approximately 3,000 mi. of the Atlantic ocean which acts as a carrier for an enormous commerce between the two continents, but which, at the same time, gives the United States a degree of isolation from European affairs which contributed greatly to its independent growth and progress. The Pacific ocean which separates the United States from the oriental nations of the far east is wider, varying from 5,000–6,000 mi , but in the Hawaiian Islands the United States acquired possession of an important midway stepping stone

The United States consists of 48 separate and theoretically sovereign states joined together by a federal government to which the original 13 states delegated certain powers as outlined in the federal constitution adopted in 1787 and put in force in 1789. The official name "The United States of America" is in general usage shortened to "United States," the term being used in the singular instead of a plural sense. The total area of the nation is 3,022,387 sq mi. (2,974,725 sq mi., land only). Its population in 1950 was 150,697,361, or 50 6 per square mile. In 1940 the population was 131,669,275, or 44 2 per square mile; in 1930 it was 122,775,046 or 41.1 per square mile; in 1920, 105,710,620 or 35 5 per square mile. Outlying possessions with a total area of 597,237 sq.mi. had a population in 1950 of 2,955,450.

(*See* ALASKA; GUAM; HAWAII; PORTO RICO; VIRGIN ISLANDS; etc.)

The article which follows is divided into these sections:

I. Physiography.
II. Geology.
III. Climate.
IV. Fauna and Flora.
V. Population and Social Conditions.
VI. National Finances.
VII. Industry and Commerce.
VIII. Defense.
IX. Constitution and Government.
X. History.

The reader is also referred to the articles on the separate states

I. PHYSIOGRAPHY

Plan of Relief.—The primary features of the United States are. (*a*) a vast western highland covering a full third of the country, dominated by mountains of which the general trend is a little west of north, (*b*) a smaller and lower eastern highland south of the St. Lawrence river, trending north-east-south-west, roughly parallel to the Atlantic coast, (*c*) a broad interior plain sloping southward and interrupted by the smaller interior highland, and (*d*) a lowland belt bordering the Atlantic and the Gulf of Mexico.

Major Physiographic Divisions.—The eight major divisions are as follows, the order being determined by the numbering of the physiographic provinces on the map (p. 720) and in table pages 721 and 722: A,—the Laurentian Upland covers most of eastern Canada and only a small part of the United States south of Lake Superior; B,—the Atlantic Plain embraces the Atlantic and Gulf coastal plains; C,—the Appalachian Highlands extend from the St. Lawrence south-west to the Gulf coastal plain with an average width of 300 miles. D,—the Interior Plains are bordered east and west by the great highlands of the continent and partly enclosed on the north by the Laurentian highland, but west of that they extend north to the Arctic ocean. On the south these Interior plains give way to the Gulf coastal plain but not without a distinct descent. E,—the Interior Highlands are surrounded by plains, the Interior plain on the west and north, and the Gulf coastal plain on the east and south. F,—the Rocky Mountain System enters the United States from Canada and extends south to latitude 36°. This system carries the main continental divide and, while not bearing the highest peaks, affords the greatest mass of land at high levels on the continent. G,—the Intermontane Plateaux west and south of the Rocky mountain system, occupy approximately half a million square miles, most of it at high altitudes and half of it ribbed by mountains. H,—the Pacific Mountain System occupies a strip about 200 mi. wide along the Pacific coast, embracing several distinct ranges and important valleys. *See* map, page 720 and table, page 721.

Rivers and Harbours.—In a very general way the major divides follow the great highlands, hence the rivers entering the Atlantic between the St. Lawrence and the Gulf of Mexico are of moderate size and of little direct value to navigation. Their indirect value is great, however, because all their valleys were carved when the continent stood at a higher level. Subsidence of the land drowned the lower courses of streams, making estuaries and harbours as at New York, Baltimore and all the other Atlantic seaports. The Hudson was drowned to Albany and the Delaware to Trenton, permitting ocean vessels to reach Philadelphia. Chesapeake bay is the largest indentation thus made. One of its branches, the Potomac, is at sea-level as far up as Washington.

The St. Lawrence system embraces the five Great Lakes on the Canadian border. The divide limiting the drainage basin of these lakes on the west and south is not far from their shores, hence all tributary streams are short. But the mouths of these streams have likewise been drowned by the tilting of the basin in such a manner that the south-western shores of these lakes are being progressively submerged while the north-eastern shores are rising. Milwaukee, Chicago, Toledo and some other ports owed their original harbours to this cause. The extraordinary harbour of Duluth lies behind a sand bar which has cut off the western end of Lake Superior.

Five-twelfths of the United States (1¼ million sq.mi.), mainly in the Interior plains, drain to the Mississippi and its branches. These afford thousands of miles of navigable water, chiefly on the main stream and its tributaries from the humid east. The Ohio is the most navigated stream in America. New Orleans is a river city 100 mi. from the Gulf; it is a seaport only in the sense that sea-going vessels can reach it. Mobile and some other Gulf ports are on drowned valleys altered and supplemented by artificial works. A small estuary at Galveston is fronted by a broad sand reef on which the city stands.

The Mississippi river has received much attention on account of navigation and flood prevention. More than three-fourths of its water comes from three main streams, the Missouri, the Upper Mississippi (above the mouth of the Missouri) and the Ohio Their several contributions are approximately as follows.

	Drainage area (square miles)	Average discharge in second-feet	Percentage of total discharge
Upper Mississippi . .	171,500	127,000	18·27
Ohio . .	202,000	300,000	43·17
Missouri .	530,000	100,000	15 83
Entire Mississippi .	1,240,000	695,000	..

The Missouri drains the largest basin but, has the least rainfall, hence its volume is least Each year the Mississippi carries to the sea 340,500,000 tons of solid matter in suspension and 136,400,000 tons in solution. Erosion would thus reduce the level of the entire drainage basin by one foot in 6,000 years

West of the continental divide on the Rocky mountains are two long rivers, the Snake-Columbia in the north and the Colorado in the south, which traverse the full width of the Intermontane plateaux Other streams are short and the total amount of water reaching the Pacific is small in proportion to the great area drained. In this part of the United States, chiefly in the States of California, Nevada, Utah and Arizona, and in the adjacent part of Mexico, is a vast area too arid to drain to the sea, comprising 3 2% of the area of the continent or nearly a quarter of a million square miles. The Pacific shore, like the Atlantic, has suffered submergence, drowning the lower courses of most streams. Thus was made the harbour of Portland, Oreg., on Columbia river, 100 mi from the sea. The local subsidence that made San Francisco bay came at a point where the chief rivers of California break through the Coast ranges to the Pacific. Puget sound, with Seattle, Tacoma and other harbours, is similar to San Francisco bay San Diego, near the Mexican border, owes its harbour to the protection of a magnificent sand reef.

Atlantic and Gulf Coastal Plain.—South of New York, the continent slopes almost imperceptibly to the shore, beyond which the sea bottom continues the very gentle slope many miles, and then descends less gradually to the oceanic abyss. The line where this relatively rapid descent begins is the real edge of the continent and this margin of shallow sea bottom is the continental shelf. Within this margin is deposited most of the sand and mud carried down from the land. A large part of the ocean's life is concentrated on this shallow bottom where the water is relatively warm and food is abundant.

Repeatedly in late geologic time this border of the continent has stood lower, and also higher, than at present, thus broadening and narrowing the continental shelf alternately. The part of the shelf above water at any one time is coastal plain. All that is shown on the map (p. 720) as coastal plain has been continental shelf at a time so recent that its structure remains unchanged. The materials of its underlying strata are the same as those now accumulating beneath the adjacent shallow sea. Some of the sand, clay and ooze has been poorly consolidated into sandstone, shale or limestone. All beds dip faintly seaward, the older and lower ones passing seaward beneath the younger beds, so that the several formations appear at the surface in strips parallel to the coast, the lower beds outcropping farthest inland. As the beds offer unequal resistance to erosion and are unlike in their soil-making properties, the striped pattern of the geologic map is apt to be reproduced in the topography of the coastal plain.

Topography.—As the surface of the continental shelf is extremely flat, so also is the land nearest the coast, which has but recently emerged and lies too near sea-level to favour the cutting of valleys. The landward edge of the coastal plain was necessarily first to emerge from the sea. It is also the highest. For both of these reasons it is more deeply eroded and more completely dissected by small streams than is the seaward edge. In the southern States this inner edge is at places more than 700 ft. above the sea and has a relief of 300 to 400 feet. At places erosion has even made new lowlands or peneplams. Other things equal, the number and depth of valleys increase inland.

Where the underlying strata resist erosion unequally, a strong stratum may give rise to a cuesta, a ridge with a very gentle slope down dip towards the sea and a steeper slope cutting across the strong stratum and leading down to an "inner lowland" on the underlying weak stratum The effect on topography is to make the *belted coastal plain* wherein the stronger beds (usually sandy) make higher, rougher and less fertile belts and the weaker beds (usually clay, marl or "chalk") make belts of smooth, fertile lowland Thus central Alsbama has its well known "Black Belt" on the outcrop of the Selma chalk (Cretaceous) which erosion has reduced to a lowland with a rich black soil, famous for its cotton. Dipping seaward, the chalk passes under stronger sandy beds which are poor soil makers, hence the rich lowland is paralleled by a broad, now much dissected cuesta of poor upland. Another lowland and another upland follow but are less well known. Northern Texas has a similar belt, the "Black Prairie," along the western boundary of the coastal plain. It is likewise on a chalk outcrop and has on its seaward side an infertile cuesta. New Jersey has a similar lowland on the weak Raritan clays which outcrop along the landward edge of the coastal plain. From Trenton south-westward this low strip is followed by Delaware river. North-east from Trenton it is followed by the great railroads running from New York to Philadelphia.

Islands.—It will be observed that the coastal plain is broadest at the south and narrows toward the north The opposite is true of the continental shelf, indicating that the continent is now relatively depressed at the north and elevated at the south One effect of this is seen in the islands from New York to Cape Cod. These islands, Staten, Long, Block, Martha's Vineyard and Nantucket, are disconnected fragments of the coastal plain, parts of one or more cuestas whose corresponding inner lowlands are submerged. The low strip described across New Jersey is continuous with Long Island sound. The same weak clays underlie both.

Coastline.—Throughout the Atlantic and Gulf coast recent (not necessarily current) sinking is in evidence. From New England to Texas the smaller streams have estuaries, as the larger ones had also until filled by sediments. North of southern Virginia all the major streams crossing the coastal plain are drowned across its entire width. The numerous large estuaries from New York to North Carolina make that part of the coast extremely ragged or crenulated Sand reefs or barrier beaches form a nearly straight "outer coast" and these continue most of the way from Long Island to Mexico They are especially long and continuous along the coast of Texas where tides are weak

The peninsula of Florida is due to an uplift of the sea bottom on an axis almost at right angles to the outline of the continent Its southern third is so little above sea-level that valley cutting is all but impossible. Here are the vast Everglades (*q.v.*), swamps whose water surface is less than 20 ft. above the sea Its most valuable part is a low limestone ridge on the Atlantic side, bearing Miami and other winter resorts. On this ridge and a line of coral reef wrapping around the southern end of the peninsula was the now abandoned Florida East Coast railroad. The northern part of the peninsula has suffered some erosion. Its underlying limestone suffers solution, giving rise to many sinkholes, some of them clogged and making lakes of considerable size. Here are the largest deposits of phosphate rock in eastern United States

Mississippi Embayment.—In the vicinity of the Mississippi river the coastal plain is greatly widened, extending north in a pronounced embayment to southern Illinois. The greater part of this area is occupied by the alluvial plains, 40 to 80 mi. wide, of the Mississippi and its tributaries. At the south this plain merges with and includes the great protruding delta, the entire alluvial plain covering an area of nearly 30,000 square miles. A large part of it is subject to flooding, or would be if not protected by artificial levees. The breaking of the levees in 1927 allowed most of the area to be inundated, the river at Arkansas City, Ark., rising at one time to 60·5 feet. The natural levees are at places 15 to 20 ft. above the back swamps. Slopes of 5 ft. per mile from the

river are common Slopes of 10 and even of 12 ft. are known.

Piedmont and Blue Ridge Provinces.—Inland from the Atlantic coastal plain is a belt underlain mainly by very old rocks, much deformed, generally metamorphosed and resistant This belt extends from central Alabama northeastward into Canada, but the part to be described here terminates at the Hudson river Its greatest width in the south is nearly 200 mi., but north of the Potomac river it averages barely 60 mi This relic of the early Palaeozoic continent is marked now by a mountain range on its northwestern side. From southern Pennsylvania, where it is called South mountain, to southern Virginia, where it is called Blue Ridge, it is rarely more than 10 or 15 mi wide and from 1,500 to 3,000 ft. high In North Carolina and adjacent states it broadens to 70 mi and culminates in Mt Mitchell (6,684 ft), the highest point in eastern United States The range is interrupted by a short gap in southern Pennsylvania Northeastward from this gap it is known as the highlands of New Jersey and New York This part, being detached from the main range (Blue Ridge province) and contiguous with the New England province, which is largely of the same character, is considered a part of the latter From New England to southern Virginia the crest, as viewed from a distance, is gently undulating and is considered to be the remains of an uplifted peneplain preserved by the strength of the rocks, while weaker rocks on both sides have been reduced to a new and lower peneplain In western North Carolina the ancient mountains were not all worn down to the peneplain indicated by the crest farther north. Partly for this reason and partly because of greater recent uplift these mountains are several thousand feet higher.

Between the mountains and the coastal plain is the Piedmont province, most of it a low plateau sloping seaward, consisting in the main of the same rocks found in the mountains. Where the rocks of the piedmont and mountain belts are similar the existence of a newer and lower peneplain in the former and not in the latter is explained by the fact that the new peneplain developed first along the lower courses of streams flowing from the mountains to the sea It spread westward, its limit of advancement being the eastward slope of the Blue Ridge This newer peneplain is itself uplifted and dissected by revived streams. Much of the northern end of the Piedmont province in Pennsylvania and adjacent states is exceptional, consisting of softer Triassic rocks As these were more readily worn down and, as already pointed out, the continent in this latitude has been less uplifted, this part of the Piedmont province is lowland rather than plateau, though still distinctly higher than the coastal plain. Taken as a whole, the rocks of this province are not very good soil makers, but the position, especially of its northern part, favours intensive cultivation Parts of the upland farther south are adapted to fruit trees and an important cotton district in South Carolina is in this province.

New England Province.—The New England province is a broadened northeastward extension of the belts already described. It has the same rocks along with some younger Palaeozoics, generally deformed, metamorphosed and peneplaned Residual mountains rising above the general level to an altitude of 4,000 to 6,000 ft. are found in the Green mountain section of Vermont and Massachusetts and the White mountain section of New Hampshire and Maine. Between and around these mountains the upland level is generally a little above 1,000 ft, studded here and there with isolated residual mountains or "monadnocks," the original Mount Monadnock being in southwestern New Hampshire. This upland is an uplifted peneplain, itself dissected by sharp valleys since uplift The surface declines seaward to the "Seaboard lowland" and it is probable that newer and lower peneplains are here represented The coastal margin below a level of 500 ft has a rolling surface with wide open valleys in contrast with the narrow and steeper valleys that incise the plateau. The land below 500 ft also includes the broad valley of the Connecticut river carved from Triassic rocks and analogous in most ways to the low northern end of the Piedmont province With this valley included, the relatively narrow seaboard lowland contains the greater part of New England's population and industry

Elevation was followed by depression and the valleys are drowned. This is typically shown on the coast of Maine where the style of depressed coast line is quite different from that of the coastal plain because of difference in topography previous to drowning. Outlying islands, formerly hills or mountains of hard rock, are abundant there Harbours are numerous and fishing is favoured by this as well as by the broad continental shelf.

Unlike the Piedmont and Blue Ridge provinces, New England was severely glaciated, its mountains overridden and scraped by the continental ice sheet, and its surface generally covered by ice-laid drift abounding in boulders Some of its valleys are partly filled with sandy outwash. Both topography and the stony soil are unfavourable to agriculture The northern part of the province was long the great lumbering district of eastern United States One of the chief effects of glaciation was the dislocation of streams Drainage, in beginning anew, was obliged to fill many basins and cross many rocky ledges. Lakes and rapids, therefore, abound, the latter being a great source of power New England, with its poor soil, abundant water power and excellent harbours early developed manufacturing and commerce

The Adirondacks.—In its physical geography the Adirondack area in northern New York is much like northern New England, a combination of subdued mountains and hilly plateaux, all severely glaciated and abounding in lakes. Like the White mountains and New England coast it is much used as a summer resort. The state of New York has reserved large areas of forest.

Appalachian Ridge-and-Valley Province.—West of the Piedmont, Blue Ridge and New England provinces is a narrow belt of folded sedimentary rocks stretching from the St Lawrence valley to the Gulf coastal plain. The length is 1,000 mi and the width rarely 75 mi , more often half that amount Between New England and the Adirondacks it is very narrow In its present state this belt consists of alternating ridges and valleys, the former being parallel, even-topped and rarely 3,000 ft. high For the most part they are nearly straight and in line with the major belt but a zigzag pattern appears in Pennsylvania. The valleys occupy more than half the space Throughout its length the Palaeozoic sandstones, shales and limestones are folded and often faulted by great lateral compression which made mountains of great height. The ridges now seen are not those made by the folding Those lay far above the level of the present mountain tops Even the synclinal trough bottoms were above the present crests All were eroded away to a peneplain covering this and adjacent provinces At the time of its making it could not have been, at highest, more than a very few hundred feet above the sea The tilted strata came to the surface of this plain in parallel strips Later came a general rise of the whole Appalachian region and the limestones and shales were worn down to a new and lower level (often a peneplain) while the sandstones, being stronger, along with the hard rocks of the Blue Ridge province and the sandstone-capped plateau on the west, retained more nearly their former level. The tops of the even-crested ridges indicate the old peneplain somewhat uniformly worn down

The greatest breadth of this Ridge-and-Valley province is in Pennsylvania where it is almost 90 mi. From here to southern Virginia the eastern third or fourth is almost without ridges Its several parts from the Lebanon valley in Pennsylvania to the Shenandoah valley in Virginia are well known for their agricultural wealth. In this central portion the master streams cross the belt transversely, their longitudinal tributaries being developed on the softer outcrops In the northern section of the province, Hudson-Champlain valley, and again in the southern section, Valley of East Tennessee and neighbouring states, the main streams are longitudinal. In the latter case this probably came about by the headward elongation of the Tennessee river capturing the former streams which flowed from the Blue Ridge to the Ohio.

Appalachian Plateaux.—West of the Ridge-and-Valley province is a plateau of almost equal length with a minimum width of 35 miles at the south but more than 200 miles wide farther north. On the side toward the Ridge-and-Valley province, it is at least as high as the ridges already described, 2,000 to 3,000 ft., but it declines northwestward and is barely 1,000 ft. high where its edge approaches Lake Erie. Its rocks are almost horizontal, generally outcropping on the southeast in an escarp-

ment overlooking the adjoining valley of the folded province Except at the north end the rocks at the surface are Carboniferous and Permian Thick beds of strong sandstone are common and generally cap the hills. Soils, therefore, are generally not good They are least fertile at the south end where the sandstones are most dominant, and best at the north end where Devonian rocks form the plateaux and glaciation has left its heterogeneous drift.

The larger part of the province is almost or quite completely dissected by stream valleys. These may approximate 1,000 ft. in depth on the higher south-east side, but the relief diminishes toward the north and west Nevertheless the hilltops are about at the same altitude and the horizon is nearly level The Cumberland plateau at the southern end, mainly in Tennessee, is exceptional in preserving large patches of undissected upland on beds of strong sandstone In parts of the eastern margin the beds are mildly folded though not enough to develop the topography of the next province to the east. The elevation is less uniform than elsewhere in this province and the horizon less level As these are also places of greater height these districts are known as mountains, the Allegheny mountains in Pennsylvania, and the Cumberland mountains in Kentucky and Virginia, but these names are applied somewhat broadly, and without exact boundaries, to the deeply dissected eastern margin The Catskill mountains in south-eastern New York are like the adjacent plateau but covered by an additional thick plate of strong conglomerate now deeply and maturely dissected The plateau in New York, and to some extent in Pennsylvania and Ohio, was glaciated, leaving the hills and valleys less angular, leaving also many lakes and displaced streams, some of which in carving new valleys have made picturesque falls and gorges The main plateau ends at the north in an escarpment not far south of the 43rd parallel and 600 to 1,000 ft. high. West of Rome, N Y, this escarpment overlooks the lacustrine plain along Lake Ontario, a part of the central lowland. East of Schenectady the descent from the plateau is to the valley of Hudson river (Ridge-and-Valley province) Between these two cities, the descent is only to a lower bench of the plateau province In this bench Mohawk river has cut its valley connecting the two lowlands named As all strata here dip slightly southward, the valley of the Mohawk is a strike valley. It is the greatest avenue of travel and commerce between the Atlantic coast and the central lowland.

The glaciated northern portion of the Appalachian plateau is favoured agriculturally and is one of the leading dairy districts of the United States. The remainder of the province is almost co-extensive with the great Appalachian coal fields, 75,000 sq mi in extent As this area was never folded the coal remains bituminous. In the province to the east the folds were so high that the carboniferous beds, being uppermost, were almost wholly eroded away. Only in a few small spots were the synclines so deep as to leave the coal below the base level of erosion. Here the coal was metamorphosed to anthracite. The total original area of the anthracite fields was 484 square miles. In the central part of the plateau province are also the great Appalachian oil and gas fields

Interior Low Plateaux.—West of the southern part of the Appalachian plateaux is a lower plateau province, mainly in the States of Kentucky and Tennessee At its eastern edge it abuts against the western escarpment of the Cumberland plateau Here the lower plateau is 1,000 to 1,400 ft. high and scored by valleys between which the surface is little eroded The ragged escarpment of the Cumberland plateau rises 800 ft higher Everywhere the level of the Interior Low plateau declines toward Ohio river, near which in western Kentucky the uplands are little more than 500 ft high. Dissection by streams increases toward the west end where it is complete The upland level in most of the province, except in the north-west, is approximately that of the Lexington (Highland Rim) peneplain which covers much of the continental interior. It is developed here on Mississippian (Lower Carboniferous) rocks Two low structural domes were thus truncated, the Nashville in Tennessee and the Cincinnati anticline, partly in Kentucky Ordovician (Lower Silurian) limestones were exposed in each, affording excellent soils In Tennessee these soluble rocks were later cut down 500 ft. making the fertile Nashville basin, surrounded by steep slopes rising to the relatively barren Highland Rim The "Bluegrass Region" in Kentucky preserves, in the main, the general level of the peneplain but is overlooked on the east by the Cumberland plateau, and on the south by a narrow monoclinal rim remaining from the former dome In the central Bluegrass district are exposed the oldest rocks and the best soil-makers of the Cincinnati anticline. Western Kentucky embraces the south end of a great coal field with its centre in Illinois. Here is a broad, faint syncline in which the upper Carboniferous rocks were sufficiently depressed to escape the erosion that stripped them away from neighbouring areas. Here again, in western Kentucky, the soil is better

Central Lowland and Superior Upland.—The term lowland is not capable of exact definition As applied to north central United States it signifies that most of the area is not obviously much above the level to which streams can cut down

Within this great province, roughly one-fourth of the United States, the chief contrasts in topography are determined by glaciation The entire province may be divided into six sections Two of them were never covered by the ice, two of them were left after glaciation as relatively smooth till plains without lakes, two others were left with abundant moraines and undrained basins Referring to the accompanying map and table, the Great Lake section (12a) has a topography controlled in detail by its thick glacial deposits, though its large features betray the relief of the underlying rock as carved by pre-glacial drainage. Terminal and recessional moraines and outwash deposits, with moraine lakes and swamps, cover perhaps half of the area; the other half is till plains (ground moraine) and lacustrine plains The beds of all the Great Lakes, except Superior, follow belts of weak strata which were presumably lowlands in pre-glacial time and were deepened by glacial erosion As the ice front retreated northward from the Mississippi-St. Lawrence divide, lakes formed between the divide and the ice With further retreat of the ice these lakes expanded and merged, changing from time to time in shape, altitude and outlet but generally discharging into the Mississippi system. When the vanishing ice covered only the St Lawrence the lakes discharged for a time through Mohawk valley to the Hudson. As each newly discovered outlet lowered the lake levels the water was progressively withdrawn from the farther ends of the basins and the old lake bottoms at the heads of the lakes (south or west ends) were laid bare An important though minor part of this Great Lake section consists of these perfectly flat former lake bottoms The glaciation of this section was in the last, or Wisconsin, ice epoch and the surface has been little altered by erosion Lakes and swamps are beginning to disappear but stream systems are poorly developed. West of Lake Michigan, in this section, is the leading dairy district of the United States

The Western Young Drift (12b) in Minnesota, northern Iowa and the Dakotas is similar but with a smaller proportion of morainic topography It has also a smaller rainfall, so that forests are limited to northern Minnesota An important feature of this section is the great lacustrine plain of former Lake Agassiz in the valley of Red river. This valley was flooded when the retreating ice cap obstructed the drainage to Hudson bay The lacustrine plain (most of it in Canada) is now the greatest area of spring wheat production in America

The two sections already described are separated by the Superior Upland and the Wisconsin Driftless Area The former, as compared with the other sections, is higher, is less deeply covered with drift, has a larger number of lakes and vastly more swamp. Its rocks are mainly igneous and metamorphic pre-Cambrian. Topographically it is a peneplain, upraised, somewhat eroded, then glaciated This is an important part of the great area of northern pine forest Much is now cut-over land, only a minor part being valuable for agriculture. It contains the chief copper mines of eastern United States and the greatest iron mines of the world

South-western Wisconsin and small parts of adjacent States were missed by the several ice invasions though surrounded by a glaciated surface that extends 250 mi farther south. Probably at no one time did the ice close around it. The margin of the ice sheet

was divided into lobes following the great valleys. In the different ice epochs they came from different directions, at one time from the north-west, at another from the north-east, the areas covered by these different advances overlapping south of this Driftless Area. The southern and western parts of this area are limestone uplands rather deeply and at places sharply carved by erosion The northern part is mainly a lowland underlain by friable Cambrian sandstone covered by glacial outwash. With due allowance for the effects of different kinds of rocks on topography, this driftless area may be regarded as a sample of the topography that was elsewhere overridden by the ice It is not very different from that which is seen beyond the limit of glaciation in eastern Ohio or western Kentucky or central Missouri

Most of Illinois, Indiana and western Ohio have a drift cover remarkable for its small relief and distinguished by a total absence of lakes The flatness is not absolute, for the retreating ice front halted at various stages, building recessional moraines, a few of which have the distinctive topography of moraines, while others are barely visible, being made apparent only by their effect on drainage. The major streams have cut down moderately into this surface and tributaries are developing, but not much headway has been made except near the Ohio and the Mississippi A margin near these streams belongs to an older drift sheet (Illinoian) while most of the section was again covered by ice in the last (Wisconsin) glacial epoch. West of this section in Iowa and northern Missouri and parts of eastern Nebraska and Kansas, are the Dissected Till Plains, distinguished from the Till Plains east of the Mississippi by greater erosion. This difference results from the fact that the glacial mantle west of the Mississippi was spread in the Kansan glacial epoch and is the oldest glacial drift widely exposed in the country. Complete drainage is re-established; valleys now occupy fully four-fifths of the area. In the type of agriculture that distinguishes the central lowland (grains and domestic animals) the Till Plains and Dissected Till Plains are pre-eminent.

South of the latitude of Kansas City (39°) the central lowland (Osage section) was not glaciated It extends almost to central Texas in a belt nearly 200 mi wide. The underlying rocks dip gently west beneath the Great Plains syncline and away from the Interior Highland. As the surface slopes in the opposite direction the formations outcrop in parallel strips trending nearly north and south The stronger beds form cuestas with east-facing escarpments, some of them so eroded as to make hilly belts a few miles wide.

Interior Highland.—Surrounded by the lowlands of south-central United States is the Interior Highland Its northern and larger part consists of the Ozark plateaux on nearly horizontal though slightly domed rocks The rocks of its southern third are folded along east-west axes. Altitudes in the Ozark plateaux are generally less than 1,600 ft., being highest near the centre, but in northern Arkansas on the southern slope of the dome the strong sandstone beds of the upper Carboniferous are preserved in a plateau that is locally more than 2,000 ft. high and ruggedly eroded, making the Boston mountains. In south-eastern Missouri in the midst of the plateau stand the St. Francois mountains, composed of granite, rising no higher than the surrounding horizontal sediments which once covered all. These ancient granite mountains were buried by marine sediments and are now being exhumed. They are among the best examples of their class The Ozark province is one of the leading sources of lead and zinc.

The belt of folded structure in Arkansas and Oklahoma, the Ouachita mountains (15*b*) is essentially like the Appalachian Ridge-and-Valley province, the product of two cycles of erosion, with ridges on the stronger outcrops and intervening lowlands on the weaker rocks. The rocks of the Arkansas Valley (15*a*) are but mildly folded and although the stronger sandstones make either flat or sloping uplands the whole strip is less uplifted than its neighbours. This province has large supplies of coal. The Ouachita mountains have the famous Hot Springs of Arkansas and produce the novaculite (natural honestone) of the United States. In and near it also are important bauxite deposits.

Great Plains Province.—The vast area known as Great Plains is a north-south belt averaging about 400 mi. in width between the mountains of western United States and the lowlands of its centre. Its height at the base of the mountains is 5,000 to 6,000 ft. and at its eastern edge 1,500 to 2,000 feet. An eastward slope of 10 ft. to the mile is common. A part of this great area is literally plain, most of the northern third is peneplain and considerable areas on the borders, both in the east and west, are dissected into hills. All of it is semi-arid and the only trees are in river bottoms or on certain isolated mountains like the Black Hills. Most of it has good soil without the necessary water to take full advantage of the fertility. Perhaps a tenth part may be irrigated.

The flat portions of the province are best illustrated in the Llano Estacado (Staked Plains) of Texas and eastern New Mexico (13*d* on the accompanying map and table). Interrupted by the valleys of transverse streams these flats extend north to southern Nebraska and, in modified form, to the South Dakota boundary forming a belt known as the High Plains. These are remnants of a vast alluvial slope made by coalescing alluvial fans from the mountains. When the streams ceased their depositing habit and began again to erode, the eastern edge of the fluviatile deposit was first to suffer. In Texas the edge is retreating westward as a well defined escarpment, there being but a few miles between the flat upland and the lowland on the east. In Kansas and adjacent States the wasting edge of the former upland plain is represented by a broad belt of hills (13*e*). In Nebraska, a thick mantle of loess obscures the transition from high plains to central lowland. Between the belt of preserved high plains and the mountains, erosion was also more favoured, partly by original slopes, partly by the nature of the vegetation. Here (13*f*-*g*-*h*) the fluviatile mantle, where formed, was destroyed and the present landscape is one of varied relief. The South Platte, Arkansas and Pecos have broad terraced and well-farmed valleys, but north-eastern New Mexico and the adjacent part of Colorado is a region of plateaux, trenched by angular valleys and surmounted by various features of volcanic origin. The Edwards plateau at the southern extremity of the province (13*i*) is a limestone tableland almost as flat as the Llano Estacado but without the fluviatile mantle It is cut off on the south and east sides by the great Balcones fault which for 300 mi forms the inner boundary of the coastal plain. Streams are dissecting the plateau at the edges and have in part removed the same limestone from a large area just north of the Edwards plateau This hilly section in central Texas (13*k*) is in a stage of the erosion cycle intermediate between the youth of the well preserved plateaux and the old age of the lowlands on the north

North of latitude 43° the Great Plains province is in large part upraised peneplain, though perhaps not all of the same cycle. Second in areal importance are the extensive gravel plains, some of them perhaps being remnants of a sheet similar in origin to that which covers the high plains. Others are simple stream terraces of Pleistocene age. Some of the streams, especially near the mountains, have valleys hundreds of feet deep and their tributaries have deeply dissected the upland. Isolated mountains are dome-like uplifts, the largest of which is the Black Hills, almost 100 mi long and 50 mi. wide, crossing the Dakota-Wyoming border. The structural uplift approximates 10,000 ft. but erosion has truncated the dome leaving the actual height less than 4,000 ft. above the plain on the east. The core of granite has thus been exposed at the top, while the strata outcrop in concentric ellipses, the stronger ones making ridges.

The northern part of the Great Plains province and a margin on the east (13*a*) was covered by the Pleistocene ice-cap leaving a strongly moraïnic topography in the Dakotas. The present course of Missouri river results from the obstruction of former drainage north-eastward to Hudson bay The ponded waters overflowing from basin to basin found the present south-eastward course. Its relative youth is shown by the small width of its valley (1 to 3 mi between bluffs) as compared with that of the Yellowstone and other tributaries.

Rocky Mountains.—As shown on the map (p. 720) the Rocky Mountain system is divided into four parts. The Southern Rocky Mountain province is a group of linear uplifts initiated

by east-west compression. The original folds were in large part levelled by erosion which thereby exposed the underlying granite, now revealed in north-south belts with a maximum width of 40 miles. Later uplift raised the general level to mountain heights but without sharp deformation. The old erosion surface was warped rather than folded, producing intermont basins. This later uplift enabled erosion to carve valleys in the granite and reduce the weaker rocks to lowlands. Commonly the granite belts are bordered by upturned sedimentary rocks, the several formations being of unlike strength, thus developing monoclinal *foothills* and valleys. Some large areas of granite 8,000 to 10,000 ft. high are plateau-like with a relief of only several hundred feet. These plainly represent a former lowland made by approximately peneplaning the first mountains. The largest of these tracts is South Park, 9,000 to 10,000 ft. high, west of Pikes peak. The same surface farther east and at many other places is carved into mountains whose summits approximate the same level. Looking across these crests, or over the undissected upland, Pikes peak is seen to rise as an isolated eminence 5,000 ft. above the level. It was a monadnock on the South Park peneplain. North of the Park and extending almost to Wyoming is the main crest of the Front range with many peaks 12,000 to 14,000 ft high. Along this entire line residual mountains rise clearly above a dissected plateau. Only a minor part of what is called "mountains" in the southern Rockies consists of these residual eminences. The greater part are carved from the uplifted peneplain. In the entire system, both north and south, most of the residual mountains have "alpine" features due to former glaciers. These are cirques and U-shaped troughs, often separated by steep and narrow crags. The San Juan mountains in south-western Colorado consist largely of volcanic rocks which once covered the area in sheets of relatively small relief. Later they were carved by water and ice into their present forms.

The Middle Rocky mountains, between the Wyoming basin and Yellowstone National park, consist of definite ranges in which structures and trends are clearly related. The axes radiate from Yellowstone park to the south, south-east and east. A long sickle-shaped arm whose eastern side is the Bighorn range almost surrounds the Bighorn basin. Of the group of ranges trending south, the Wasatch in northern Utah is outlined on the west by a great fault, the range on the upthrown side overlooking Great Salt lake on the downthrow. Meeting this range at right angles is the Uinta range which extends eastward forming the southern rim of the Wyoming basin.

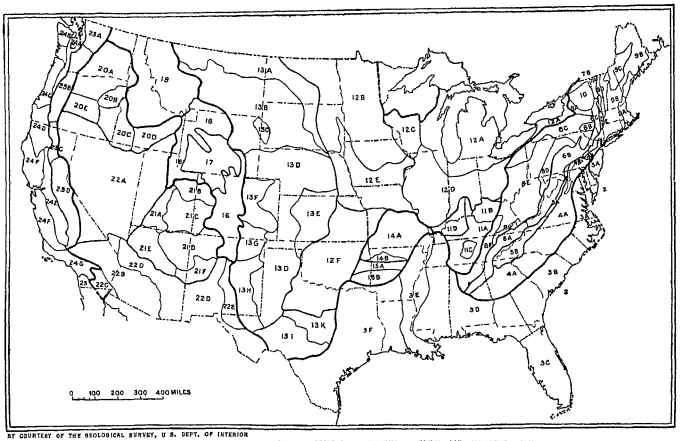
Yellowstone park is a plateau of rhyolitic lava with an average height of about 8,000 ft., enclosed by mountains on three sides but open to the west where a rapid descent leads down to the Snake river (basalt) plateau. A single narrow belt of mountains north and east of the plateau connects those to the north and those to the south. The lava fills a basin probably 2,000 ft deep and appears to have conserved the heat revealed by geysers and hot springs. The hot springs are among the most extensive in the world and the geysers have no rival.

North and west of Yellowstone park the mountains (with few exceptions) are not in "ranges" in the usual sense of that word. Linear arrangement in agreement with structure is found to a limited extent, *e.g.*, in the Lewis range of Glacier National park, but in general the present relief does not suggest corrugation. Much the larger part of the area is a vast mountain upland divided only by stream valleys or by "Tertiary basins" in which the mountain surface has sagged. Generally the dominant ridges within a single view are of sub-equal height so that the horizon is not far from level. Altitudes between 6,000 and 9,000 ft. are prevalent. The Bitterroot mountains on the Montana-Idaho boundary are the upturned edge of a fault block tilted westward. Except for this deformation the surface is as described above. The history of the Northern Rocky mountains is much like that of those farther south. At similar altitudes glacial features are more pronounced. They are specially marked and picturesque in Glacier National park in the Front range near the Canadian boundary. The Selkirk and Bitterroot ranges are likewise noteworthy in this respect.

Wyoming Basin.—North of the southern Rocky mountain province is the Wyoming basin whose floor, almost 40,000 sq mi. in extent, is a plateau 6,500 to 7,500 ft. high and largely free from mountains. Beneath its horizontal Tertiary rocks, and rising through them here and there, are the older folded sedimentaries and granite, showing that the Rocky mountain system is structurally continuous. Within and around this plateau the drainage is strikingly out of harmony with structure and topography. Green, Yampa, Bighorn, North Platte and Laramie rivers all leave the basin by canyons 1,000 to 3,000 ft. deep which might be avoided by going around the mountains. Green river, especially, was once a favourite illustration of antecedent river. This assumes that the river was in its place before the mountains rose across its course. It is now believed that these streams are superposed, *i.e.*, they chose their courses when the mountains were buried by weak Tertiary rocks (since eroded away) lying on top of those that now make the basin floor.

Colorado Plateau.—South and west of the Rocky mountains is a region of 125,000 sq mi. whose underlying rocks are in the main horizontal and whose surface is tabular. In part it consists of wide-spreading plains at high altitude; elsewhere the plateau consists of tabular remnants between deep and branching canyons. In general the plateau abuts against the mountains on the north and east and ends in an escarpment overlooking lowlands on the west and south. The best known part of the province is the south-western section (*21e*) traversed by the Grand Canyon of the Colorado. This has a maximum depth of 6,000 ft. and a minimum width of less than 5 mi. from rim to rim. The conditions favouring canyons are all present in this province. Great altitude above base level, strong through-flowing streams and geologically recent uplift favour downcutting, while strong rocks and arid climate favour preservation of steepness. In this section the surface is on Permian limestone not deeply eroded. These rocks dip north under younger strata. At the same time the surface rises terrace-like over system after system until Eocene (Tertiary) beds and lava flows are found capping the high plateaux of Utah (*21a*) 9,000 to 11,000 ft. high, bounded, both east and west, by escarpments. Most of the strata underlying the high plateaux formerly extended southward over the plateau in which the Grand Canyon is cut. A mass of rock equal in thickness to the entire depth of the canyon was stripped from this plateau leaving a relatively low surface which was later uplifted. In other words, if the present canyon broadens and similar canyons develop and broaden until the entire plateau has been carried away to the depth of the present canyon bottom, then the streams of the present, newly inaugurated erosion cycle will have accomplished what was done once before. The same Eocene beds which appear in the high plateaux form a wide band on the northern margin, dipping northward until they turn up in the foothills of the Uinta range, and ending at the south in an escarpment. The general surface slopes agree with the structure. This is the Uinta basin (*21b*). South of it, and east of the high plateaux is the area of arid Canyon Lands (*21c*) deeply trenched by Colorado river and its tributaries, though its eastern margin in Colorado contains some broad fertile valleys. Farther south is the Navajo section (*21d*), like the Canyon lands but more arid and less canyoned because there are no mountains on the border to supply through-flowing streams. The Datil section (*21f*) on the south-east is largely lava-covered as is a very considerable area farther west (San Francisco mountain and vicinity) in the Grand Canyon section. Here also is the Zuni uplift, a dome like the Black hills.

Basin-and-range Province.—West and south of the Colorado plateau is a region marked by numerous small, roughly parallel mountain ranges separated by nearly flat detrital plains generally 4,000 to 5,000 ft. above the sea, but declining in altitude toward the Gulf of California. The northern half has long been known as the Great Basin and is the largest area of internal drainage in North America. The 100 or more mountain ranges divide it into an almost equal number of undrained basins. The hydrographic centres of some of these are marked by salt lakes; some others have playas, mud flats covered occasionally by a few inches of



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MAP SHOWING PHYSIOGRAPHIC DIVISIONS OF THE UNITED STATES (SEE TABLE P. 721)

water. All are filled or veneered by detritus eroded from the mountains and deposited as alluvial fans. Such surfaces are nearly level and tend to rise until the basin is full. A few basins along the course of Humboldt river have been so aggraded with detritus as to establish through drainage which may reach Carson Sink or stop at Humboldt lake, according to season and weather. Many of the mountain ranges are 50 to 75 mi long and 3,000 to 5,000 ft. above the basins and trend approximately north-south. Trees appear only in exceptional spots. Some of the ranges are known to be upraised or up-tilted fault blocks. As there is a strong family resemblance among ranges, it is considered probable that faulting is at least the master process in the making of these ranges. The internal structures are complex showing that the rocks were strongly folded and (in the best known cases) peneplaned and lava-covered before faulting made the present mountains. In northern Nevada and southern Oregon the mountains were uplifted so recently that their origin by faulting is beyond doubt. Farther south some ranges are so old and eroded that their origin is not obvious. Some of the ranges bear evidence that the master faults were made before the peneplain, the present mountains consisting of the more resistant fault-blocks exhumed by selective erosion. Both of these types of mountains are present but the relative number of each, or even which is more numerous, is not yet known.

South of latitude 35° 30′, and extending from California to New Mexico, many of the intermontane basins are connected by through drainage or at least by continuous slopes on which water might flow to the sea if the rainfall were sufficient.

Columbia Plateau.—The surface of the Columbia plateau between the Northern Rocky mountains and the Cascades is made by flows of dark lava. These flows submerged an uneven surface of erosion, locally almost mountainous as may be seen in vertical section in the mile-deep canyon of Snake river between Idaho and Oregon. The Snake river basin east of the 115th meridian represents the simplest and most youthful phase of lava plains. Here the flat surface, 4,000 to 5,000 ft. high, remains as it was when the lava cooled, without erosion and only beginning to weather and to form soil. It is trenched only by the canyon of Snake river whose depth increases westward to 700 feet. Farther west, in south-western Idaho and south-eastern Oregon, there is more erosion. Near the State boundary the terraced valleys afford valuable irrigable land. The plateau in eastern Washington declines from nearly 3,000 ft. on the east to less than 500 ft. where Columbia river breaks through the Cascades. This northern section (*20a*) consists of older lavas, subjected to long erosion and having a rolling surface covered (at least in the east) with wind-blown soil. Here are the famous wheat fields of eastern Washington and western Idaho, cultivated by methods of "dry farming" by which a crop is raised in alternate years. In eastern Oregon near the middle of the province a group of mountains stood as an island in the floods of lava. Around these a later bulging raised the plateau surface to 7,000 ft., exposing it to greater erosion. This is the Blue Mountain section (*20b*). The rise lay across the course of Snake river which succeeded in cutting down as fast as the land rose, making a canyon 5,000 ft. deep.

Sierra-Cascade Mountains.—From Canada to southern California a continuous barrier of mountains separates the Pacific border from the Intermontane plateaux. The Sierra Nevada south of the 40th parallel presents to the Great Basin one of the highest and steepest mountain fronts on the continent. It is the escarpment of a great fault, or compound fault, west of which an old mountain range, worn down almost to a lowland, rose again with a westward tilt. Streams descending its long western slope have greatly increased its ruggedness by cutting gorges. These were later occupied by glaciers which deepened the valleys and steepened their sides. Yosemite valley is only an extra fine example of the typical glacial trough with its uneven floor whose basins retained lakes until filled by gravel, and its over-steepened walls notched at the top by tributary valleys, the "hanging valleys" which end in falls. These mountains are mainly of granite but in the northern half is a belt of folded and metamorphosed sedimentaries making the "Gold Belt" which has yielded a large part of California's output of gold.

Table Showing the Physiographic Divisions of the United States

Divisions	*Characteristics*
Laurentian Upland	
1. Superior Upland	1 Submaturely dissected, recently glaciated peneplain on crystalline rocks of complex structure.
Atlantic Plain	
2. Continental Shelf	2. Sloping submarine plain of sedimentation.
3. Coastal Plain	
a. Embayed section	3a. Submaturely dissected and partially submerged, terraced coastal plain.
b. Sea Island section	3b. Young to mature terraced coastal plain with submerged border.
c. Floridian section	3c. Young marine plain sandhills, swamps, sinks and lakes.
d. East Gulf Coastal Plain	3d. Young to old belted coastal plain
e. Mississippi Alluvial Plain	3e. Flood plain and delta
f. West Gulf Coastal Plain	3f. Young, grading inland to mature coastal plain.
Appalachian Highlands	
4. Piedmont Province	
a. Piedmont Upland	4a Submaturely dissected peneplain on disordered resistant rocks, moderate relief
b. Piedmont Lowlands	4b. Less uplifted peneplain on weak strata; residual ridges on igneous rocks
5. Blue Ridge Province	
a. Northern section	5a. Maturely dissected mountains of crystalline rocks; accordant altitudes.
b. Southern section	5b. Mature to subdued mountains of disordered crystalline rocks.
6. Ridge-and-Valley Province	
a. Tennessee section	6a Second-cycle mountains of folded strong and weak strata; valley belts predominating over even-crested ridges.
b. Middle section	6b. The same, but even-crested ridges predominate over valleys except on east side.
c. Hudson Valley	6c. Glaciated peneplain on weak folded strata.
7. St. Lawrence Valley.	
a. Champlain section	7a Rolling lowland, glaciated; in part covered by young marine plain.
b. Northern section	7b. Young marine plain with local rock hills
8. Appalachian Plateaux	
a. Mohawk section	8a. Maturely dissected, glaciated plateau; varied relief.
b. Catskill section	8b. Maturely dissected plateau of mountainous relief and coarse texture (glaciated).
c Glaciated Allegheny Plateau	8c. Mature glaciated plateau of moderate relief.
d Allegheny Mountain section	8d. Mature plateau of strong relief, some mountains due to erosion of open folds.
e Unglaciated Allegheny Plateau	8e. Mature plateau of fine texture, moderate to strong relief.
f. Cumberland plateau section	8f. Submaturely dissected plateau of moderate to strong relief.
g. Cumberland Mountain section	8g. Higher mature plateaux and mountain ridges on eroded open folds.
9. New England Province	
a. Seaboard Lowland	9a. Peneplains below 500 feet, past-maturely eroded and glaciated, few monadnocks.
b. New England Upland	9b Dissected and glaciated peneplains on complex structures; monadnocks.
c. White Mountain section	9c. Subdued and glaciated mountain masses of crystalline rock.
d. Green Mountain section	9d. Linear ranges of subdued and glaciated mountains and residual plateaux.
e. Taconic section	9e. Maturely dissected and glaciated mountains and peneplain on resistant folded strata.
10. Adirondack Province	10. Subdued mountains and dissected peneplain glaciated.
Interior Plains	
11. Interior Low Plateaux	
a. Highland Rim section	11a. Young to mature plateau of moderate relief.
b. Lexington Plain	11b. Peneplain on weak rocks; trenched by main rivers and locally dissected.
c. Nashville Basin	11c. Peneplain on weak rocks, slightly uplifted, moderately dissected.
d. Shawnee section	11d. Low, maturely dissected plateau with silt-filled valleys.
12. Central Lowland	
a. Great lake section	12a Maturely dissected and glaciated cuestas and lowlands; moraines, lakes, and lacustrine plains.
b Western Young Drift section	12b Young glaciated plain; moraines, lakes, and lacustrine plains.
c. Wisconsin Driftless section	12c. Maturely dissected plateau and lowland invaded by glacial outwash (Margin of old eroded drift included.)
d. Till Plains	12d. Young till plains, morainic topography rare; no lakes.
e. Dissected Till Plains	12e Submaturely to maturely eroded till plains.
f. Osage Plains	12f. Old scarped plains beveling faintly inclined strata; main streams entrenched.
13. Great Plains Province	
a. Missouri Plateau, glaciated	13a. Glaciated old plateaus; isolated mountains.
b. Missouri Plateau, unglaciated	13b. Old plateau, terrace lands, local badlands, isolated mountains
c. Black Hills	13c. Maturely dissected domed mountains.
d. High Plains	13d Broad inter-valley remnants of smooth fluviatile plains
e. Plains Border	13e. Submaturely to maturely dissected plateau
f. Colorado Piedmont	13f Late mature to old elevated plain
g. Raton section	13g. Trenched peneplain surmounted by dissected, lava-capped plateaux and buttes.
h. Pecos Valley	13h. Late mature to old plain.
i. Edwards Plateau	13i. Young plateau with mature margin of moderate to strong relief.
k. Central Texas section	13k. Plateau in maturity and later stages of erosion.

Table Showing the Physiographic Divisions of the United States—continued

Divisions	*Characteristics*
Interior Highlands	
14. Ozark Plateaux	
a Springfield-Salem plateaux	14a Submature to mature plateaux.
b. Boston "Mountains"	14b. Submature to mature plateau of strong relief.
15. Ouachita Province	
a. Arkansas Valley	15a. Gently folded strong and weak strata, peneplain with residual ridges
b. Ouachita Mountains	15b. Second-cycle mountains of folded strong and weak strata
Rocky Mountain System	
16. Southern Rocky Mountains	16. Complex mountains of various types; intermont basins.
17. Wyoming Basin	17 Elevated plains in various stages of erosion, isolated low mountains
18. Middle Rocky Mountains	18 Complex mountains, mainly anticlinal ranges, intermont basins
19. Northern Rocky Mountains	19 Deeply dissected mountain uplands, not anticlinal ranges, intermont basins.
Intermontane Plateaus	
20. Columbia Plateaux	
a. Walla Walla Plateau	20a. Rolling plateau with young incised valleys.
b. Blue Mountain section	20b. Complex mountains and dissected volcanic plateaux.
c. Payette section	20c. Young plateaus of prevailingly weak rocks; broad alluvial terraces. (Applies to northern part only.)
d. Snake River Plain	20d. Young lava plateau.
e. Harney section	20e. Young lava plateau, features of recent vulcanism; internal drainage.
21. Colorado Plateaux	
a. High Plateaus of Utah	21a. High block plateaux, in part lava-capped; include terraced plateaux on south side
b. Uinta Basin	21b Dissected plateau; strong relief.
c Canyon Lands	21c Young to mature canyoned plateaux, high relief.
d Navajo section	21d Young plateaux, smaller relief than 21c, into which it grades.
e Grand Canyon section	21e High block plateaux, trenched by Grand Canyon.
f. Datil section	21f. Lava flows entire or in remnants, volcanic necks.
22. Basin-and-Range Province	
a. Great Basin	22a. Isolated ranges (largely dissected fault blocks) separated by aggraded desert plains
b. Sonoran Desert	22b Widely separated short ranges in desert plains.
c. Salton Trough	22c Desert alluvial slopes and delta plain; Gulf of California
d Mexican Highland	22d. Isolated ranges (largely dissected block mountains) separated by desert plains
e. Sacramento section	22e. Mature block mountains of gentle dip; block plateaux, bolsons.
Pacific Mountain System	
23 Sierra-Cascade Mountains	
a. Northern Cascade Mountains	23a. Sharp alpine summits of accordant height; higher volcanic cones
b. Middle Cascade Mountains	23b. Generally accordant summits, higher volcanic cones.
c. Southern Cascade Mountains	23c. Volcanic mountains variously eroded, no very distinct range.
d. Sierra Nevada	23d. Block mountain range tilted westward, accordant crests; alpine peaks near east side.
24. Pacific Border Province	
a. Puget Trough	24a. Lowlands of diverse character; in part submerged.
b. Olympic Mountains.	24b. Generally accordant crests, local alpine peaks.
c. Oregon Coast Range	24c. Uplifted peneplain on weak rocks, dissected; monadnocks of igneous rock.
d. Klamath Mountains	24d. Uplifted and dissected peneplain on strong rocks; extensive monadnock ranges.
e. California Trough	24e. Low fluviatile plains.
f. California Coast Ranges	24f. Parallel ranges and valleys; on folded, faulted and metamorphosed strata, rounded crests of subequal height.
g. Los Angeles Ranges	24g. Uplifted fault blocks; alluviated lowlands
25. Lower Californian Province	25 Dissected west-sloping granite upland (in northern part).

North of Feather river the range changes completely. There is no evidence of uplift, only a piling up of volcanic materials from hundreds of vents. Lava flows, ash beds and cinder cones are of all ages from those that are fresh and shapely to others almost eroded away Mt Shasta with its beautiful cone (14,161 ft), and Lassen's peak, the only volcano in the country witnessed in action, belong to this southern section of the Cascades (23c) A little north of the Oregon boundary there is evidence that crustal uplift is added to volcanic accumulation Farther north the range owes its height more and more to uplift and less and less to the piling up of ejecta The volcanic cover gives out entirely in central Washington, north of which the Northern Cascade mountains (23a) consist of metamorphosed Paleozoic rocks and granite, intricately dissected into sharp peaks and ridges most of which, in a single view, rise to an almost uniform height The level thus determined varies from 6,000 to 8,500 ft., being gently arched. Above this nearly level horizon in both Oregon and Washington rise the isolated cones of extinct volcanoes 3,000 to 7,000 ft. higher. The best known are Mt. Rainier (14,408 ft.) in Washington and Mt Hood (11,245 ft) in Oregon. Crater lake in southern Oregon is the finest example of its class in America. It originated by the engulfment of the upper part of a volcano thus truncating the cone and leaving a pit 5 to 6 mi. in diameter at the water-level, which is here 6,117 ft high Above it the walls of the caldera rise 500 to 2,200 ft. and below it the basin is 2,000 ft. deep

Pacific Border.—The Pacific Border embraces a chain of coast ranges with long and important valleys between these and the Sierra-Cascade mountains. The most northerly range is the Olympic mountains (24b), not unlike the Northern Cascades but lower The Oregon Coast range (24c) is a gentle anticline of Tertiary beds, relatively recent in origin. It is succeeded on the south by the Klamath mountains, (24d), a range of long standing, consisting largely of metamorphosed Paleozoic rocks, once eroded down to a peneplain but uplifted again, locally as high as 7,000 ft , then deeply and ruggedly eroded. Most of the California coast is occupied by the California coast ranges (24f). These are relatively low mountains (generally between 2,000 and 4,000 ft.)

ranged in parallel ridges due largely to faulting of an earlier, much deformed and much worn down mountain belt Some broad valleys south of San Francisco are filled with late Tertiary sediments because of depression at that time. Still later the coast seems to have been depressed some 1,500 ft below its present level Shorelines etched against the mountain side are presented here and there at various levels between the sea and the 1,500 ft contour. As shown by these old shorelines, the depression that caused San Francisco bay is relatively recent.

Puget sound is the submerged northern end of a trough (242) 350 mi. long between the Cascades and the Coast range Its southern end is the valley of the Willamette, a southern tributary of the Columbia Some of the valleys in this long trough are agriculturally rich Commercially the region of the sound is favoured by its fine harbours and the four or more transcontinental railroads which these harbours have attracted The Great Valley of California (246) between the Coast range and the Sierra Nevada is 400 mi. long and 50 mi. wide In the upwarp of the adjacent mountain belts, this belt was bent down. As a consequence it was covered with the silt, sand and gravel washed from the mountain slopes. That deposition is still going on in the valley is evident from the habits of the two master streams, the Sacramento from the north and the San Joaquin from the south. These have small gradients and run between high natural levees; sandbars are abundant; at the head of San Francisco bay the two streams unite to build an extensive delta. The filling of the valley is mainly from the higher mountains on the east Deposition is in the form of alluvial fans which in the southern part have crowded the San Joaquin westward to the foot of the Coast range, the great alluvial fan of Kings river, extending across the valley, has cut off its southern third forming Tulare basin, partly occupied at times by a playa lake Here the climate is so arid that all inflow is evaporated and there is no drainage to the San Joaquin. Irrigation is highly developed, especially in the more arid southern half on the great alluvial fans. Fruits, nuts and raisins are the chief products.

The Sierra Nevada and the Great Valley extend south to latitude 35° beyond which there are ranges trending nearly east-west from the Mojave desert to the Pacific. The famous fruit-growing lowlands of California lie mainly farther south. The Gulf of California occupies a down-warped trough similar to the Great Valley In recent geologic time the gulf reached 150 mi farther north. This extension was cut off by the delta of the Colorado river and its waters evaporated. It is now the basin of the Salton Sink, still in part below sea level and known, where irrigated, as the rich Imperial Valley.

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II. GEOLOGY

The surface of North America, like that of all continents, stands two to three miles above adjacent ocean floors and apparently has so stood during the 2,000,000,000 years of its recorded history. Variations from time to time in ocean basin capacity, in oceanic volume and in relief of the continent's surface have, however, produced great variations in the amount of continental surface emerging as land above ocean levels. Shallow seas comparable to Hudson bay (average depth 200 ft.) have repeatedly spread over large fractions of the North American continental platform, leaving their record in limestone, shale and sandstone sediments with entombed remains of the marine life of the time. Repeatedly, also, these shallow marine floodings have been withdrawn and the destructive processes of weathering and erosion from exposure to the atmosphere have attacked the land areas, destroying part of the earlier sedimentary record. Thus marine deposits made during the next time of flooding have come to lie unconformably on the eroded surfaces of older deposits, the unconformity being essentially the land surface at the close of the intervening time of emergence. Elsewhere, large areas remained above sea level and experienced only erosion while the marine transgressions were occurring.

None of the marine submergences duplicated any other, yet the deciphered history shows that the continent possessed certain recurring lineaments, the invading seas early taking possession of linear tracts (geosynclines), subparallel to the eastern, western and southern continental margins and lingering there when marine withdrawals were occurring. Other negative areas (epicontinental, epeiric shelf) were more briefly inundated and certain tracts (shields, geanticlines, positive areas, kratons) repeatedly, although not invariably, escaped even the maximum floodings.

These alternating experiences of the continental surface, largely constructional when beneath epicontinental or geosynclinal seas and largely destructional when exposed to the atmosphere, constitute the framework of its geological history. The correlation of successive similar events in widely separated regions is possible because of the concomitant progressive evolutionary changes which the embedded fossils, chiefly marine invertebrates, in the sedimentary rocks record.

Based on the stratified sediments and their fossils, on the interrupting unconformities and on evidence for successive times of mountain making (orogeny) and igneous activity, most geologists have adopted a classification of four great eras of earth history, subdivided into about 15 periods The terms for these divisions of earth history used herein are those commonly accepted in the United States and Canada.

The Pre-Cambrian Era.—This slightly awkward term springs from two facts. One is that Cambrian sedimentary rocks, the oldest in the record of the succeeding Palaeozoic era, are also the oldest rocks with a good record of abundant and varied organisms. Pre-Cambrian rocks have only very rare showings of organic structures. The other fact is that these pre-Cambrian rocks have been so tremendously disordered and metamorphosed by orogenic movements and so extensively intruded by igneous invasions from below that the number of years actually involved in making them is unknown. In most geological literature two such eras are specified, Archaeozoic and Proterozoic, but the distinctions of dominantly igneous origin of the Archaeozoic rocks and dominantly sedimentary origin for the Proterozoic rocks has proved in later studies to be inapplicable and the terms are being abandoned.

Theoretically the rocks made during this earliest era of earth history underlie all younger rocks Large areas also exist where there is no cover of later deposits, either because one was never made or because erosion destroyed any cover once existing In the United States all exposed Pre-Cambrian rocks belong to the second group and owe their present position to the occurrence of orogenic deformations in later geological time and the inescapable consequence of such uplifts: destructive erosion. Indeed, the largest of these areas, in northern Minnesota, Wisconsin and Michigan, has virtually lost the mountains themselves, only a few residual hills surviving the reduction of former massive ranges to a peneplained area of low relief. Traced northward into Canada, this tract about the west end of Lake Superior broadens into a great expanse of uncovered Pre-Cambrian rocks, occupying almost all of the provinces of Quebec and Labrador, and most of Manitoba, Ontario, the Northwest Territories and Baffin Island. This, the Canadian shield, is North America's greatest positive area. Some of it may never have been submerged in any later time; most of it has certainly had but slight and geologically short-lived sedimentary cover.

The Piedmont plateau and Great Smoky mountains, lying west of the Atlantic coastal plain, are portions of a smaller positive area (Appalachia) composed largely of Pre-Cambrian rocks The Adirondack mountains of New York, the Green mountains of Vermont and the White mountains of New Hampshire are, despite their magnitude as topographic eminences, only the Pre-Cambrian core rock of former ranges whose folded and faulted structures indicate the way such cores have been forced locally higher than the surrounding "basement" rocks still covered by perhaps a mile of later formations. Small and isolated outcrops of Pre-Cambrian rocks in the central lowlands and Great Plains are the St. Francis mountains of Missouri, the central part of the Black hills of South Dakota, tracts in southwestern Minnesota and adjacent South Dakota, the Wichita and Arbuckle mountains

of Oklahoma and the Llano uplift of central Texas In the Rocky mountain system many ranges possess exposed Pre-Cambrian core rock, the uplift and erosional uncovering of which is in general of later date than in the eastern occurrences noted Some basin range mountains, particularly in Arizona and adjacent California, are similar in this respect. The mile-deep Grand canyon of the Colorado was cut down into the Pre-Cambrian basement which here is under a thick plateau cover of flat-lying younger rocks.

Most of these ancient rocks have suffered great metamorphic alteration under repeated high compressions and temperatures during past orogenies. Prevailingly, the high-angle foliation of schists and slates, from growth of platy mineral crystals oriented at right angles to the lateral pressures, largely obliterated original stratification and possible organic records. Little success attended attempts at correlation of formations, orogenies and erosion cycles of widely separated regions. Even unravelling the stratigraphic succession in any one region is difficult The most nearly satisfactory classification is for the Canadian shield where four systems of sedimentary rocks and contemporaneous lava flows were deposited, each time of deposition being terminated by orogenic deformation and associated granitic intrusions, and each orogeny followed by erosion so long continued that the newly made mountains were virtually wiped off the face of the earth and a peneplain left truncating the profoundly altered roots of those vanished ranges Unconformably on such peneplaned surfaces were deposited the sediments of the next following submergence.

Later Pre-Cambrian rocks in the southern part of the Canadian shield record glaciation by an ice sheet nearly 1,000 mi. across Elsewhere and at other times, aridity seems recorded. Whatever organisms existed, as they assuredly did, were marine aquatic forms, little affected by climates of the land areas Seaweed vegetation that secreted calcium carbonate is on record. Animals allied to sponges, worms, corals and crustaceans existed but left very few fossil traces, chiefly because of lack of hard parts Abundant disseminated graphite in some Pre-Cambrian metasedimentary rocks is accepted as derived from organic carbon.

The pre-eminence of the United States in manufacture of steel is in part the result of the enormous Pre-Cambrian iron ore deposits (altered ferruginous sediments) of the Lake Superior region. The great native copper-mining district of the Keweenaw peninsula, Mich., is developed in lavas and conglomerates of late Pre-Cambrian age, the metal having been deposited in cavities by thermal water rising from deep-seated magma bodies.

Pre-Cambrian time was tremendously long. Perhaps three-fourths of all recorded earth history occurred before the Cambrian seas with their abundant population of marine invertebrates transgressed the continents Reckoned from the radioactive disintegration of uranium and thorium minerals of the oldest Pre-Cambrian igneous rock studied, their intrusion, cooling and crystallization occurred 2,300,000,000 years ago And the Pre-Cambrian rock which received the intrusion was already in existence.

The Palaeozoic Era.—The pattern for North American positive and negative areas for Pre-Cambrian time is known only in fragments and traces. The Palaeozoic record, however, is sufficiently well-preserved that generalized maps of the land and water areas of the continent may be made, not only for each of the six periods but for different epochs during the advance, the maximum spread and the retreat of each marine flooding. Four persistently positive areas are known The Canadian shield, nearly 2,000,000 sq mi in area, was the largest. It still exists with only Hudson bay submerging a relatively small part of it Appalachia lay along the Atlantic seaboard, reaching from the Canadian maritime provinces southwestward to Georgia and Alabama, and extending an unknown distance eastward beyond the present continental margin. Llanoria lay to the south and largely subsided during later time into the depths of the present Gulf of Mexico. Cascadia, along the Pacific coast, similarly vanished.

Parallel and close to the inner margins of these positive areas lay three geosynclines or repeatedly subsiding troughs, the Appalachian geosyncline where now are the Appalachian mountains, the nearly east-west Ouachita geosyncline across Oklahoma, Texas and northern Mexico, and the Cordilleran geosyncline reaching from the Gulf of California northward across Nevada, Utah, Idaho and British Columbia The thick and relatively coarse detrital sediments deposited in them (now exposed in eroded mountain structures) are in contrast with the much thinner, finer-textured and largely calcareous deposits made contemporaneously in the broad shallow epeiric seas of the continental interior. Obviously, the thick trough fillings of shallow water deposits record repeated subsidences in the geosynclines as aggradation continued The coarseness indicates derivation from closely adjacent positive areas Repeated risings in those land areas, either as mountainous uplifts or broad warpings, are also required to account for the enormous thicknesses of land waste in the trough sediments The Appalachian geosyncline received from 30,000 to 50,000 ft. of Palaeozoic deposits.

Cambrian Period.—During early Cambrian time, marine overlap on the continent was limited to the Appalachian and Cordilleran geosynclines. By the middle of the period, the sea had spread across the interior also and aquatic forms could pass from the Atlantic to the Pacific. At least 30% of the continent was then below sea level The dominant limestone and dolomite formations of the middle Cambrian Age were derived largely from calcareous tests and shells of inconceivable numbers of middle Cambrian marine invertebrates Late Cambrian time witnessed a gradual withdrawal of this epicontinental flooding but, for the first time, the Ouachita geosyncline appeared in the history.

This is a generalized statement of events, the like of which were occurring in other continents as well during the more than 70,000,000 years of Cambrian time. Minor fluctuations of the sea level and warpings of the continent make a more complicated history than can be outlined here The period was brought to a close by an almost complete emergence of all continents, perhaps because of a deepening of the ocean basins The newly exposed Cambrian deposits thereupon suffered some erosion before the return of the sea in the next submergence Because no mountain folding occurred in North America during this emergent interval and therefore erosion could not bite deeply into the new land, most of the Cambrian sediments survived to become buried later beneath Ordovician and younger deposits.

Cambrian time is noteworthy for the spectacular appearance in the fossil record of almost all invertebrate phyla. Evolutionary changes that occurred during the Cambrian provide us with "index fossils," certain species which lived only during the early, middle or late Cambrian. There were even more extinctions of old and appearances of new forms during the interval following the withdrawal of Cambrian waters and preceding the advance of the Ordovician seas

Ordovician Period.—The relatively shallow epicontinental seas, returning to inaugurate the Ordovician period, first entered the geosynclinal troughs, later spread from the arctic to the Gulf of Mexico in the greatest submergence the continent has ever had. The remaining land areas, scarcely half of North America's total area, were low-lying islands which determined the shifting outlines of embayments and supplied detritus, chiefly fine-grained, to their associated basins. Dominantly the basins received organically derived calcium carbonate, hence the large proportion of limestone and dolomite in the record.

Several low domes (Cincinnati-Nashville, Ozark, etc) with intervening saucerlike basins (Michigan, Illinois) were prominent in the Ordovician palaeogeography. The domes (or arches) were repeatedly submerged and emerged, as numerous discontinuities in their stratigraphic sequences show, while the basins were undergoing more nearly continuous sedimentation.

The fossil record tells of different immigrations at different times into the shifting epeiric seaways from bordering oceans.

Crustal disturbances in northern Appalachia, chiefly during the late Ordovician, culminated in close folding, thrust faulting, mountainous uplifts and volcanic activity Interbedding of lava flows and volcanic ash beds (bentonite) with Ordovician marine deposits are part of this record So are the coarse nonmarine clastics in the nearby Appalachian geosyncline.

Insofar as the deposits tell of climate, there could not have

been a zonation like that of the present earth for some coral species ranged in latitude from the southern United States north into arctic Canada and even Greenland Only wide and equably distributed mild temperatures of the epicontinental waters can account for this

Ordovician rocks have yielded immense quantities of petroleum and natural gas, in Ohio for a decade or so before 1900 and in Oklahoma and adjacent Texas beginning about 1920. Most roofing slate quarried in the United States comes from metamorphosed Ordovician shales in the northern part of the Appalachian geosyncline Most decorative marbles of domestic origin are secured from altered Ordovician limestones in the same great trough of sedimentation. The Illinois-Wisconsin-Iowa lead- and zinc-mining district is developed in mid-continent Ordovician sediments; the sulphide ores, however, postdating the host rock

Duration of the Ordovician period appears to have nearly equalled that of the Cambrian

Silurian Period.—The stratification of most Silurian rocks in the United States parallels that of the subjacent Ordovician formations. But the differences in fossil fauna below and above the contact indicate a considerable time of emergence (a hiatus or lost interval) when the Ordovician marine forms had been forced to retreat to already populated continental margins and were there crowded into intense competition for living room and food. Evolutionary changes in marine life during all such emergences were maximal, both in extinctions and in appearance of new forms.

The Silurian record, like the Cambrian and the Ordovician, tells of slow and irregular advance of the sea into the geosynclines and epicontinental areas, interrupted at least twice by emergences suggesting those greater ones which geologists use for delimiting periods The early Silurian transgression entered the United States along the Appalachian geosyncline and spread westward across part of the central lowlands and into the Great Plains along the Ouachita trough. By middle Silurian time, the sea had spread over the Great Lakes region and northward to reach the arctic, actually lapping over on parts of that great positive area, the Canadian shield In late Silurian time, restriction and dismemberment of the epicontinental seas left a relict "dead sea" in the Great Lakes region. In it, immense quantities of salt were deposited, along with much gypsum and associated marine sediments. This huge evaporation pan must have had a connection with the sea by which it became replenished at intervals with more salt water. By this time, also, the late Ordovician mountains above noted had been so reduced by erosion that the sea overlapped the disordered strata of their stumps and buried them beneath late Silurian sediments.

There is scarcely a more striking feature of any Palaeozoic period's history than that of the middle Silurian mid-continent archipelago of "coral" reefs. Dozens are known in outcrops and quarries of Niagaran (mid-Silurian) strata in Indiana, Illinois, Iowa, Wisconsin and Canada. Their wide range in latitude indicates the nonzonal character of the mid-Silurian climate, just as the late Silurian salt and gypsum record at least a local aridity.

In addition to the great salt reserves, early middle Silurian rocks along the Appalachian trough contain a sedimentary iron ore, basis of the Birmingham, Ala , iron-mining and steelmaking district.

The 30,000,000 years of Silurian time closed quietly in North America although in high northern latitudes of all continents, one of the great mountain-making events of earth history occurred. Vulcanism of late Silurian age occurred in Maine and adjacent Canada

Devonian Period.—The marine withdrawal and continental emergence, conventionally chosen for subdividing geological time, was incomplete in parts of the Appalachian geosyncline for the Silurian-Devonian interval, sedimentation and a faunal record bridging the gap left elsewhere by the unconformity between the two systems. Indeed, only this trough of sedimentation seems to have gone below sea level during the entire early Devonian. By the middle of the period, overflow had submerged the Great Lakes region and a much more extensive flooding had advanced southward from the arctic, skirting the Canadian shield and reaching the upper Mississippi valley. It also connected with marine water in the Cordilleran geosyncline and so remained until the end of the period. The eastern and western seas were joined across the continental interior briefly but long enough for mingling of arctic and low latitude organisms

By the middle of Devonian time, mountains were again growing in northern Appalachia, the early Devonian deposits deformed in their making but the late Devonian sediments unaffected. The tremendous quantities of coarse waste deposited in the adjacent Appalachian trough testify to the rapid growth of a lofty range

In the evolution of living forms, the Devonian probably ranks next to the Cambrian in importance for at this time begins the record of life on land and in fresh water. The first known air-breathing vertebrates (Amphibia) and a great variety of primitive fishes appeared The oldest known land plants, some with trunks 40 ft. long, are buried in middle Devonian nonmarine deposits of southeastern New York Favouring climates appear to have prevailed, both on land and on the northern shallow seas.

Mississippian Period.—All the familiar seaways of the continent, excepting the northern part of the Appalachian geosyncline, were occupied during this period, the invasion following the familiar plan of an early possession of the great troughs and a later shallow spreading over the continental interior The northern Appalachian geosyncline trapped great thicknesses of waste from renewed upbowing of the middle Devonian mountains but, like most of late Devonian sedimentation there, the subsiding trough was kept filled above sea level and the deposits were nonmarine. Erosion to the penultimate stage of peneplanation had preceded the Mississippian marine encroachments and the invading seas spread so widely over this lowland that their deposits lie in places on all older systems, even Pre-Cambrian. Apparently Appalachia and Llanoria were one continuous land mass, the sea with its fauna entering from the arctic, Pacific and western Gulf of Mexico. Hundreds of feet of limestones characterized the interior deposits; thousands of feet of more largely clastic rocks were laid down in the troughs adjacent to Llanoria and Appalachia. Either late in Mississippian time or early in the Pennsylvanian period, much crustal unrest occurred in these margining lands and the deformations were extended to sediments in the troughs Other unrest occurred in the interior, Upper Mississippian formations in Illinois recording eight successive brief withdrawings and returnings of the sea.

Mississippian time, 30,000,000 years long, saw the beginnings of that very extensive swampiness which, for an equal length of time, characterized much of the continent during the following period. Commercial coal of Mississippian age occurs in Virginia. A later mineralization was responsible for the Missouri-Oklahoma-Kansas lead- and zinc-mining district in Mississippian rocks

Pennsylvanian Period.—Except for mountainous Llanoria and Appalachia, the continent was a great flat lowland in opening Pennsylvanian time The habitually subsiding geosynclines first went below sea level but only the western one received marine deposits. The other two were filled as rapidly as they sank with waste from their high borderlands The Appalachian trough also received thick peaty accumulations made in immense swamps and now constituting the early Pennsylvanian coal beds of West Virginia and Alabama

In the middle Pennsylvanian, swamps had spread over much of the interior as well, and the enormous coal reserves of half a dozen central lowland states were being initiated. Repeatedly sea water inundated and was withdrawn from these swamps, leaving interbedded marine deposits and minor unconformities. Farther west, Pennsylvanian sediments are chiefly marine

Orogenic movements occurred in the United States, not only during initial Pennsylvanian stages but at different times and places throughout and at the close of the period Southern Oklahoma saw a northward thrusting from Llanoria into the Ouachita trough. Southwestern Texas and western Colorado had comparable deformations. These seem to have been forerunners of the enormous lateral squeezings of parts of the continent during the following period. Pronounced orogenies of late Pennsylvanian and

of Permian time occurred in most continents.

The great coal deposits, also made in other continents, bespeak a warm, humid, equable Pennsylvanian climate for most of the globe. The character of the plants and associated amphibians, insects, spiders and fresh-water clams and snails tells the same story. So do the high-latitude Pennsylvanian corals.

Permian Period.—Despite the orogenies noted, Pennsylvanian time passed into Permian without marked breaks of sedimentation in the geosynclines. It was not for long, however. By middle Permian time, the Appalachian trough had been completely filled and before the Palaeozoic era had closed, that incredible thickness of sediments (maximum, 50,000 ft.) had been crushed into longitudinal folds and thrust sheets of a great mountain range As a site of sedimentation, the geosyncline ceased to exist from that time on Lingering seas in Texas and New Mexico left a great limestone reef (Carlsbad) with adjoining salt pan lagoons and associated highly oxidized red sands and muds. Obviously the humid Pennsylvanian climate had been altered here to one of marked aridity. A "dead sea" finally came to exist in this region.

The Appalachian orogeny, styled a "revolution," culminated at the close of the period The 500 mi. of original width of the trough was squeezed into half of that. Restoration of the great folds indicates uplift of three or more miles The Ouachita geosyncline was also crushed from the south and the dominant folded mountain structures of Arkansas and adjacent Oklahoma were made. Without undergoing such marked orogeny, the Cordilleran geosynclinal region experienced considerable volcanic activity.

The greatest salt deposits of the world are in the Permian system. Associated gypsum and dune sand indicate an aridity exceeding that of today Not too surprisingly, another climatic consequence of the widespread emergence and uplift was glaciation on four continents, the vicinity of Boston, Mass , yielding a record for the United States.

As might be expected, great changes in the life of the earth resulted from these extreme geographic and climatic changes. The typical coal swamp plants were replaced by conifers and cycads. Reptiles took precedence over amphibians and among their varied forms was a group whose teeth, jaws and skulls foreshadowed the arrival of mammals in the Mesozoic era.

The Mesozoic Era.—The widespread mountain making, continental emergence, climatic rigours and biological changes of the Permian mark the close of the Palaeozoic era and the opening of succeeding Mesozoic time

Triassic Period.—The waning importance of Appalachia and Llanoria as positive areas and the elimination of their persistently subsiding bordering geosynclines left only the Cordilleran trough for marine sedimentation on the continent during the Triassic Interbedded with such marine deposits is much volcanic material. Eastward from this trough are interfingered nonmarine shales and sandstones, part of a great alluvial plain where now are the Rocky mountains, Colorado plateau and western Great Plains In the eastern United States, much of Triassic time was consumed in erosion of the newly made Appalachian mountains. Late in the period, tensional faulting made a series of elongated basins from North Carolina to Nova Scotia which were filled with nonmarine deposits and intercalated lava flows as rapidly as they were deepened At the close of the period, tilting and uplift gave this faulted region a mountainous aspect again.

During the Triassic appeared the great conifers of the Arizona petrified forest, nearly 200 ft. high. The small beginnings of the greatest land reptiles, the dinosaurs, date from this time. The sea also had its reptiles, the plesiosaurs and ichthyosaurs. True mammals, however, are not known from Triassic deposits.

Jurassic Period.—The marine Jurassic overlaps on United States territory were from the Pacific, arctic and Gulf, only the former enduring for the entire period. The arctic invasion reached as far south as Colorado and Utah late in Jurassic time; the Gulf invasion (reaching north to Arkansas) did not begin until late in the period. Vigorous vulcanism, some of it submarine, accompanied marine sedimentation in the west. The arctic embayment was long and narrow. During the next period it developed into a new geosyncline which, in the end, suffered the fate of all subsiding troughs with excessively thick sediments; it was crushed into a mountain system, the Rocky mountains. Much Jurassic nonmarine deposition also occurred in the western states, thick dune sand formations dovetailing with marine beds.

Orogeny which deformed and metamorphosed the thick western sediments at about the period's end was accompanied by enormous granitic intrusions, reminiscent of similar Pre-Cambrian events. The California "Mother lode" and the Nevada Comstock lode date from this igneous activity It was modern stream waste from erosion of the Mother lode (placers) which gave California the gold rush of 1849

Nonmarine Jurassic deposits have yielded skeletons of almost unbelievably huge dinosaurs. A new reptilian venture was the pterosaur, a flying saurian The first birds appeared (no remains known in America at mid-20th century) and, most significant, the first mammals Small but agile, they lived successfully with the enormous dinosaurs in Wyoming and vicinity.

Cretaceous Period.—The last great submergence of North America marks the last period of the Mesozoic era The world over, Cretaceous seas probably submerged more continental surface than any previous flood had ever done. In a pulsatory fashion western Gulf water advanced northward to meet arctic water, forming a huge mediterranean sea by the middle of the period Marginal overlap by Atlantic and Pacific water indicated the final disappearance of Appalachia and Llanoria as borderlands The eastern Gulf reached north to the southern tip of Illinois.

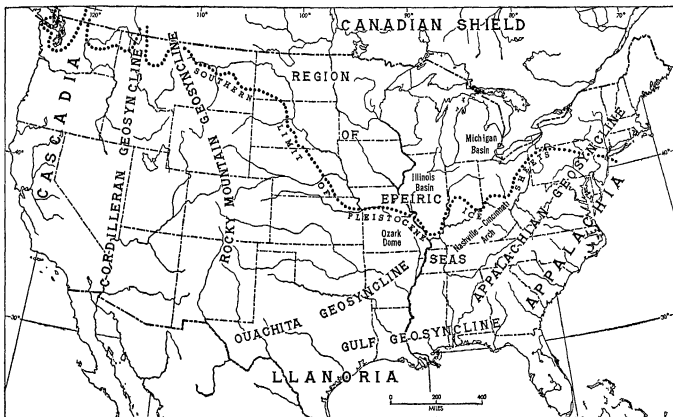
This North American mediterranean occupied the Rocky mountain geosyncline and its sediments, mostly clastics from the late Jurassic mountains to the west, eventually obliterated the seaway and made another great alluvial lowland with swamps and sluggish streams. The late Cretaceous coal beds of this part of the United States are second only to the Pennsylvanian coal reserves.

Major orogeny again followed thick sedimentation in a subsiding trough. Thrusting from the west at the end of Cretaceous time compressed the weak Cretaceous strata and all subjacent rocks into uplifted folds and fault blocks along the entire length of this geosyncline. The making of the Rocky mountain system, coinciding with that of other systems on other continents, is therefore the time marker for closing the Mesozoic era and opening the Cenozoic.

In plant evolution, Cretaceous time saw the appearance of angiosperms (plants with covered seeds), dominant among land plants ever since. The reptilian horde reached its climax and gave place, following the Rocky mountain revolution, to mammals of almost all existing orders. From the variety of land-living organisms and the known palaeogeography, Cretaceous climates are judged to have been about as diversified as those of today

The Cenozoic Era.—Almost all landscapes of the world, whatever their character, are products of Cenozoic events. In the United States existing mountain ranges are Cenozoic uplifts, most of them along the axes of earlier orogenies. Most of them have summit flats or accordances, surviving from a peneplanation that had destroyed earlier deformative uplifts. Plateaus are broad uplifts with little deformation or are lava-flooded areas All volcanic cones of the country are Cenozoic growths The great drainage systems were outlined and developed during this era, as were all coast lines. The monotonous plains are determined by Cenozoic stream and coastal deposits, the debris derived from destruction of the late Mesozoic and early Cenozoic highlands All lake country in the northern states records a late Cenozoic ice-sheet glaciation. All soils and subsoils are Cenozoic in age. Almost all existing exposures of older rocks are the result of the vigorous erosion of Cenozoic time. Most of these features are consequences of crustal movements which produced at the maximum as emergent a condition and as great a relief as the continent has ever had.

The two Cenozoic periods are differentiated on the basis of climate, the coming of the "Ice Age" closing the Tertiary and inaugurating the Quaternary. Marine overlaps were limited to coastal lowlands and the lower Mississippi valley. Cenozoic formations therefore are largely nonmarine deposits occupying intermontane basins and piedmont areas. The life record thus is



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GEOLOGICAL MAP OF THE UNITED STATES

largely of land animals and plants

The story of Cenozoic erosion, generalized, is that of the reduction of early highlands to worn-down peneplains which truncated the stumps of the newly made Rockies and the rejuvenated Appalachians and are recognizable even in the landscapes of the Appalachian plateaus and the central lowlands. Several times of renewed uplift interrupted this erosion and complicated the record with successive partial peneplains whose remnants today constitute accordant summits and steplike erosional flats at lower altitudes Rivers came to flow across such base-levelled surfaces without respect to hard or soft rocks below their valley bottoms In later uplifts many hard rock crossings have become spectacular water gap canyons in all areas of pre-Cenozoic folding and faulting. Other canyons are due to physiographic youth alone. Quaternary glaciers aided in the deep sculpturing of many western mountain ranges. The submerged continental shelf is notched by submarine canyons that seem to date from greatly lowered ocean levels at times during the era Elevated shore lines tell of other times when the ocean level was higher even than now.

Cenozoic deposits made by streams, wind and glacial ice and in lakes of closed basins are limited to favourable places, are very diverse in character, and in many cases are difficult to correlate. Particularly difficult has been the correlation of coastal marine sediments with the intermontane, although each class possesses a wealth of palaeontologic material.

The Gulf coast Tertiary rocks have been penetrated from below by a large number of cylindrical salt domes or plugs, the salt derived from older rocks and forced upward "like grease in a grease gun" (R. C. Moore) at weaker points. Another noteworthy feature of the Gulf coast is an actively subsiding structural and sedimentational trough across southern Louisiana, known from well logs to contain Tertiary sediments twice as thick as the Gulf is deep. It is pointed out as a modern geosyncline.

Cenozoic vulcanism was most marked in the Pacific border states where a row of towering cones surmounts the Cascade range and where the Columbia plateau of nearly horizontal lava flows covers about 200,000 sq.mi. Yellowstone park plateau is another well-known area of late Cenozoic vulcanism, its geysers testifying to hot rock at no great depth.

An orogeny which is still continuing began in middle Tertiary time Most of the displacements were by faulting and occurred (and still are occurring) along the west coast. A continental uplift throughout the country seems to have been contemporaneous with this

Of much significance to human occupation was the extensive continental glaciation in Quaternary time Canada, the source area of the great ice sheet, four times sent its marginal overflow south into the Great Lakes and central lowlands region, and four times was melted back in the as yet unexplained climatic oscillations. The interglacial stages had climates as mild as, even milder than, that of the present The Ohio and Missouri river courses were determined by these encroachments of glacial ice, the Great Lakes basins outlined and the cover of "drift" deposited over the region invaded. Outwash gravel and sand is traceable down the Mississippi to within 150 mi of the Gulf. Dust blown off these outwash tracts settled on drift-covered and driftless areas alike to constitute the fertile loess soils of Mississippi valley states. The ice-weighted part of the continent sank under its load and is still slowly rising from removal of that load Perhaps 1,000,000 years would measure the glacial experience. The entire era was about 60 to 70 times as long.

The present forests of deciduous trees were already outlined at the close of Mesozoic time. Grasses possessed the Cenozoic subhumid plains. Herbivorous mammalian evolution responded to the new food plants and carnivorous mammals swarmed to prey on the herbivores. Migration from other continents brought many kinds to North America, other kinds evolved here and spread to South America and the eastern hemisphere Land bridges for such migrations, presumably in high latitudes, were essential. Extinctions of earlier mammals went along with appearance and deployment of newer types. The Tertiary record of these faunal changes is wonderfully detailed and diversified Early human cultures arrived from Eurasia late in the Quaternary period, charcoal

and flint implements being far more numerous, however, than skeletal remains.

To the igneous and crustal activity of Cenozoic time are due most of the metalliferous veins of the western states. Some of the large oil pools of the United States are found in Cenozoic sediments as are also the Pacific coast coal deposits and the "bench" placers in California.

BIBLIOGRAPHY.—Two authoritative texts with special treatment of the geology of the United States are R C Moore, *Introduction to Historical Geology* (1949), and Carl O Dunbar, *Historical Geology* (1949) Moore's book is somewhat more elementary but gives considerable attention to the evolution of life Voluminous geological reports and many maps have been issued by the U.S Geological Survey, and the geological surveys of most of the states. All publications on North American geology are elaborately cross-indexed in a series of bulletins of the U S. Geological Survey. (J H. Bz)

III. CLIMATE

The climate, or average weather, within the continental United States exhibits a wide diversity although the country lies almost wholly within the "prevailing westerly wind" belt The characteristics of this generally easterly drifting air are changed as the air crosses the continent; these modifications are caused by changes of latitude and altitude, proximity to oceans and their currents, ascent and descent of the air over high mountain barriers and flow across the low smooth interior Further, surges of polar and tropical air masses, and the several types of "storms" add their effects to increase the variety of climates. The effectiveness of each of these so-called controls differs from one place to another. However, there are wide areas within which the characteristics of temperature, precipitation, etc., are nearly similar, but are distinctly different from the characteristics of adjacent areas

Based solely on moisture characteristics, especially with respect to effectiveness on either native or cultivated vegetation, C. Warren Thornthwaite divided the United States into five climatic provinces· superhumid, humid, subhumid, semiarid and arid These provinces are large, may extend through a latitudinal range of 10° or more and may be subjected to alternating flows of polar *v.* tropical or marine *v* continental air masses. Though each province may experience rather wide variations in temperature, except on the highest mountains, at least three months or more of the year have temperatures conducive to plant growth

Superhumid Province.—This is found along the north Pacific coast inland to the crest of the Cascade mountains Precipitation varies from more than 30 to more than 150 in Winter is the distinct wet season, the precipitation being caused by frequent "cyclonic" storms which enter the United States in this latitude and by ascent of the wind up the Olympic, Cascade and Coastal ranges. In the mountains much of the precipitation falls as snow which may be 10 to 30 ft deep by the end of March. Summer is predominantly dry, most stations receiving less than one inch each summer month. So little precipitation falls during the summer that there is a distinct water deficiency despite the enormous surplus that falls in the rest of the year. Temperatures are relatively high during the winter rainy season, averaging about 40° F. at sea level—much higher than to the east at the same latitude The highest summer temperatures rarely reach 90° F. and the warmest month is much cooler than it is inland. This is the cloudiest region in the United States, 140 to 200 days overcast, but there may be more than 80 clear days, mostly in summer, each year. It is foggy in the summer along the immediate coast and in fall inland from the coast. It has fewer than ten thunderstorms per year.

Humid Province.—All of the United States east of a line from Lake Superior to the Texas coast and scattered small areas in the western mountains have adequate rainfall varying from not less than 30 in to slightly more than 50 in. per year It is nicely distributed for plant growth because the rainier season is in summer This seasonal distribution is the result of convectional showers "cyclonic" storms and thunderstorms the latter occur between 25 (northern part) and 80 (central Florida) times a year. Much of the winter precipitation is snow north of the Ohio river where it may cover the ground from 40 days to nearly 150 days (northern Michigan) Along the Gulf coast snow is rare. The average annual temperature is less than 40° F. in northern Minnesota but increases to 70° F along the Gulf coast and 75° F in southern Florida. In January the averages are 5° F., 55° F., and 70° F respectively. Arctic and polar air may flow easily and rapidly across this area, bringing "cold wave" temperatures in its wake Coldest observed are about −50° F in Minnesota, −20° F. in Tennessee, 0° F in northwest Florida, and 40° F in Key West In summer there is little difference from the northern part (65° F, July average) to the southern part (80° F) Except for southern Florida and eastern Maine, temperatures of 100° F., or higher have been observed everywhere in this province There are about 100 frost-free days in the north and about 300 along the Gulf coast Killing frosts may occur each year down to central Florida. Frost may penetrate the soil to depths of four to six feet in the north In general, there are from 100 to 140 clear and 100 to 140 overcast days each year except in Florida Dense fog is present from 5 to 30 times a year, chiefly in winter Prolonged drought in summer is rare, but "hot waves," caused by flows of warm and very moist air from the Gulf of Mexico, are frequent During the autumn months devastating hurricanes, with wind speeds up to 125 m.p.h. and torrential rain, may strike Florida or, less commonly, the Gulf coast.

Subhumid Province.—This province is a belt 300 to 500 mi wide to the west of the humid province. The western boundary is a north-south line from mid-North Dakota through Texas. Its position is more distant from moisture-bearing winds from the Gulf of Mexico and the Atlantic ocean and thus has less precipitation than the humid province From east to west the annual totals decrease from about 30 to 18 in. along the Canadian border and from more than 40 to about 25 in. in southern Texas The higher temperatures and greater evaporation in the south make the precipitation less effective for plant growth than it is to the north Most of the precipitation falls during the warmer half year, it is largely concentrated in the late spring-early summer months which is especially important for cereal crops. The amount of precipitation varies considerably; Richard J. Russell stated that along the east side 1 year in 20 is semiarid, whereas along the western boundary 10 years in 20 are semiarid Temperatures are strikingly continental; *i.e.*, cold in winter and hot in summer, and are quite similar to those of the western edge of the humid province. Rapid and large temperature changes are a winter characteristic with blizzards and cold waves in the north and "northers" in the south of frequent occurrence. In North Dakota temperatures of −50° F have been observed and in central Texas, 0° F. Summer temperatures are nearly the same from north to south despite the 25° difference of latitude. Highest temperatures recorded have been between 105° and 115° F. The frost-free season is the same as the western part of the humid province.

Semiarid Province.—West from the subhumid province to the eastern slope of the Rocky mountains is an unbroken belt, 300 to 500 mi. wide, from Mexico into Canada and much of the area between the Cascade-Sierra Nevada ranges and Rocky mountains which is the semiarid province. Most of it is higher than 3,000 ft above sea level. Being still farther removed from moist Gulf of Mexico and Atlantic air, and with only dry air from the Pacific reaching this area, there is still less rain and snow than to the east In northern Montana the annual average is about 12 in ; this increases to about 25 in. in the south of Texas Over the Great Plains the rainy season is late spring-early summer from convection and cyclonic storms. Much of the rain falls as intense showers with as much as one-third the annual amount falling in a single day; contrariwise, two, three or four months may pass without any rain Hail is frequent in spring and early summer. In the intermountain area the precipitation is more evenly spread throughout the year Twenty to 40 in. of snow may fall during the winter, but ordinarily does not remain long. Chinooks, warm, dry air descending on the lee (east) slope of the Rockies, are fairly frequent during the winter. Lowest winter temperatures have varied between −66° F. (Yellowstone park) and 10° F. (Texas) and highest summer temperatures have

ranged between 105° F and 115° F

The great valley of California, while having the same amount of rain as the Great Plains and Rocky mountain areas, is quite different in that almost no rain falls from May to September. Winter rain is caused by cyclonic storms and by ascent over mountains Summer drought is so long that nearly all crops must be irrigated. Summer temperatures closely approach those of the arid province Killing frosts occur regularly each year Snow, hail and thunderstorms are almost unknown at low altitudes and fog is a frequent winter phenomenon.

Arid Province.—This province is largely restricted to parts of Nevada, Utah, Arizona, New Mexico, southeast California and some of southwest Texas Precipitation is generally less than 10 in per year, most of which falls as showers during the summer The smallest annual average is 1 35 in. per year, at Greenland Ranch, Calif. Summer temperatures are so high, and hence evaporation is so great, that no cultivated crops can be raised without irrigation July averages about 80° F. and highest temperatures are well above 110° F On July 10, 1913, 134° F., second highest in the world, was recorded at Greenland Ranch. Winter averages well above freezing though frost may be expected during at least two months each year More than 200 clear days and 60 or less overcast days occur each year; Yuma, Ariz., averages more than 280 days clear and more than 90% of the total possible amount of sunshine Because of the clear dry air it is not uncommon for midafternoon temperatures to be 40° to 50° warmer than those at sunrise.

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(F. E. CH)

IV. FAUNA AND FLORA

Fauna.—The fauna of the United States includes most of the types of animals of temperate and arctic North America; indeed, when Alaska is included, the only conspicuous type missing is the musk ox of northeastern Canada, only lately extinct in Alaska and Eurasia. Only a very few properly tropical forms enter the limits of the United States. A few tropical frogs and snakes enter extreme southern Texas, and the American crocodile is present in southern Florida; the formerly more wide-ranging jaguar and ocelot are scarcely to be found north of the Rio Grande, though the common armadillo, which represents a distinctively South American group, has extended its range as far east as the Mississippi and north into Oklahoma. The treeless arctic tundra, where the subsoil remains frozen throughout the year, has striking circumpolar animals, like the lemmings, the ptarmigan, the arctic fox and the polar bear, all of which are little or not at all different from the corresponding forms in Siberia and Lapland The tundra proper enters the territory of the United States only in Alaska.

Excluding from consideration these tropical and arctic elements, the fauna of the United States falls into a well-marked pattern, associated with the more conspicuous botanical formations. The southeastern region of hardwood and pine, a rich mixed forest, extends somewhat beyond the Mississippi, contrasting sharply with the Sonoran desert of the southwest. The great central grasslands from the Dakotas to the Gulf contrast as sharply with the transcontinental coniferous forest at the north; this forest sends great "peninsulas" southward in the Appalachian and Rocky mountains, accompanied by northern types of animals.

The Rocky mountains, with other western ranges, supply a suitable environment for various rock-dwelling types, whose relatives are found in the mountain ranges of Eurasia. The more western ranges, the Cascades and the Sierra Nevada, and the Pacific coastal region, have a distinctive fauna with a mixture of unique elements and of forms related to those of the southeastern forest region The Pacific region has a varied flora, mostly sharply distinct from that of the southeastern forest

Arrangement of the account of the distribution of the fauna of the United States according to these regional provinces has the merit that it can be compared further with the distribution of insects and of other invertebrates, some of which may be expected to fall into the same patterns as the vertebrates, while others, with different modes or different ages of dispersal, will have geographic patterns of their own

The transcontinental zone of coniferous forest at the north, the taiga, and the tundra zone into which it merges at the northern limit of tree growth, are strikingly paralleled by similar zones in the Rockies and on Mt Washington in the east, where the area above timber line and below snow line is a kind of tundra, often with tundra animals like the ptarmigan and the white *Parnassius* butterflies, while the spruce and other conifers below timber line form a belt sharply set off from the grassland or hardwood forest or desert at still lower altitudes

A whole series of important types of animals spread beyond the limits of such regions or zones, sometimes over most of the continent. Aquatic animals, in particular, may live equally in forest and plains, in the Gulf states and at the Canadian border. Such widespread animals include the Virginia deer and black bear, the puma and bobcat, the otter and mink, and the beaver and muskrat. The distinctive coyote ranges over all of western North America and eastward to Wisconsin The larger gray wolf is found throughout the continent. The snapping turtle ranges from the Atlantic coast to the Rocky mountains.

At the north, in the coniferous forest zone, the relations of animals with European or Eurasian representatives are numerous and this zone, often referred to under the Siberian name of "taiga," is essentially also circumpolar. The relations are less close than in the arctic forms, but the American moose represents the Eurasian elk, and beaver, hare, red fox, otter, wolverine and wolf are equally familiar as names for recognizably related animals on the two sides of the Atlantic Even some fishes, like the whitefishes (Coregonidae), the yellow perch and the pike, exhibit this kind of old world-new world relation A distinctively American element in this taiga assemblage is supplied by the Canada porcupine.

The hardwood forest area of the east and the southeastern pinelands compose the most important of the faunal regions within the United States. A great variety of fishes, amphibians and reptiles of this region have related forms in eastern Asia, and this pattern of representation is likewise found in the flora. This area is rich in catfishes, minnows and suckers. The curious ganoid fishes, the bowfin and the gar, are ancient types. The "spoon-billed cat," a remarkable type of sturgeon in the lower Mississippi, is represented elsewhere in the world only in the Yangtze in China. The Appalachian region is headquarters for the salamanders of the world, with no less than seven of the eight families of this large group of amphibians represented; no other continent has more than three of the eight families together. The eel-like sirens and amphiumas are confined to the southeastern states The lungless salamanders of the family Plethodontidae exhibit a remarkable variety of genera and a number of species centring in the Appalachians. There is a great variety of frogs, and these include tree frogs of the genus *Hyla*, whose main development is South American and Australian. The emydid freshwater turtles of the southeast parallel those of eastern Asia to a remarkable degree, though the genus *Clemmys* is the only one represented in both regions. Much the same is true of the water snakes (*Natrix*), the pit vipers (*Ancistrodon*) and various other genera of snakes (*Elaphe, Opheodrys*), though still others are peculiarly American. The familiar alligator is a form with an Asiatic relative, the only other living true alligator being a species in

DISTRIBUTION OF THE MAIN TYPES OF NATURAL VEGETATION IN THE UNITED STATES. THE THREE MAJOR NATURAL DIVISIONS OF VEGETATION ARE FOREST, GRASSLAND AND DESERT SHRUB. THE FOREST FALLS INTO TWO CLEARLY MARKED REGIONS, WESTERN AND EASTERN. THE WESTERN REGION COMPRISES SEVEN LARGE FOREST SUBDIVISIONS AND TWO SUBDIVISIONS OF WOODLAND. THE EASTERN REGION COMPRISES NINE FOREST SUBDIVISIONS. FOUR-FIFTHS OF THE FOREST WAS ORIGINALLY IN THE EAST. OF THIS ORIGINAL FOREST THERE REMAINS NOW ONLY ABOUT 10 PER CENT IN VIRGIN CONDITION, 50 PER CENT HAS BEEN CUT OVER AND NOW GROWN UP TO TREES OF SUFFICIENT SIZE FOR SAW LOGS OR COMMERCIAL USE, AND ABOUT 10 PER CENT CUT OVER OR DEVASTATED BY FIRE AND REDUCED TO BRUSHLAND

central China.

In its mammals and birds the southeastern fauna is less sharply distinguished from the life to the north and west and is less directly related to that of eastern Asia The forest is (or was) the home of the Virginia deer, the black bear, the gray fox, the raccoon and the common opossum. The wild turkey and the only lately extinct hosts of the passenger pigeon were characteristic. There is a remarkable variety of woodpeckers. The bird life in general tends to differ from that of Eurasia in the presence of birds, like the tanagers, American orioles and hummingbirds, that belong to South American families. Small mammals abound with types of the world-wide rodent family Cricetidae, and with distinctive moles and shrews.

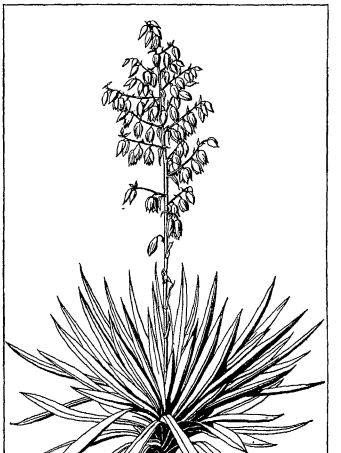
The western grasslands merge by insensible degrees into semi-desert and desert toward the great basin and the Sonoran desert. Most distinctive of the grassland animals proper is the American bison, whose nearly extinct European relative, the wisent, is found in the forest. The most distinctive of the American hoofed animals is the prongbuck, which represents a family intermediate between the deer and the true antelopes in that it sheds its horns like a deer but retains the bony horn cores. The prongbuck is perhaps primarily a desert mammal, but it formerly ranged widely into the short-grass plains. Everywhere in open country in the west there are conspicuous and distinctive rodents. The burrowing pocket gophers are peculiarly American, rarely to be seen, but making their presence known by their pushed-out mounds of earth. The ground squirrels of the genus *Citellus* are related to those of central Asia, and resemble them in habit; in North America the gregarious prairie dog is a closely related form. The American badger, not especially related to the badger of Europe, has its headquarters in the grasslands. The prairie chicken is a bird distinctive of the plains region, which is invaded everywhere by birds from both the east and the west.

The Sonoran desert of the southwest, which may be regarded as including southeastern California, southern Nevada and Arizona, a corner of Utah, parts of New Mexico and extreme western Texas, is a paradise for reptiles Distinctive lizards abound, and the rattlesnakes, of which only a few species are found elsewhere in the United States, have their headquarters there. Among lizards the poisonous Gila monster is wholly Sonoran, though with a Mexican relative, Sonoran types range to the Pacific coast and northward in the great basin. Noteworthy mammals are the graceful bipedal kangaroo rats (almost exclusively nocturnal), the ring-tailed cat, a relative of the raccoons, and the peccary.

The Rocky mountains and other western ranges afford distinctive habitats for rock and cliff dwelling hoofed animals and rodents. The little pikas, related to the rabbits, live in the rock-slides at high altitudes as they do in the mountain ranges of eastern Asia Marmots live in the Rockies as in the Alps. Every west American range formerly had its own race of mountain sheep. At the north the so-called Rocky mountain goat lives at high altitudes—it is more properly a goat antelope, related to the takin of the mountains of western China. The dipper, remarkable for its habit of feeding in swift-flowing streams, though otherwise a bird without special aquatic adaptations, is a Rocky mountain form with relatives in Asia and Europe

In the Pacific region, the extremely distinctive frog *Ascaphus*, which inhabits icy mountain brooks, represents a family of frogs by itself, perhaps more nearly related to the frogs of far-off New Zealand than to more familiar types. The Cascades and Sierras form centres for salamanders of the families Ambystomidae and Plethodontidae second only to the Appalachians, and there are also distinctive newts. The burrowing lizards, of the well-defined family Anniellidae, are found only in a limited area in coastal California. The only family of birds distinctive of North America, that of the wren tits, Chamaeidae, is found in the chaparral of California. The mountain beaver, *Aplodontia* (which is not at all beaverlike), is likewise a type peculiar to North America, confined to the Cascades and Sierras; and there are distinct kinds of moles in the Pacific area.

The mammals of the two coasts are strikingly different, though true seals (the harbour seal and the harp seal) are found on both The sea lions, with longer necks and with projecting ears, are found only in the Pacific—the California sea lion, the more northern Steller's sea lion and the fur seal The breeding rookeries of the latter are now confined to the Pribilof Islands in the Bering sea The Pacific walrus is distinctively a creature of the



SPANISH BAYONET (YUCCA GLORIOSA)

This handsome species of yucca, with a woody trunk sometimes 8 feet high and 6 inches in diameter, is native to sand dunes and sea beaches from North Carolina to Florida and bears in October immense clusters of large creamy-white flowers. Many species are widely cultivated in mild climates as garden ornamentals

Alaskan coastal waters. The Atlantic species does not range south of Greenland.

The larger rivers of Florida are inhabited by the Florida manatee or sea cow, a close relative of the more widespread and more distinctively marine West Indian species.

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Flora.—The dominant features of the flora of the United States are indicated by the terms forest, grassland, desert and alpine tundra. A coniferous forest of white and red pine, hemlock, spruce, jack pine and balsam fir extends interruptedly in a narrow strip near the Canadian border from Maine to Minnesota and southward along the Appalachian mountains Here may be found smaller stands of tamarack, spruce, paper birch, willow, alder and aspen or poplar. Southward, a transition zone of mixed conifers and deciduous trees gives way to a hardwood forest of broadleaved trees Thus forest, with varying mixtures of maple, oak, ash, locust, linden, sweet gum, walnut, hickory, sycamore, beech and the more southerly tulip tree, once extended uninterruptedly from New England to Missouri and eastern Texas. Pines are prominent on the Atlantic and Gulf coastal plain and adjacent uplands, often occurring in nearly pure stands called pine barrens. Pitch, longleaf, slash, shortleaf, Virginia and loblolly pines are most common Hickory and various oaks combine to form a significant part of this forest, with magnolia, white cedar and ash often seen In the frequent swamps, bald cypress, tupelo, white cedar and cane predominate. Pines, palmettos and live oaks are replaced at the southern tip of Florida by the more tropical royal and thatch palms, figs, satinwood and mangrove.

The grasslands occur principally in the Great Plains area and extend westward into the intermontane basins and benchlands of the Rocky mountains. Numerous grasses such as buffalo, grama, side oat, bunch, needle and wheat grass, together with many kinds of herbs, make up the plant cover. Coniferous forests cover the lesser mountains and high plateaus of the Rocky mountains, Cascades and Sierra Nevada. Yellow pine, Douglas fir, western larch, white pine, red cedar, lodgepole pine, several spruces, coast hemlock, grand fir, red fir and the lofty redwood are the principal trees of these forests The densest growth occurs west of the Cascade and Coast ranges in Washington, Oregon and northern California, where the trees are often 100 ft or more in height. Here the forest floor is so dark that only ferns, mosses and a few shade-loving shrubs and herbs may be found.

The alpine tundra, found in the United States only in the mountains above the limit of trees, consists principally of small plants that bloom brilliantly for a short season. Sagebrush is the most common plant of the arid basins and semideserts west of the Rocky mountains, but juniper, nut pine and mountain mahogany are often on the slopes and low ridges. The desert, extending from southeastern California to Texas, is noted for the many cacti, some of which grow to the height of trees; the joshua tree and other yuccas, creosote bush, mesquite and acacias.

The United States is rich in the variety of its native forest trees, some of which, as the species of sequoia, are the most massive known C. S. Sargent described 717 species, together with numerous varieties; G. B. Sudworth gave the names and geographical distribution of 1,177 species and varieties Of these, 182 are of economic value, either because of the timber and other useful products which they yield or by reason of their importance in forestry.

Besides the native flowering plants, estimated to comprise from 20,000 to 25,000 species, many hundreds of species, introduced from other regions—chiefly Europe, Asia and tropical America—have become naturalized. A large proportion of these are common annual weeds of fields, pastures and roadsides. In some districts these naturalized "aliens" comprise 50% or more of the total plant population. W. L. Jepson enumerated 4,019 species, of which 3,727 are native to the state (1,416 species endemic) and 292 (7%) naturalized from other regions. In the northeastern United States from Minnesota to Kansas and eastward the proportion of introduced species is much greater, *Gray's Manual of Botany* (1950) giving 7,135 species and varieties of which 5,912 are native and 1,223 (17%) introduced.

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(P H O; R C R)

V. POPULATION AND SOCIAL CONDITIONS

Geographical Growth of the Nation.—The achievement of independence found the people of the United States owning the entire country from the Gulf of Mexico to the Great Lakes, excepting Florida, as far west as the Mississippi river; but the actual settlements were, with a few minor exceptions, confined to a strip of territory along the Atlantic shore The depth of settlement, from the coast inland, varied greatly, ranging from what would be involved in the mere occupation of the shore for fishing purposes to a body of agricultural occupation extending back to the base of the great Atlantic chain, and averaging about 250 mi Westward, beyond the general line of continuous settlement were four extensions of population through as many gaps in the Appalachian barrier, constituting the four main paths along which migration westward first took place the Mohawk valley in New York; the upper Potomac—upper Ohio river connections; the Appalachian valley through southwestern Virginia into Tennessee; and, around the southern base of the Appalachian system. Four outlying groups beyond the mountains—one about Pittsburgh, one on the Great Kanawha river in West Virginia, one in northern Kentucky and the last along the Cumberland river in Tennessee—constituted perhaps a 20th part of the total population of the nation. Finally, there were in 1790 about a score of small trading and military posts, mainly of French origin, scattered over the then almost unbroken wilderness of the upper Mississippi valley and region of the Great Lakes.

The returns for the 17 decennial censuses of the United States are summarized in Table I.

TABLE I.—*Population of Continental United States*

Census years	Land area in square miles	Population	Decennial increase per cent	Population per square mile	Number of aliens admitted in preceding decade*
1790	867,980	3,929,214		4 5	—
1800 . .	867,980	5,308,483	35 1	6 1	—
1810	1,685,865	7,239,881	36 4	4.3	—
1820 . .	1,753,588	9,638,453	33.1	5.5	250,000†
1830 . .	1,753,588	12,866,020	33 5	7 3	151,824
1840 . .	1,751,588	17,069,453	32 7	9 7	599,125
1850 . .	2,944,337	23,191,876	35-9	7-9	1,713,251
1860 . .	2,973,965	31,443,321	35 6	10.6	2,598,214
1870 . .	2,973,965	39,818,449‡	26.6	13 0	2,314,824
1880 . .	2,973,965	50,155,783	26 0	16 9	2,812,191
1890 . .	2,973,965	62,947,714	25 5	21 2	5,246,613
1900 . .	2,974,159	75,994,575	20 7	25 6	3,687,564
1910 . .	2,973,890	91,972,266	21 0	30.9	8,795,386
1920 . .	2,973,776	105,710,620	14.9	35 5	5,735,811
1930 . .	2,973,776	122,775,046	16 1	41.2	4,107,209
1940 . .	2,977,128	131,669,275	7 2	44.2	528,431
1950 . .	2,974,725	150,697,361	14.5	50 7	1,035,039

*Figures represent number of immigrant aliens admitted, that is, gross immigration; deducting emigrant aliens departed, the net figure for the decade ending in 1910 are 5,167,504; for 1910–20, 3,588,827, for 1920–30, 3,062,233; for 1930–40, 68,693, and for 1940–50, 878,640

†Estimated total up to 1820.

‡Revised figure

Except for the isolated military or trading posts, which always preceded the settlement frontier, the population advanced across the prairie region of the midwest with a practically solid front until halted for a time at the eastern edge of the Great Plains. The north and the south sections of the country started out with population growths in the decade 1790–1800 very nearly equal (36 5% and 33.7%); but in every succeeding decade before the Civil War the rate of growth in the north was greater, and that of the south less, than its increment in the initial decade. In 1790 the two sections were almost of equal population; by 1800, the population of the north was practically double that of the south.

In the decade 1890–1900 the increase of the south exceeded slightly that of the north, because of the rapid development of the southern states west of the Mississippi, but in general the increase of the two sections thereafter was nearly equal

The temporary halt in the western advance at the edge of the Great Plains was caused by the comparative aridity of this region and the discovery of more desirable agricultural valleys and mineral wealth in the mountainous sections and Pacific coast states of the farther west Population, therefore, leaped over these more barren regions and formed in isolated islands beyond. The first of these overland migrations, which were to become a feature of American life in that generation, was the migration over the Oregon trail to the Oregon country (beginning 1832), the Mormon emigration to Utah (beginning 1847) and the gold rush to California, by sea and the Overland trail (beginning 1848). By the treaty of 1848, ending the war with Mexico, a number of old Spanish settlements in the southwest were added to the population. Discoveries of mineral wealth between 1858 and 1880 in Colorado, Nevada, Idaho, Montana and Wyoming created other isolated areas of settlement in these states which spread gradually into the more attractive agricultural valleys of the mountains. Between 1880 and 1890 a large part of the Great Plains was taken up. But a small portion of this region was used for farming purposes until after 1900 when the system of dry farming (*q v*) became generally known Settlement was then rapid up to the entrance of the United States into World War I, more land being settled than could be held during the period of agricultural depression which followed. Similarly the population of the mountain states to a large degree followed the rise or fall of prosperity in the mining industries, but the growth of agriculture in these states proved to be a stabilizing factor.

Growth of the Nation in Population.—Between 1790 and 1940 the population increased from 3,929,214 to 131,669,275, and then to 150,697,361 in 1950. The increase during the decade 1940–50 was thus 19,028,086, or more in absolute number than the increase in any earlier decade in the census history of the United States. On a percentage basis, the 1940–50 increase amounted to 14.5%, as compared with 7 2% between 1930 and 1940. The rate of increase, however, was lower than that in any census decade except the one just preceding. (*See* Table I) In 1800, every important European country, even including Spain and Turkey, exceeded the United States in population; in 1950, only the Union of Soviet Socialist Republics had a larger population (unofficially estimated at something over 200,000,000). The population of the United States in 1900 was more than 14 times as large as in 1800, while the population of Belgium, then the fastest growing of the European countries, had only a little more than doubled during this 100-year period. Natural increase, however, which in Europe was the only important source of population growth, was only one of several factors in the United States. There were also very large additions to the population through immigration and much less important gains through the annexation of territory.

In 1790 there were about 600,000 white families in the United States. Speaking broadly, there were few very rich and few very poor. Both the social traditions and the religious beliefs of the people encouraged fecundity. The land was largely unsettled, and conditions for almost 100 years were such as to encourage migration westward and the establishment of new families under pioneer conditions. Labour was scarce and even on the farm it was difficult to obtain hired help. Under these conditions, large families possessed a direct economic advantage Between 1790 and 1830 immigration contributed relatively little to the population increase of nearly 9,000,000, since the total immigration during this period was only about 250,000. The population increase, which amounted to about 34 5% per decade, was therefore mainly the result of the excess of births over deaths.

From 1830 to the Civil War the rate of increase in the total population of the country continued at the same rate as in the preceding 40 years, the decennial increase for the entire 70 years averaging 34.6% and in no case falling below 32.7%. But after 1830 an increasing proportion of this increase was the result of immigration, the accessions, especially in the decade 1840–50 from Ireland and Germany, being enormous, and the total immigration in that decade rising to 1,427,337 as compared with 538,-381 during the preceding decade. It would appear, therefore, that while the natural increase of the native population was actually slowing up, the heavy and increasing immigration concealed this from view at the time In 1850, 9.7% of the population was foreign-born, and in 1860, 13.2%.

The ten years from 1860 to 1870 witnessed the operation of the first great factor which reduced the rate of national increase, namely the Civil War. The superintendent of the ninth census, 1870, computed the effects of this cause, first, through direct losses, by wounds or disease, either in actual service of the army or navy, or in a brief term following discharge; secondly, through the retardation of the rate of increase in the Negro element caused by the privations, exposures and excesses attendant upon emancipation; thirdly, through the check given to immigration by the existence of the war; and finally, through the temporary reduction of the birth rate, resulting from the withdrawal of perhaps one-fourth of the national militia during four years—to be a loss to the population of 1870 of approximately 2,515,000.

The rate of population increase declined steadily from 26 6% in the decade 1860–70 to 20 7% in the last decade of the 19th century, though from 1900 to 1910 there was a slight rise to 21.0% resulting chiefly from a large immigration of 8,795,386 (net, 5,167,504). In the next decade, 1910 to 1920, the rate of growth dropped to 14.9%, with a net immigration of 3,588,817, and in the decade 1920 to 1930, with a net immigration of 3,062,-133, it increased somewhat to 16.1%. Between 1930 and 1940, the rate of increase was only 7 2%, or less than half the rate recorded in any earlier decade. This abrupt change was due in part to the practical cessation of immigration and in part to a continued rapid decline in the birth rate Between 1940 and 1950, however, the trend was reversed and the absolute number of persons added to the population of the United States was larger than in any earlier decade, though the rate of increase, 14.5%, or more than twice the 1930–40 rate, was still a bit smaller than the rate recorded for any of the pre-1930 decades Increased immigration (878,640, net) contributed a little to this more rapid growth, but the increase resulted in the main from unexpected increases in the numbers of births.

The causes of the decline in the rate of natural increase in the later decades have been a subject of much speculation by sociologists The decline was not peculiar to the United States, but was shared by practically all the industrialized countries in the world. It was not to be expected, of course, that the rate established from 1790 to 1830 by a vigorous and fertile race, in a new country endowed with tremendous natural resources, would continue indefinitely. Early in the 1870s Francis A. Walker, superintendent of the 1870 and 1880 censuses, upon noticing that in spite of increased immigration the population in 1860 was only 10,000 more than it would have been if the rate of natural increase up to 1830 had been maintained, expressed the opinion that the decline might be due to the "competitive shock" of immigration and that immigration had actually contributed little to the final total population but merely substituted foreign stock for native stock. A more generally accepted explanation, however, is that the decline in the rate of natural increase was due to industrial development and urbanization and the complex forces dependent upon these two. While large families are not so much of an economic asset, even in rural areas, as they were in the early days, they are at least less of an economic burden on the farms, where there is still much work that can profitably be done by the growing boys and girls, than in the cities, where almost everything that is used or enjoyed must be paid for in cash.

One other factor sometimes brought forward as an explanation of the decline in the birth rate is the growing tendency toward late marriages which seemed to prevail among the ambitious and intellectual classes. There is not much statistical support for the assumption of such a decline, however, since the percentage of the population married showed an almost continuous, though not rapid, increase from 1890 to 1940. In 1890, for example, 56.8%

TABLE II—*Population of the United States by Regions, Divisions and States*

Region, division and state	1950	1940	Increase 1940-50	Per cent of increase	
				1940-50	1930-40
United States	150,697,361	131,669,275	19,028,086	14·5	7·2
Regions					
Northeast	39,477,986	35,976,777	3,501,209	9·7	4·5
North central	44,460,762	40,143,332	4,317,430	10·8	4·0
South	47,197,088	41,665,901	5,531,187	13·3	10·1
West	19,561,525	13,883,265	5,678,260	40·9	16·7
Northeast:					
New England	9,314,453	8,437,390	877,163	10·4	3·3
Middle Atlantic	30,163,533	27,539,487	2,624,046	9·5	4·9
North central:					
East north central	30,399,368	26,626,342	3,773,026	14·2	5·3
West north central	14,061,394	13,516,990	544,404	4·0	1·7
South					
South Atlantic	21,182,335	17,823,151	3,359,184	18·8	12·9
East south central	11,477,181	10,778,225	698,956	6·5	9·0
West south central	14,537,572	13,064,525	1,473,047	11·3	7·3
West:					
Mountain	5,074,998	4,150,003	924,995	22·3	12·1
Pacific	14,486,527	9,733,262	4,753,265	48·8	18·8
New England.					
Maine	913,774	847,226	66,548	7·9	6·2
New Hampshire	533,242	491,524	41,718	8·5	5·0
Vermont	377,747	359,231	18,516	5·2	−0·1
Massachusetts	4,690,514	4,316,721	373,793	8·7	1·6
Rhode Island	792,896	713,346	79,550	11·2	3·8
Connecticut	2,007,280	1,760,442	246,838	14·0	8·4
Middle Atlantic					
New York	14,830,192	13,479,142	1,351,050	10·0	7·1
New Jersey	4,835,329	4,160,165	675,164	16·2	9·9
Pennsylvania	10,498,012	9,900,180	597,832	6·0	2·8
East north central					
Ohio	7,946,627	6,907,612	1,039,015	15·0	3·9
Indiana	3,934,224	3,427,796	506,428	14·8	5·8
Illinois	8,712,176	7,897,241	814,935	10·3	3·5
Michigan	6,371,766	5,256,106	1,115,660	21·2	8·3
Wisconsin	3,434,575	3,137,587	296,988	9·5	6·8
West north central					
Minnesota	2,982,483	2,792,300	190,183	6·8	8·9
Iowa	2,621,073	2,538,268	82,805	3·3	2·7
Missouri	3,954,653	3,784,664	169,989	4·5	4·3
North Dakota	619,636	641,935	−22,299	−3·5	−5·7
South Dakota	652,740	642,961	9,779	1·5	−7·2
Nebraska	1,325,510	1,315,834	9,676	0·7	−4·5
Kansas	1,905,299	1,801,028	104,271	5·8	−4·3
South Atlantic:					
Delaware	318,085	266,505	51,580	19·4	11·8
Maryland	2,343,001	1,821,244	521,757	28·6	11·6
District of Columbia	802,178	663,091	139,087	21·0	30·2
Virginia	3,318,680	2,677,773	640,907	23·9	10·6
West Virginia	2,005,552	1,901,974	103,578	5·4	10·0
North Carolina	4,061,929	3,571,623	490,306	13·7	12·7
South Carolina	2,117,027	1,899,804	217,223	11·4	9·3
Georgia	3,444,578	3,123,723	320,855	10·3	7·4
Florida	2,771,305	2,367,474	403,831	17·1	20·2
East south central					
Kentucky	2,944,806	2,845,627	99,179	3·5	8·8
Tennessee	3,291,718	2,915,841	375,877	12·9	11·4
Alabama	3,061,743	2,832,961	228,782	8·1	7·1
Mississippi	2,178,914	2,183,796	−4,882	−0·2	8·7
West south central					
Arkansas	1,909,511	1,949,387	−39,876	−2·0	5·1
Louisiana	2,683,516	2,363,880	319,636	13·5	12·5
Oklahoma	2,233,351	2,336,434	−103,083	−4·4	−2·5
Texas	7,711,194	6,414,824	1,296,370	20·2	10·1
Mountain:					
Montana	591,024	550,436	31,588	5·6	4·1
Idaho	588,637	524,873	63,764	12·1	17·9
Wyoming	290,529	250,742	39,787	15·9	11·2
Colorado	1,325,089	1,123,296	201,793	18·0	8·4
New Mexico	681,187	531,818	149,369	28·1	25·6
Arizona	749,587	499,261	250,326	50·1	14·6
Utah	688,862	550,310	138,552	25·2	8·4
Nevada	160,083	110,247	49,836	45·2	21·1
Pacific					
Washington	2,378,963	1,736,191	642,772	37·0	11·1
Oregon	1,521,341	1,089,684	431,657	39·6	14·7
California	10,586,223	6,907,387	3,678,836	53·3	21·7

of the female population 15 years old and over were married, in 1910, 58·9%, in 1930, 61·1% and in 1940 (at the close of the depression decade), 61·0%. During the next decade, however, this percentage increased greatly, standing in 1950 at about 66·8%, the official figure being 65·5% of the female population 14 years old and over

Mention is made in this connection also of the increase in the extent to which women, especially married women, are employed in a wide variety of business and professional pursuits. Here again, however, the change was most marked in the decade between 1940 and 1950. (*See* Table XIII below).

The much more rapid growth in population between 1940 and 1950 has already been noted. This increase in rate of growth was mainly the result of an unexpected increase in the birth rate (following a substantial increase in the marriage rate) The birth rate in 1920 (based on registered births) was 23·7; by 1930 the rate had declined to 18·9 and by 1933 to a minimum of 16·6, with slight fluctuations during the rest of the decade. A rate of 17·9 was recorded in 1940 The increases from that time on were rather rapid, with a high point of 21·5 in 1943 and then 23·3 in 1946, and a maximum of 25·8 in 1947, from which time to 1950 there was only a small decline. During the same period the death rate had gone down from 13·0 in 1920 to 11·3 in 1930; 10·7 in 1940, and 9·6 in 1950; and by 1946 there had been an appreciable resumption of immigration, the net immigration during the last five years of the decade ending July 1, 1950, amounting to more than 750,000

The birth rates and death rates prevailing in the United States from 1939 to 1950 are presented in Table III, together with the

TABLE III—*Vital Rates for the United States*

Year	Birth rate*	Death rate*	Marriage rate	Divorce rate
1939	17·3	10·6	10·7	2·9
1943	21·5	10·9	11·6	3·0
1946	23·3	10·0	16·4	4·3
1947	25·8	10·1	13·9	3·4
1948	24·2	9·9	12·4	3·3
1949	24·1	9·7	10·9	3·2
1950	23·5	9·6	11·8	—

*Rates per 1,000 of the population, based on registered births and deaths.

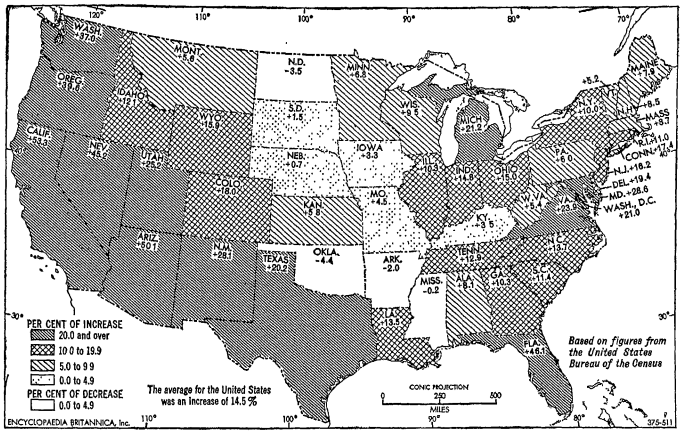


FIG. 1.—PER CENT OF CHANGE IN TOTAL POPULATION, BY STATES. 1940 TO 1950

closely related rates for marriages and divorces The total number of births in 1939, including an adjustment for underregistration, was 2,390,000; and the average for a number of years preceding was even smaller. By 1943, however, the number of births had increased to 3,209,000, followed by figures smaller by 200,000 or 300,000 in the next three years, then by the record number of 3,986,000 in 1947, or nearly 80% above the number recorded in 1933 (2,243,000), and around 3,700,000 in 1948, 1949 and 1950 The number of deaths, on the other hand, remained at about the same level, being 1,433,000 in 1939, 1,652,000 (the maximum) in 1945, and falling back to 1,467,000 in 1950.

While the population of the United States as a whole made unexpectedly large gains between 1940 and 1950, these gains were not by any means uniformly distributed over the country. Table II presents the population figures for 1940 and 1950, by states (grouped into divisions and regions), with rates of increase for the decade 1940–50 and for the preceding decade, 1930–40.

The total numerical increase between 1920 and 1930 was 17,064,426, of which again a very large fraction took place in the industrial states of the middle Atlantic and east north central divisions, New York recording a gain of more than 2,000,000, and Illinois and Michigan gains of more than 1,000,000 each. California, with an increase of 2,250,390, or 65.7%, showed the largest gain for any individual state, while Florida, with an increase of 51 6%, showed the next largest relative gain. Since the highest probable gain from natural increase, even under conditions existing in 1920, was less than 15%, it is obvious that gains such as those recorded for California and Florida must have resulted mainly from migration from other states.

The increase in the population of continental United States between 1930 and 1940 was 8,894,229, or 7.2% (as compared with 17,064,426, or 16 1%, between 1920 and 1930) While the contribution made to this increase by those states usually classified as industrial states was considerable, it was decidedly less in proportion to the total than in the three or four decades immediately preceding.

Two of the states showing the most significant increases between 1940 and 1950 were California and Florida; both had had heavy increases for several decades, largely because of in-migration from other states. Every state except Mississippi, Arkansas, Oklahoma and Idaho showed a higher rate of increase between 1940 and 1950 than in the preceding decade; and in many states, especially in the west, the current rate was two or three times the rate between 1930 and 1940. In California the absolute increase in population amounted to 3,678,836; and in four other states, New York, Texas, Michigan and Ohio, to



BY COURTESY OF U S BUREAU OF THE CENSUS

FIG. 2.—CENTRES OF POPULATION, 1790–1950

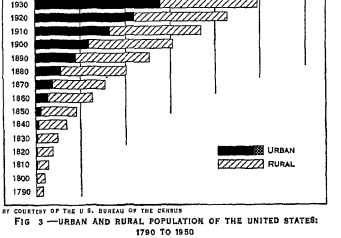
more than 1,000,000. Among the regions the increase was most rapid (40 9%) in the west, next (13.3%) in the south, with the north central (10.8%) and the northeast (9.7%) following.

The percentage increases during the decade ending in 1950 are indicated, by states, on the accompanying map of the United States (fig. 1). This map serves, incidentally, as a good indicator of the trends of internal migration within the United States, most of states with the black shading being states to which there was extensive movements of population from other parts of the

country between 1940 and 1950.

Centre of Population.—In 1790 the centre of population was located 23 mi E of Baltimore, Md, thus emphasizing the fact that the settlements were largely in the extreme eastern part of the country's area and also suggesting that the population was about evenly divided between the north and the south By 1850 the centre had moved westward about 260 mi. to a point 23 mi S E. of Parkersburg, W Va. By 1940 it had moved 320 mi. farther west, still following closely the 30th parallel, and was located 2 mi. S E. of the village of Carlisle, in Sangamon county, Ind The movement of the centre of population from 1790 to 1940 is shown on the accompanying map (fig 2)

Urban and Rural Population.—In 1790 the population of the United States was almost entirely rural and supported directly from the soil. There were no large cities, and no industry of importance other than agriculture. There were only two cities with



BY COURTESY OF THE U S. BUREAU OF THE CENSUS

FIG 3 —URBAN AND RURAL POPULATION OF THE UNITED STATES: 1790 TO 1950

The crosshatched part of the 1950 bar represents the population of the additional areas counted as urban under the new 1950 definition

more than 25,000 inhabitants, and only 24 places with more than 2,500. And it was not until toward 1820 that the largest city (New York) passed the 100,000 mark In 1850 there were 26 cities of over 25,000, including one with more than 500,000 and five others with more than 100,000 In 1910 there were 50 cities with more than 100,000, including three with more than 1,000,000, and in 1940 there were 92 cities of over 100,000, including five with over 1,000,000.

Table IV shows the urban population and the number of urban places on selected dates from 1790 to 1950. The figures given for urban population in 1940 and earlier years represent the number of inhabitants living in incorporated places (cities, boroughs, villages and, in some states, towns), supplemented by small areas classified as urban under special rule in states where there were many large population aggregates not incorporated as cities or villages. For 1950 a new definition of urban population was set up including, in addition to the incorporated places of the earlier

TABLE IV.—*Total and Urban Population of the United States*

Census year	Total population	Urban population		Number of urban places of		
		Number	Per cent of total	100,000 or more	25,000 or more	2,500 or more
1790	3,929,214	201,655	5.1	—	2	24
1820	9,638,453	693,255	7 2	1	5	61
1850	23,191,876	3,543,716	15 3	6	26	236
1880	50,155,783	14,129,735	28.2	20	77	939
1910	91,972,266	41,998,932	45 7	50	228	2,262
1940	131,669,275	74,423,702	56.5	92	412	3,464
1950*	150,697,361	96,440,548	64	106	477	4,270

*The definition of urban population was expanded for use in the 1950 census, as explained in the text. The 1950 figure given in the table (96,440,548) is a semifinal figure obtained by assuming that the proportion urban in the final population was the same as in the preliminary,

definition, 397 unincorporated places of 2,500 or more and the thickly settled suburban area, or "urban fringe," around all cities of 50,000 or more—these additional areas having an aggregate population of about 7,500,000 The rural population was in all cases that part of the total which was not classified as urban.

Up to 1830 the percentage of the population urban increased very slowly, which means that the growth of the urban population was little more rapid than that of the rural Between 1830 and 1840 the percentage urban in the country as a whole increased from 8.8 to 10 8, or by not quite one-fourth

TABLE V.—*Cities of 500,000 or More: 1950*
(Population for 1950 based on a preliminary count)

City	Population 1950	Population 1940	Increase	
			Amount	Per cent
New York, N.Y	7,835,099	7,454,995	380,104	5.1
Chicago, Ill	3,606,136	3,396,808	209,628	6 2
Philadelphia, Pa	2,064,794	1,931,334	133,460	6 9
Los Angeles, Calif.	1,957,692	1,504,277	453,415	30 1
Detroit, Mich	1,838,517	1,623,452	215,065	13 2
Baltimore, Md	940,205	859,100	81,105	9 4
Cleveland, O	905,616	878,336	27,300	3 1
St Louis, Mo	851,913	816,048	36,375	4 5
Washington, D C	797,670	663,091	134,579	20 3
Boston, Mass.	790,863	770,816	20,747	2 6
San Francisco, Calif.	760,783	634,536	126,227	19 9
Pittsburgh, Pa	673,763	671,659	2,104	0 3
Milwaukee, Wis.	632,621	587,472	45,279	7 7
Houston, Tex	594,321	384,324	209,807	54 6
Buffalo, N.Y	577,908	573,005	1,493	0 3
New Orleans, La	567,257	494,537	72,720	14 7
Minneapolis, Minn.	517,277	492,370	24,907	5 1
Cincinnati, O	500,510	455,610	44,900	9.9

In many individual states, however, the increase during this decade was much greater, the percentage urban in 1840 in some cases doubling that in 1830

Between 1840 and 1850 the percentage urban in the country as a whole increased from 10.8 to 15.3, or by nearly one-half This relative increase was exceeded in several of the older states, including Maine, New Hampshire, New Jersey and New York, but the most notable increases in urbanization during this period were in some of the newer states.

In the state of Ohio, for example, the percentage urban increased from 5 5 to 12 2; in Indiana, from 1.6 to 4.5; in Illinois, from 2 0 to 7 6; in Michigan, from 4.3 to 7.3; and in Missouri, from 4.3 to 11.8.

By 1850, settlement was well under way in most of the states which later attained a high percentage of urban population, and after that date the trend of the percentage urban in the country as a whole was less affected by the expansion of the settled area, or by the beginning of urbanization in the newer states, than it was in the decades preceding 1850.

In 1930 there were 21 states in which more than one-half of the population was urban. The census dates on which these states were first shown to have more than one-half of their population living in urban territory may be of some significance as indicating the geographic progress of urbanization over the country. Massachusetts and Rhode Island were the first of these states, their population being returned as more than 50% urban in 1850. New York was added to the list in 1870; New Jersey in 1880; Connecticut in 1890; and in 1900, Pennsylvania, Illinois and California. At the beginning of the 20th century, therefore, there were only 8 states in which the population was more than one-half urban. In 1910, New Hampshire, Ohio, Maryland, Colorado and Washington were added to the list; in 1920, Indiana, Michigan and Delaware; and in 1930, Wisconsin, Missouri, Utah, Florida and Oregon, though the percentage urban in Oregon had declined in 1940 to 48.8.

It is possible to compare the proportion urban in 1950 with that in 1940 and earlier on the basis of the 1940 definition, under which the urban population in 1950 would have been around 88,900,000, or 59.0% of the total On this basis it would appear that the rate of urbanization which had prevailed up to 1930, when the population was 56.2% urban, had not been resumed.

This notation is supported by the fact that the 1940–50 increase in the urban population on the 1940 basis was only 18.7%, as

TABLE VI—*Population of the U.S. by Colour, Nativity and Sex* (Figures for 1950 are based on the tabulation of a small sample)

Subject	1950	1940	Per cent of increase	Per cent distribution	
				1950	1940
Colour and Nativity					
Total	150,697,000	131,669,275	14·5	100·0	100·0
White	135,215,000	118,214,870	14·4	89·7	89·8
Native white	125,068,000	106,795,732	17·1	83·0	81·1
Foreign-born white	10,147,000	11,419,138	−11·1	6·7	8·7
Nonwhite	15,482,000	13,454,405	15·1	10·3	10·2
Negro	14,894,000	12,865,518	15·8	9·9	9·8
Other races	588,000	588,887	−0·2	0·4	0·4
Sex					
Male	74,633,000	66,061,592	13·0	49·5	50·2
Female	76,064,000	65,607,683	15·9	50·5	49·8
Sex ratio	98·1	100·7	—	—	—

compared with 14·5% for the total population.

The urban trend from 1790 to 1950 is shown graphically in the accompanying chart (fig. 3), which not only indicates the rapid increase in the relative importance of the urban population from 1860 to 1930, but also shows effectively that for the major part of the nation's history it has been dominantly rural. Incidentally, this chart also helps visualize the increase in total population over 160 years.

Large Cities.—Table V gives the population of the 18 cities which had more than 500,000 inhabitants in 1950, with comparable figures for 1940. Only five of these cities showed a percentage increase above that of the United States as a whole, the largest absolute increase, amounting to nearly 500,000, being made in Los Angeles

Racial Composition.—The population of the United States in 1950 comprised 135,215,000 white persons, 14,894,000 Negroes and 588,000 persons of other races, mainly Indians, Chinese, Japanese and Filipinos The white population thus represented 89·7% of the total and the Negro population, 9·9%, leaving for the minor races (*i.e.*, those of minor statistical importance) only 0·4%. The percentage Negro had declined steadily from 1790, when it was 19·3, to 1890, when it had reached 11·9; from 1890 to 1930 there was a slower decline to 9·7 on the latter date, followed by slight, but hardly significant increases in the two following decades, to 9·8 in 1940 to 9·9 in 1950 The percentage white, of course, increased as a result of the decline in the proportion Negro, since the total of the "minor" races had never exceeded 0·5%.

The population of the United States included, in 1950, only 10,147,000 foreign-born white, as compared with 11,419,138 in 1940. There was thus an actual decrease of 11·1% in this class, which may be compared with an increase of 17·1% in the native white population The distribution of the population of the United States by colour and nativity is shown for 1950 and 1940 in Table VI.

There were significant changes in the geographic distribution of the Negro population, especially after 1910, resulting from an extensive migration of southern Negroes to northern (and western) industrial centres. The percentage of Negroes of the population of the middle Atlantic states, for example, increased from 2·2 in 1910 to 4·6 in 1940, and in the east north central division, from 1·6 in 1910 to 4·0 in 1940 In the state of Michigan, taken alone, the increase was even more rapid, from 0·6% in 1910 to 4·0% in 1940, and 7·0% in 1950 Of the total population of Illinois in 1950, 7·3% was Negro, as compared with 4·8% in 1940, and 1·9% in 1910 Similar increases occurred in other industrial states and even greater relative increases in some important industrial cities.

The number of American Indians returned in the census year 1940 was 333,969 or practically the same number as in 1930. These figures may be compared with 265,683 in 1910, the last census prior to 1930 in which special effort was made to secure complete enumeration of all persons having any considerable proportion of Indian blood. The number of persons returned as full-blood Indians in 1930 (153,933), however, was only slightly larger than the 150,053 returned in 1910. These figures would indicate that most of the increase had been in persons of mixed Indian blood Because of the difficulty of identifying these latter or of establishing the dividing point at which such persons should be counted as Indians, it was difficult to get thoroughly dependable counts of the Indian population, especially in those states where the Indian population had become largely intermingled with the white.

Foreign White Stock.—Under the classification "foreign white stock" the bureau of the census includes foreign-born white persons and persons with one or both parents foreign-born In 1940 this classification included slightly more than one-fourth of the population, the number having decreased from 39,845,798 (or 32·5% of the total) in 1930, to 34,576,718, or 26·4% of the total in 1940 The foreign white stock in 1940 comprised 11,419,138 foreign-born white and 23,157,580 natives of foreign or mixed parentage; the latter, in turn, comprised 15,183,740 with both parents foreign-born; 5,267,140 with father foreign-born and mother native, and 2,706,700 with mother foreign-born and father native. It may be noted that all of these figures are smaller than corresponding figures for 1930. The distribution of the foreign white stock in 1940 by country of origin is shown in Table VII

TABLE VII—*Foreign White Stock by Country of Origin: 1940*

Country of origin	Total	Foreign-born	Native of foreign or mixed parentage			
			Total	Both parents foreign	Father foreign-born	Mother foreign-born
All countries	34,576,718	11,419,138	23,157,580	15,183,740	5,267,140	2,706,700
England	1,077,675	621,975	1,455,700	583,060	498,000	301,240
Scotland	725,861	270,321	446,540	218,720	136,200	93,620
Wales	148,260	51,360	112,900	53,580	38,720	21,600
Northern Ireland	377,256	100,416	276,840	125,220	98,140	49,480
Ireland (Eire)	2,420,931	572,931	1,848,180	1,184,180	358,000	295,840
Norway	941,888	403,888	538,000	406,780	90,420	40,800
Sweden	1,301,300	445,070	856,230	577,360	188,500	90,160
Denmark	443,815	158,175	285,640	182,400	90,000	33,240
Iceland	6,584	2,104	4,480	2,800	1,000	680
Netherlands	372,384	112,164	260,320	148,100	77,700	35,320
Belgium	130,358	53,938	76,600	44,820	21,720	9,860
Luxembourg	27,166	6,886	20,380	11,380	6,540	2,160
Switzerland	293,213	88,693	204,680	112,600	65,680	27,400
France	349,950	103,930	246,120	125,880	79,060	40,280
Germany	5,216,622	2,217,772	3,998,840	2,414,280	1,206,380	478,180
Poland	2,905,850	993,470	1,912,380	1,284,420	243,800	84,160
Czechoslovakia	984,501	310,971	674,020	503,280	108,520	54,820
Austria	1,961,246	479,066	781,340	600,440	126,580	54,320
Hungary	665,068	290,218	371,840	270,140	47,920	24,780
Yugoslavia	582,331	162,331	419,300	282,240	83,020	53,040
Russia (U.S.S.R.)	2,060,244	1,040,884	1,509,360	1,255,200	221,280	92,880
Lithuania	394,811	165,771	229,040	167,240	24,580	6,220
Finland	284,290	117,210	167,080	132,080	22,300	12,700
Rumania	247,700	115,940	131,760	103,000	20,340	8,360
Greece	326,672	161,232	165,440	123,180	30,280	1,560
Italy	4,504,780	1,623,580	2,971,200	2,348,580	533,060	89,560
Other Europe	391,647	163,987	226,660	161,180	51,840	12,440
America						
Canada	2,057,160	1,065,480	1,891,680	731,120	627,200	541,140
Mexico	1,076,653	377,433	699,220	455,760	150,320	87,140
All other	779,301	275,481	494,820	306,360	134,520	63,940

In terms of contribution to the total foreign white stock, Germany ranked first, with 5,236,612, or 15 1% of the total, and Italy second, with 4,594,780, or 13 3% of the total. It may be noted, however, that the number of Germans of the second generation was more than three times the number of German-born, while the number of second-generation Italians was less than twice the number of the first generation. Other comparisons of this kind can be made by referring to the detailed figures in the table.

Since less than 1% of the Negroes are foreign-born, and since the other racial groups constitute a very small fraction of the total population of the United States, the foreign white stock may be considered to represent practically the whole foreign element in the population of the United States

In the matter of geographic distribution, it may be noted that both the foreign-born and the children of the foreign-born are found mainly in the northern and western states, there being relatively few in any of the states south of Maryland except in Florida and Texas.

The highest percentages of foreign-born white were found in 1940 in New York, with 21 2%; Massachusetts, Rhode Island and Connecticut each with more than 19% and New Jersey with 16 7%.

In the early stages of large-scale immigration to the United States, a large proportion of the immigrants settled on the new farmland which was being opened up in the west, but after about 1890 when the supply of free land (or land nearly free) was practically exhausted, there was an increasing tendency for the foreign-born to settle in the industrial cities.

Thus, we find that while only 8 8% of the total population in 1940 was foreign-born, this class represented 12 5% of the urban population, 5 1% of the rural-nonfarm and only 3 1% of the rural farm.

With the disappearance of the frontier land, agitation for restriction of immigration began to appear. The newer immigrants created lasting problems of assimilation and housing and their competition with the native labourer was more keenly felt now that the latter had no frontier to which to escape. The problem became more acute after World War I, when the United States, faced with the problem of reabsorbing its own war veterans into normal industrial life, realized that some barrier should be erected to restrict immigration from Europe

Immigration increased from 141,132 in the year ending June 30, 1919, to 805,228 in 1921. Following somewhat lower figures in 1922 and 1923, immigration rose again in 1924 to 706,896. In this year the Immigration act of 1924 went into effect, with the result that in 1925 only 294,314 immigrant aliens were admitted to the United States. Admissions in the next few years were around 300,000, but further restrictions imposed as a result of the economic depression materially reduced the number admitted, so that the total for the decade ending in 1940 was only 528,431; and if from this figure be subtracted the number of emigrant aliens departing the net immigration for the decade would be only 68,693. Immigration remained at a low figure until 1946, in which year 108,721 immigrant aliens were admitted (net, 90,578); this figure increased gradually to 249,187 in 1950 (net, 221,589). Further information with regard to the general trend of immigration is given in the last column of Table I.

Sex Distribution.—The population of the United States in 1950, as shown in Table VI, comprised 74,633,000 males and 76,064,000 females, or 98.1 males per 100 females, as compared with 100.7 in 1940 and a maximum of 106.0 in 1910, which represented an excess of 2,692,288 males The excess of males had been reduced in 1940 to 453,909, and as the change in the sex ratio continued, the number of females passed the number of males around the middle of 1944, and by 1950 the excess of females, on the basis of the 1950 census count, amounted to 1,431,000.

In interpreting this figure, however, one should bear in mind the fact that in 1950 several hundred thousand males were in military service outside the United States and therefore not counted in the census.

Age.—The median age of the population of the United States —that is, the age which divides the population into two equal groups, one younger and the other older—showed an increase each decade from 1820, when it was 16 7 years, to 1950, when it was 30 1 years, the median ages for 1930 and 1940 being 26.5 years and 29 0 years respectively. The increase was chiefly the result of two causes: first, an increase in the average length of life; and second, a reduction in the birth rate which resulted in a decrease in the proportion of young persons in the population Immigration also tended to raise the median age since most immigrants were above 20 years of age The median age of the foreign-born white population in 1940 was 51.0 years, as compared with 26 9 years for the native white and 25.3 for the Negro population.

The age distribution of the population is shown for 1950 and 1940 in Table VIII

TABLE VIII.—*Population of the United States by Age*
(Figures for 1950 are based on the tabulation of a small sample)

Age	1950	1940	Per cent of increase	Per cent distribution	
				1950	1940
All ages	150,697,000	131,669,275	14 5	100 0	100 0
Less than 5 years	16,334,000	10,541,591	54 9	10 8	8 0
5 to 9 years	13,241,000	10,884,522	23 9	8 8	8 1
10 to 14 years	11,361,000	11,715,035	−3 3	7 5	8 9
15 to 19 years	10,739,000	11,311,523	−5 0	7 1	9 4
20 to 24 years	11,317,000	11,187,811	1 2	7 5	8 8
25 to 29 years	12,503,000	11,006,638	9 0	8 0	8 4
30 to 34 years	11,601,000	10,249,388	13 3	7 7	7 8
35 to 39 years	11,103,000	9,543,377	17 3	7 4	7 2
40 to 44 years	10,028,000	8,787,843	14 5	6 7	6 7
45 to 49 years	8,990,000	8,255,225	8 9	6 0	6 3
50 to 54 years	8,274,000	7,256,840	14 0	5 5	5 5
55 to 59 years	7,320,000	5,841,865	25 7	4 8	4 4
60 to 64 years	5,950,000	4,728,340	25 8	3 9	3 6
65 to 69 years	5,000,000	3,806,657	31 3	3 4	2 9
70 to 74 years	3,456,000	2,650,532	30 3	2 3	2 0
75 years and over	3,837,000	2,643,125	45 2	2 5	2 0
Median age, years	30 1	29 0	—	—	—

The most striking feature indicated by the figures in Table VIII is the great increase in the population under 5 years of age—an obvious result of the greatly increased numbers of births between 1945 and 1950, to which reference has already been made Against an increase of 14 5% in the total population, the population under 5 years of age increased by 54 9%, while the numbers of persons in the three 5-year groups representing persons from 10 to 24 years of age (those born during the extremely low birth-rate years) were actually smaller in 1950 than in 1940. While the population under 5 years of age formed 10 8% of the total in 1950, as compared with 8 0% in 1940, the population 15 to 19 years of age represented only 7.1% of the total in 1950, as compared with 9.4% in 1940.

At the other end of the age scale, persons 65 years old and over continued to show more rapid increase than those in any other age group except the youngest, and to increase their percentage of the total population, persons 65 years old and over representing 8.2% of the total in 1950, as compared with 6 9% in 1940.

Education.—Up to 1930 the census figures which offered the best index of educational attainment were based on a question with respect to literacy, though the figures shown in the census tables were usually the number or percentages of illiterates, that is, persons not able to read and write. The percentage of illiteracy in the total population decreased rather rapidly from 20 0 in 1870 to 6.0 in 1920 and 4.3 in 1930. On the latter date the percentage illiterate in the native white population was only 1.5, and when classified by age, it appeared that practically all of these illiterates were in the older age groups.

Partly because there seemed to be little room for further improvement in literacy in the major classes of the population, and partly to provide a classification more definite and tangible than the question on ability to read and write, a question on the number of years of schooling was substituted in 1940 for the traditional question on literacy. The results of this new inquiry, with respect to persons 25 years old and over, are presented in Table IX This age group was selected as comprising, for the most part, persons whose formal education had been completed, since many

of the persons under 25 years of age would be still in school and thus still in process of adding to their educational attainment.

Of the total population 25 years old and over in 1940, 4·6% had completed college, 14·1% had completed high school only, and 34·6% had completed grade school only, while 13·5% had completed less than 5 years of formal school attendance

The median number of years of school completed for the total population was 8·4. For the native white population alone, the median was 8·8, as compared with 7·3 for the foreign-born white, and 5·7 for the Negro population. A word of caution should be given with regard to the relation between these medians, which are expressed in tenths, and the basic classifications which are expressed in full years The median point for the total population is located at about the middle of the 8-year group, representing theoretically persons who have had 8·4 years in school, while the entire 8-year group includes also those who have had from 8·5 to 8·9 years (but less than 9 years). Note that these medians are purely theoretical index numbers, like the median size of family, for example, since the returns for school years completed are in full years and not in months or fractions. (L. E. T.)

TABLE IX.—*Persons 25 Years Old and Over by Years of School Completed: 1940*

Years of school completed	Total number	Per cent distribution				
		Total	Native white	Foreign-born white	Negro	Other races
Persons 25 years old or over	74,775,836	100·0	100·0	100·0	100·0	100·0
No school years completed	2,709,923	3·7	1·3	12·2	10·0	18·8
Grade school 1 to 4 years	7,204,689	9·7	6·1	16·1	21·3	17·1
5 and 6 years	6,525,111	11·4	9·7	14·3	21·5	14·0
7 and 8 years	25,897,052	34·6	36·0	36·4	29·8	22·6
High school 1 to 3 years	11,181,096	15·0	17·3	6·9	8·5	10·1
4 years	10,551,680	14·1	16·6	7·4	4·1	9·8
College 1 to 3 years	4,075,184	5·4	6·6	2·9	1·8	2·9
4 years or more	2,407,331	3·6	5·4	2·3	1·2	2·4
Not reported	1,041,970	1·4	1·5	1·5	1·8	2·4
Median school years completed	8·4	8·4	8·8	7·3	5·7	6·8
Per cent less than 5 years completed	13·5	13·5	7·6	28·3	41·3	15·9

Religious Bodies.—While the following statistics of membership may be used in a very general way for comparison of denominational strength, it must be remembered that membership is counted very differently in different denominations, the membership of children especially differing between Roman Catholic and most Protestant bodies. The Church of Christ, Scientist, is not included because the manual of that body forbids the numbering of the people and the reporting of such statistics for publication

According to the census of religious bodies taken by the United States bureau of the census in the year 1936 there were in the United States 256 religious denominations, represented by 199,302 organizations with 55,807,366 members.

By 1950, total church membership was estimated at 81,862,328 persons, according to the *Christian Herald*. Membership had been increasing for many years and this was the highest proportion of the total population ever reported—more than one out of two. Of this total, 50 larger denominations of more than 200,000 members each represented 97.2% of all church membership in the continental United States The remaining members, less than 3%, were in more than 200 bodies. Of the total church membership, 57·3% was Protestant, 32·6% Roman Catholic, 6.1% Jewish and 1.2% Greek Orthodox, Russian Orthodox, Armenian Orthodox and Polish National Catholic. Though Protestants as a group outnumbered Roman Catholics almost two to one, the Roman Catholic Church was far ahead of any other single denomination.

According to the 1936 federal census, the Roman Catholic was the leading denomination in membership in every one of the northern and western states, except in Idaho and Utah, where the Latter-Day Saints (Mormons) predominated by a large margin. In the southern states the leading denominations were either Baptist or Methodist. The Lutherans were relatively strongest in the north-central division of the country, their members consisting chiefly of Germans and Scandinavians. The other important Protestant bodies were widely and fairly evenly distributed over the country. Jewish congregations were most important in New York, Pennsylvania, Illinois, Massachusetts and New Jersey.

The immigration from southeastern Europe gave great strength to some sects which had no existence in the religious census of 1890, notably those of the Eastern Orthodox Churches (Russian, Serbian, Syrian and Greek). (X)

Employment Status.—One of the most important characteristics of any population is its relation to employment, with the various possible classifications by occupation, industry, etc. Of the total population of the United States 14 years old and over in 1950, which amounted to 111,915,000, 58,735,000, or 52·5%, were in the civilian labour force. Of this number, 55,843,000, or 95·1%, were employed, and 2,892,000, or 4·9%, were unemployed The percentage of males 14 years old and over in the civilian labour force was 77·3 (supplemented by an additional 1·5% in military service), while the corresponding percentage for females was 28·6, the major part of the women not in the labour force being engaged in caring for their own homes These figures are summarized, with percentages for the four main geographic regions into which the country is divided, in Table X

TABLE X.—*Employment Status of the Population 14 Years Old and Over, By Regions, By Sex: 1950*

(For composition of regions, see Table III Figures for 1950 are based on the tabulation of a small sample)

Sex and employment status	Total number	Per cent distribution				
		U S total	North east	North central	South	West
Total, 14 and over	111,915,000	100·0	100·0	100·0	100·0	100·0
Total labour force	59,597,000	53·2	53·6	51·7	52·3	51·6
Civilian labour force	58,735,000	52·5	52·8	51·4	51·4	52·2
Employed	55,843,000	49·9	49·6	51·4	49·3	48·4
Unemployed	2,892,000	2·6	3·2	1·1	2·0	3·8
Not in labour force	52,318,000	46·8	46·4	48·3	47·7	48·4
Male, 14 and over	54,078,000	100·0	100·0	100·0	100·0	100·0
Total labour force	43,268,000	79·8	78·1	80·3	78·1	77·7
Civilian labour force	42,446,000	77·3	76·5	79·8	76·4	75·0
Employed	40,317,000	73·1	71·7	77·7	73·6	69·6
Unemployed	2,130,000	3·9	5·1	2·1	2·9	5·4
Not in labour force	11,655,000	21·2	21·9	19·7	21·7	22·3
Female, 14 and over	57,997,000	100·0	100·0	100·0	100·0	100·0
Total labour force	16,329,000	28·6	30·1	28·0	27·2	29·6
Civilian labour force	16,289,000	28·6	30·2	27·9	27·1	29·5
Employed	15,526,000	27·3	29·1	26·9	25·8	27·4
Unemployed	763,000	1·3	1·1	1·0	1·3	2·1
Not in labour force	40,668,000	71·4	69·4	72·0	72·8	70·4

Since there is a definite relation between age and labour force participation, there is presented in Table XI a brief summary for the population, male and female, classified by age.

TABLE XI.—*Employment Status of the Population 14 Years Old and Over, By Age and Sex: 1950*

(Figures for 1950 are based on the tabulation of a small sample)

Age	Population 14 years old and over		Per cent in civilian labour force		Per cent of labour force employed	
	Male	Female	Male	Female	Male	Female
Total	54,078,000	57,663,000	83·2	16·4	98·4	97·4
14–19 yrs	7,431,000	7,243,000	49·4	15·0	98·0	92·4
20–24 yrs	7,167,000	6,904,000	91·0	33·3	95·7	95·5
25–34 yrs	11,379,000	11,374,000	97·6	28·5	98·2	98·0
35–44 yrs	11,533,000	11,434,000	96·3	21·4	99·0	99·3
45–54 yrs	8,329,000	8,233,000	94·6	17·4	99·1	97·7
55–64 yrs	6,127,000	6,129,000	88·6	11·5	97·9	99·0
65 yrs and over	2,985,000	2,772,000	63·6	5·2	100·1	97·7

It may be noted that from ages 25 to 54 years nearly the whole male population was in the civilian labour force—with considerable additional numbers, especially of those just above 20 years of age, in military service. In the female population the maximum labour force participation was in the age groups 20 to 24 years and 35 to 44 years, the intervening group containing many married women with young children

Another factor affecting labour force participation, especially for women, is marital status. A brief summary of the available data, classified in accordance with this factor, is presented in Table XII.

In accordance with these figures, 9,273,000 married women

TABLE XII.—*Labour Force Status of the Civilian Population 14 Years Old and Over, By Sex and Marital Status: 1950*
(Figures are based on a small sample survey)

Sex and marital status	Civilian population 14 and over	In labour force		Employed	
		Number	Per cent of pop.	Number	Per cent of labour force
Male	54,187,000	44,426,000	82 0	41,424,000	93 2
Single	14,213,000	8,808,000	62 0	7,710,000	88 0
Married, wife present	35,025,000	34,913,000	99 6	31,499,000	95 4
Married, wife absent	1,096,000	817,000	74 5	2,305,000	88 1
Widowed or divorced	3,853,000	1,790,000	46 0		
Female	56,613,000	17,705,000	31 4	16,674,000	93 7
Single	12,116,000	5,621,000	50 5	5,272,000	93 8
Married, husband present	35,023,000	8,550,000	23 8	8,038,000	94 0
Married, husband absent	1,536,000	703,000	45 4	3,364,000	92 8
Widowed or divorced	8,018,000	2,901,000	36 0		

were in the labour force in 1950, as compared with 5,621,000 single women. This represents a material change in the extent of employment of married women, even as compared with 1940, when the number of married women in the labour force was only 4,560,835, as compared with 6,349,474 single women Between 1940 and 1950, to be sure, the percentage of all women who were married had increased materially, but the increase in labour force participation on the part of married women was far greater.

Another fundamentally important classification of the labour force is that based on the industry in which employed. A brief summary of this distribution for employed workers in 1950 is presented in Table XIII, with percentages for the four regions as well as for the United States.

The largest single group in the series presented in this table is that designated "manufacturing," which gave employment to 25.3% of the whole number of employed workers in the United States as a whole, and an even larger percentage in the northeast and north central regions; the widest variation among the regions in the matter of industrial classification was that with respect to agriculture. In the country as a whole, 12.8% of the workers were in agriculture. In the northeast, however, only 3 8% were in this industry, as compared with 20.6% in the south and 14.5% in the north central region. All of these figures represent a marked decline (in the relative importance of agriculture, as measured by employment) from 1940, when corresponding percentages were as follows: 18.7 for the United States, 4.7 for the northeast, 19 5 for the north central region, 38 2 for the south and 15 9 for the west. Thus decline was largely the result of increased use of farm machinery and improvement in production methods.

Family Income.—A new inquiry on the 1950 census schedule was one relating to income—total income, as compared with wage or salary income alone, which was collected in 1940 A summary of the tabulation of family income, that is, of families classified by income, is presented in Table XIV.

A family, it may be noted, is defined for this purpose as a group of two or more related persons living in the same household or otherwise sharing the same accommodations. These figures, like those in the preceding table, are shown for the four regions, among which there are many significant differences. The median income of the 36,441,000 families for which data were obtained was $3,068. The regional medians ranged from $3,435 in the west and $3,362 in the northeast to $2,248 in the south The largest single group for the United States as a whole was the 3,989,000 families with income of $3,000 to $3,499, which formed 10 9% of the whole number of families. This same group included the largest number of families in all of the regions except the south, where the numbers of families in each of the four groups with incomes of less than $2,000 exceeded the numbers of families in any other income group.

Size of Household.—In 1850 there were 5.6 persons in the average U S. family or household. In 1890 the average population per family was 4 9; in 1900, 4 7; in 1910, 4.5, in 1920, 4 3; and in 1940, 3.8; these figures were obtained, in all cases, by dividing the total population by the number of families or households. In 1950 the average population per household or occupied dwelling unit was 3.5. The unusually large numbers of marriages in the decade ending in 1950 had obviously tended to increase the number of households, while the large numbers of births, being for the most part first or second births, had not accumulated to an extent sufficient to affect the average size of family or household.

Tenure of Home.—The whole number of occupied dwelling units or homes in the United States in 1950 was 42,520,000, this being the same as the number of households. Of these homes, 23,383,000, or 55 0%, were occupied by owners, while 19,136,000, or 45 0%, were occupied by tenants or renters Of the whole number of homes, 61.4% were single-family detached houses. In the rural-farm area, 95 1% of the homes were of this type; in the rural-nonfarm area, 81.9%; and in the urban area, 48 2%. Conversely, 10 0% of the urban homes were in structures containing 10 dwelling units or more, as compared with 0 5% in the rural-nonfarm areas, and practically none at all on the farms For the country as a whole, 6.7% of the homes were in these multifamily structures.

TABLE XIV.—*Families in the United States By Income, By Regions: 1949*
(Figures for 1950 are based on the tabulation of a small sample)

Income level	Total number	Per cent distribution				
		U S total	North-east	North central	South	West
Families reporting	36,441,000	100 0	100 0	100 0	100 0	100 0
Less than $500	3,129,000	8 6	7 0	7 0	12 4	6 3
$500-$999	2,630,000	7 2	5 6	5 4	12 0	4 5
$1,000-$1,499	2,664,000	7 3	4 9	6 3	10 8	5 7
$1,500-$1,999	2,777,000	7 5	5 8	6 5	10 0	6 2
$2,000-$2,499	3,378,000	9 3	9 0	9 0	9 9	8 5
$2,500-$2,999	3,707,000	10 2	9 6	8 0	8 1	11 2
$3,000-$3,499	3,989,000	10 9	12 9	11 5	8 0	11 6
$3,500-$3,999	3,179,000	8 7	9 4	10 0	6 1	10 6
$4,000-$4,499	2,620,000	7 2	8 5	7 8	4 0	8 6
$4,500-$4,999	1,786,000	4 9	5 2	5 5	3 7	5 8
$5,000-$5,999	2,864,000	7 9	9 0	8 8	5 3	9 4
$6,000-$6,999	1,557,000	4 3	5 0	4 6	3 0	5 3
$7,000-$9,999	1,714,000	4 7	5 6	5 0	3 3	5 5
More than $10,000	1,954,000	5 0	5 8	5 8	3 0	5 4
Median income	$3,068	$3,068	$3,362	$3,257	$2,248	$3,435

Of the owner-occupied homes, taken alone, 81.4% were single-family houses, as compared with 37.1% of the renter-occupied homes. These figures are presented in detail for urban and rural areas in Table XV.

Homes by Number of Rooms.—The median number of rooms in the occupied dwelling units in 1950 was 4.7, being 5.3 in the owner-occupied units and 3 8 in the renter-occupied units. These figures are summarized in Table XVI, from which it may be noted, in particular, that the 1-room, 2-room and 3-room

TABLE XIII.—*Employed Workers By Major Industry Groups, By Regions: 1950*
(Figures for 1950 are based on the tabulation of a small sample)

Industry group	Total number	Per cent distribution				
		U.S. total	North-east	North central	South	West
Total	55,843,000	100 0	100 0	100 0	100.0	100 0
Agriculture	7,138,000	12 8	3.8	14 5	20 6	9.6
Mining	971,000	1 7	1.4	3.0	2 8	1 8
Construction	3,480,000	6 2	5.8	5 3	6 8	8 1
Manufacturing	14,110,000	25.3	33 2	28 2	18.4	17.2
Durable goods	7,561,000	13.5	15.5	18 2	7 1	10 1
Nondurable goods	6,566,000	11.8	17 2	9 5	11.1	6.9
Not specified manufacturing	183,000	0 3	0 5	0.4	0 2	0.2
Transportation, communication, and other public utilities	4,259,000	7.6	7.8	7 9	6 8	8 7
Wholesale and retail trade	10,392,000	18 6	18 9	18 2	17 5	21 5
Service industries	12,037,000	21.6	23.4	19 7	20 4	25 0
All other industries	2,603,000	4 7	4.4	3 7	5 2	6.3
Industry not reported	850,000	1 5	1.3	1 7	1.5	1.8

dwelling units represented a much larger fraction of the whole number of tenant homes than of owned homes This is explained in part by the fact that dwelling units in apartment houses, which are practically all rented, are likely to be smaller, that is, to have fewer rooms, than the single-family detached houses.

Toilet Facilities.—An important current index of the quality of housing is the presence or absence of bathing and toilet facilities. Of the urban homes reporting in 1930, 86.9% had a flush toilet inside the structure for the exclusive use of the household; in the rural-nonfarm area, 55.6% of the homes were thus equipped, as compared with only 28.8% of the rural-farm homes Of the owner-occupied urban homes, 91.8% were provided with flush toilets, as compared with 82.0% of the renter-occupied homes and amount of rent paid, tend to support the assumption that the standard of living of the American people is relatively high The low and decreasing percentage of the working population engaged in agriculture, and the increasing percentages engaged in manufacturing, distribution and service activities (all evidences of further industrialization) indicate some of the reasons for the improving standards. And the increases in the rate of population growth doubtless represented in part the indirect result of this improved economic status.

TABLE XV.—*Occupied Dwelling Units By Tenure and Type of Structure· 1930*
(Figures for 1930 are based on the tabulation of a small sample)

Tenure and type of structure	Total number	Per cent distribution			
		U S total	Urban area	Rural nonfarm	Rural farm
All occupied dwelling units	42,520,000	100 0	100 0	100 0	100 0
1 dwelling unit detached without business	26,119,000	61 4	48 2	81 9	95 7
Other 1 to 4 dwelling unit	11,325,000	26 6	34 6	12 5	4 2
5 to 9 dwelling unit	1,951,000	4 6	6 7	0 9	0 2
10 to 19 dwelling unit	1,091,000	2 6	3 8	0 4	—
20 dwelling unit or more	1,741,000	4 1	6 2	0 1	—
Trailers	290,000	0 7	0 6	1 3	0 2
Owner occupied	23,382,000	100 0	100 0	100 0	100 0
1 dwelling unit detached without business	19,023,000	81 4	74 6	88 9	95 9
Other 1 to 4 dwelling unit	3,942,000	16 9	23 5	9 2	3 7
5 dwelling unit or more	185,000	0 8	1 2	0 2	0 2
Trailers	234,000	1 0	0 9	1 7	0 2
Renter occupied	19,138,000	100 0	100 0	100 0	100 0
1 dwelling unit detached without business	7,096,000	37 1	21 2	70 2	93 7
Other 1 to 4 dwelling unit	7,383,000	38 6	46 2	16 1	0 0
5 to 9 dwelling unit	1,819,000	9 5	12 6	2 1	—
10 to 19 dwelling unit	1,067,000	5 6	7 4	1 0	—
20 dwelling unit or more	1,715,000	9 0	12 3	0 1	—
Trailers	56,000	0 3	0 3	0 5	0 2

TABLE XVI.—*Occupied Dwelling Units By Tenure and Number of Rooms· 1930*
(Figures for 1930 are based on the tabulation of a small sample)

Number of rooms	All occupied dwelling units		Owner-occupied dwelling units		Renter-occupied dwelling units	
	Number	Per cent	Number	Per cent	Number	Per cent
Total	42,520,000	—	23,383,000	—	19,136,000	—
Number reporting	41,863,000	100 0	23,033,000	100 0	18,830,000	100 0
1 room	1,021,000	2 4	21,000	0 0	807,000	4 3
2 rooms	2,958,000	7 1	578,000	2 5	2,378,000	12 6
3 rooms	6,025,000	14 4	1,421,000	6 2	4,604,000	24 5
4 rooms	9,176,000	21 9	4,133,000	18 0	4,853,000	25 8
5 rooms	9,233,000	21 8	5,877,000	25 5	3,356,000	17 3
6 rooms	7,290,000	17 4	5,530,000	24 0	1,760,000	9 3
7 rooms	3,055,000	7 2	2,437,000	10 6	599,000	3 2
8 rooms	1,795,000	4 3	1,485,000	6 4	310,000	1 6
9 rooms or more	1,433,000	3 4	1,169,000	5 1	264,000	1 4
Median number of rooms	4 7	—	5 3	—	3 8	—

Similar differences appeared in the other areas for which data are available These figures are presented, with additional details, in Table XVII.

Value or Rent.—Occupied homes in urban and rural-nonfarm areas combined (omitting farm homes, since it is difficult to obtain a separate value for the home on a farm), are classified in Table XVIII by value or rent The median value of the owner-occupied homes was $7,400 More than half of the whole number of homes were in three groups ranging in value from $6,000 to $14,999, while only 7.7% represented homes valued at less than $2,000. The median monthly rental of the tenant-occupied homes was $35. Considerably more than half the whole number of these homes carried rentals ranging from $30 to $49, and for only 4.4% was the rental less than $10.

Many of the items briefly presented above, including, for example, the figures on income, plumbing equipment in the homes and amount of rent paid, tend to support the assumption that the standard of living of the American people is relatively high The low and decreasing percentage of the working population engaged in agriculture, and the increasing percentages engaged in manufacturing, distribution and service activities (all evidences of further industrialization) indicate some of the reasons for the improving standards. And the increases in the rate of population growth doubtless represented in part the indirect result of this improved economic status.

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TABLE XVII.—*Toilet Facilities in Occupied Dwelling Units, By Tenure: 1930*
(Figures for 1930 are based on the tabulation of a small sample)

Tenure and toilet facilities	Total number	Per cent distribution			
		U S total	Urban area	Rural nonfarm	Rural farm
All occupied dwelling units reporting	42,169,000	100 0	100 0	100 0	100 0
Flush toilet inside structure, exclusive use	30,614,000	72 6	86 9	55 6	28 8
Flush toilet inside structure, shared	1,688,000	4 0	5 5	5 7	0 4
Other toilet facilities (incl privy)	9,177,000	21 8	7 0	39 9	66 1
No toilet	690,000	1 6	0 6	2 9	4 7
Owner-occupied units reporting	23,219,000	100 0	100 0	100 0	100 0
Flush toilet inside structure, exclusive use	17,579,000	75 7	91 8	61 9	35 3
Flush toilet inside structure, shared	377,000	1 6	1 0	1 9	0 5
Other toilet facilities (incl privy)	5,075,000	21 9	6 3	35 2	61 0
No toilet	202,000	0 9	0 9	1 0	3 4
Renter-occupied units reporting	18,950,000	100 0	100 0	100 0	100 0
Flush toilet inside structure, exclusive use	13,041,000	68 8	82 0	44 0	16 4
Flush toilet inside structure, shared	1,414,000	7 5	9 5	3 9	0 6
Other toilet facilities (incl privy)	4,102,000	21 6	7 7	47 8	75 7
No toilet	389,000	2 1	0 7	4 5	7 2

TABLE XVIII.—*Occupied Urban and Rural-Nonfarm Homes By Value or Rent: 1930*
(Figures for 1930 are based on the tabulation of a small sample)

Owned homes (single-family houses only)			Rented homes		
Market value	Number	Per cent	Monthly rental paid	Number	Per cent
Owner-occupied units reporting	14,699,000	100 0	Renter-occupied units reporting	15,421,000	100.0
Less than $2,000	1,136,000	7 7	Less than $10	680,000	4.4
$2,000 to $3,000	820,000	5 7	$10 to $14	580,000	3.8
$3,000 to $4,000	1,061,000	7 2	$15 to $19	1,598,000	10.4
$4,000 to $5,000	1,033,000	7 0	$20 to $29	3,070,000	19.9
$5,000 to $6,000	1,230,000	9.0	$30 to $39	3,090,000	20 0
$6,000 to $7,000	2,057,000	14 0	$40 to $49	2,540,000	16.5
$7,000 to $9,000	2,725,000	18 5	$50 to $59	1,611,000	10.4
$10,000 to $14,999	2,930,000	19 9	$60 to $74	1,122,000	7.3
$15,000 to $19,999	938,000	6 4	$75 to $99	787,000	5.1
$20,000 or more	679,000	4.6	$100 or more	343,000	2.2
Median value	$7,400	—	Median rent	$35	—

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(L. E T.)

VI. NATIONAL FINANCES

Establishment of the Financial System.—Under the Articles of Confederation, the federal government had been empowered to borrow and make requisitions on the states, but not to tax Thus, it was largely dependent upon the states, which levied all taxes. In the first two years of the confederation, congress asked for $10,600,000; the states responded with less than $1,600,000 During the entire period of the confederation, 1781–89, the federal government received barely enough to meet current expenses, and not enough to meet interest requirements on the continuously rising debt. The national finances finally broke down completely in 1786 Further borrowing had become virtually impossible and requisitions yielded practically nothing This collapse, caused by the financial impotence of the government, was the immediate reason for the call in 1787 for a constitutional convention.

The new constitution, which came into effect in 1789, gave the federal government power to lay and collect taxes, duties and excises; to borrow money, pay debts, and coin money and regulate its value The states, on the other hand, were deprived of the right to coin money, emit bills of credit, make anything but gold and silver legal tender in payment of debts or to lay any duties on imports or exports Federal expenditures were restricted to appropriations made by congress. These new financial powers of the federal government were implemented by the grant to congress of powers to provide for calling out the militia to execute the laws of the union, and by the provisions making the judicial power of the federal government coextensive with its legislative power

The creation of the treasury department, with a single head in preference to a proposed commission, and the appointment of Alexander Hamilton (*q v.*) as secretary of the treasury, settled the next important financial question. Attention was then directed to making provision for the public debt. In addition to gifts of nearly $2,000,000 from the French and Spanish treasuries, the United States had borrowed about $11,800,000 (including arrears of interest) in France, Holland and Spain In addition, the domestic debt of the federal government, consisting of a great variety of obligations, was estimated by Hamilton in 1790 at $42,400,000, exclusive of the continental currency Finally, the individual states, in the prosecution of the war, had contracted debts of various descriptions, aggregating approximately $18,300,000 Under the Funding act of Aug. 4, 1790, all of the foregoing indebtedness was converted into new federal loans. Despite the great previous depreciation in value of nearly all the obligations, they were all paid off at par and accrued interest in new bonds, with the single exception of the continental bills of credit About $6,000,000 of this continental currency, of which about $78,000,000 was estimated to be outstanding, was funded into the new debt at the rate of 100 to 1, the remainder was not presented This exceptional treatment was justified on the ground that the continental bills had long since ceased to circulate as currency, and as far back as 1781 had been bought and sold by speculators at rates ranging from 500 to 1,000 to 1.

The final step necessary for a stable financial system was the establishment of a uniform currency system. The Mint act of April 2, 1792, provided for a bimetallic monetary system, based upon a dollar consisting of $24\frac{3}{4}$ grains of pure gold or $371\frac{1}{4}$ grains of pure silver, a ratio of 1 to 15. The act provided for the unlimited and gratuitous coinage by the mint, to be established in Philadelphia, Pa., of both metals, at the option of any holder.

NATIONAL FINANCES 1792–1913

Until the Civil War, customs duties constituted the main source of revenue of the federal government The few internal revenue taxes that had been intermittently in force were largely abolished in 1817 Sales of public lands yielded varying amounts annually, ranging, after 1800, from $168,000 in 1801 to $25,000,000 in 1836 The national debt was extinguished in 1835—though the depression following the panic of 1837 and the Mexican War quickly created a new debt The Civil War, disrupting the economic as well as the political life of the nation, and waged relentlessly for four long years, created serious fiscal problems. The treasury was forced to suspend specie redemption of its legal tender notes (greenbacks), which, issued in the amount of $449,000,000 during the war, depreciated severely in terms of gold, this depreciation amounting to as much as 61% at one time Despite the introduction of a series of highly productive internal revenue taxes, heavy annual deficits were incurred The interest-bearing public debt rose from approximately $65,000,000 in 1860 to $2,322,000,000 in 1866. On June 30, 1860, the government's gross debt was only $2.06 per capita, by June 30, 1866, it had risen to $77 69 per capita—a figure not reached again until World War I. The National Banking act of 1863, which authorized the establishment of national banks and the issue by such banks of circulating notes secured by United States bonds, helped to provide a market for the Civil War bond issues Financial recovery was swift in the years following the Civil War The wartime excise taxes were largely retained, and the combination of these and the still growing customs receipts resulted in a long series of uninterrupted budget surpluses (1866–93) The treasury resumed specie payments in 1879, and the interest-bearing public debt was continuously reduced, falling below $1,000,000,000 by 1888.

The resumption of specie payments soon brought monetary controversies to the fore The original gold-silver mint ratio of 15 to 1 set in 1792 had closely approximated the actual market ratio Very soon thereafter, however, a decline in the market value of silver tended to send gold coins out of circulation and out of the country. After several years of discussion, congress in 1834 reduced the content of the gold dollar and in 1837 raised it slightly, without changing the weight of the silver dollar The resulting ratios, 16 002 and 15 988 to 1, both overvalued gold rather decidedly Silver dollars were melted and sold as bullion. Following discoveries of gold in California and Australia in 1848 and 1849, the value of silver rose so much in terms of gold that congress in 1853 had to reduce the bullion content of fractional silver coins to prevent their being melted and sold as bullion. In revising the list of coins to be struck by the mint, preparatory to the resumption of specie payments, congress in 1873 eliminated the silver dollar. This attracted little notice at the time because no silver dollars had been coined for many years. Soon afterward, the discovery of new silver supplies in the United States and the demonetization of silver by several European countries caused a decline in the market price of silver A strong movement arose in the United States for the resumption of unlimited coinage of silver dollars. Many supporters of this movement hoped thereby to check the current decline in general commodity prices Partial concessions to this movement were made by congress in 1878 and in 1890 when the Bland-Allison and the Sherman Silver Purchase acts, respectively, were passed. Under the former, the secretary of the treasury was directed to purchase $2,000,000 to $4,000,000 of silver bullion at market prices each month, and to issue therefor legal tender silver dollar coins, or silver certificates representing the deposit of such coins in the treasury. This act was succeeded by the Sherman act, whereunder the secretary of the treasury was directed to purchase 4,500,000 oz. of silver bullion per month and to pay therefor in legal tender treasury notes redeemable in either gold or silver, at his option. Neither of these acts provided for the unlimited coinage of silver and, therefore, left the monetary system on an essentially monometallic gold base The Sherman act was repealed in 1893, after the treasury's gold reserve had been greatly reduced by the repeated redemption of the Sherman notes in gold. The outstanding public question during the presidential campaign preceding the election of 1896 was

whether the United States should re-establish a bimetallic monetary system on the basis of both gold and silver, or maintain a single gold standard. Following Pres William McKinley's election, the silver movement lost much of its impetus, mainly because the increasing output of the South African gold mines and the expanding volume of credit provided by the banking system made possible a period of rising prices In the Gold Standard act of 1900, the monetary standard of the United States was formally declared to consist of 25 8 grains of gold nine-tenths fine; and the secretary of the treasury was directed to maintain all forms of money of the United States at par.

NATIONAL FINANCES 1913–30

Taxation.—A notable development in the federal revenue structure after 1913 was the adoption and entrenchment of direct taxes, levied at progressive rates, as the basic source of public revenues The 16th amendment, authorizing the federal government to "lay and collect taxes on incomes from whatever source derived" was ratified in 1913, and was utilized almost immediately in the Tariff act of Oct. 3 of that year. The entrance of the United States into World War I quickly caused income taxation, supplemented for a time by excess-profits taxes, to take preeminent rank in the revenue system In 1910, more than 96% of the total internal revenue and customs receipts of the federal government was derived from customs duties and excise taxes on tobacco and alcoholic beverages; in 1920, 69%, and in 1930, 66 5%, was derived from income and profits taxes. The principles of direct and progressive taxation were also applied to estates, beginning with the Revenue act of 1916.

World War I transformed the importance of federal revenues and expenditures in the economic life of the country. Prior to 1917, the total ordinary expenditures of the federal government had exceeded $1,000,000,000 only once During the next six years, in contrast, total ordinary expenditures aggregated more than $48,000,000,000. Similarly, prior to 1917, total ordinary receipts had never reached $1,000,000,000; but during the next six years they aggregated more than $26,000,000,000. Under the Revenue act of 1918, the rates of tax on individual incomes of the year 1918 started at 6%, after an exemption of $1,000 for a single person, $2,000 for a married person and $200 for each dependent, and rose to 77% (65% surtax) on net incomes of more than $1,000,000. The taxes on corporations included one-tenth of 1% on their capital stock in excess of $5,000, 12% on their net incomes, and combined war profits and excess-profits taxes ranging up to 80% of profits in excess of certain credits, for the taxable year 1918. Many new taxes were imposed on commodities and business transactions.

Public Debt.—The enormous increase in taxation in 1917–20, while unprecedented in the previous history of the country, did not provide revenues sufficient to pay even one-half of the immediate financial cost of World War I, inclusive of loans to foreign governments The deficit financing made necessary by the prodigious financial costs of the war was conducted with remarkable facility The federal reserve system, which had been placed in operation in Nov 1914, played a valuable role in this connection Bank loans secured by the government obligations were made eligible for rediscount by the federal reserve banks; and this fact enormously increased the disposition and ability of the U.S. public to purchase the government's obligations The treasury's principal practice was to obtain funds initially through the issue of short-term certificates of indebtedness, which were sold mainly to banks, and subsequently to fund these loans into large popular bond issues The five such War Loans issued during the war and post-Armistice periods raised an aggregate sum of approximately $21,000,000,000; and the number of separate subscriptions ranged from approximately 4,000,000 for the First Liberty Loan to nearly 22,800,000 for the Fourth Liberty Loan Immediately after the war, congress provided for the systematic discharge of the public debt, which attained a peak of $26,594,267,878 on Aug. 31, 1919. The debt was reduced about $10,000,000,000 over the next ten years.

A series of drastic tax reductions also followed After Pres. Warren G. Harding's inauguration, the excess-profits tax on corporations was repealed (this was partially offset by an increase in the corporation income tax), the rates on individual incomes were reduced and a number of excise taxes eliminated (Revenue act of 1921) In 1924, further reductions in individual income tax rates and excise duties were made In 1926 sharp reductions were made in the income tax rates applicable to large individual incomes. The maximum surtax on individual incomes, which had previously been successively reduced from 65% to 50% and to 40%, was now fixed at only 20%.

The Budget.—An important fiscal development of this period was the inauguration of an executive budget, under an act of congress of June 10, 1921. A bureau of the budget was established to prepare the annual budget and such supplemental and deficiency estimates as the president might desire to recommend to congress At first, the budget was largely an accounting document designed to secure economy in government Under the stress of depression and war, however, the budget became the main instrument for the presentation of the president's views on the requirements of fiscal policy for the economic well-being of the nation.

Loans to Foreign Governments.—During and after World War I, the United States made loans aggregating more than $10,000,000,000 to foreign governments. More than $7,000,000,000 of these loans were made to allied governments before the Armistice to assist them in purchasing war supplies in the United States. After the Armistice, about $2,500,000,000 of loans were made, and, in addition, about $740,000,000 of excess war supplies, foodstuffs and other relief supplies required for needy populations were sold on credit Funding agreements were reached with 15 of the 20 debtor countries providing for repayment over a period of 62 years. In Dec 1931 congress authorized a moratorium on these debts during the fiscal year 1932 At the expiration of this moratorium, six countries resumed their payments in full and two made token payments; in 1933 Finland continued paying in full but the other seven made only token payments After Dec. 1933 all remittances ceased except those of Finland, which continued payments in full, and Greece and Hungary, which continued to make certain partial payments. It was gradually recognized that war loans must be considered part of the cost of war and not readily collectable.

NATIONAL FINANCES 1930–39

The world-wide depression that began in 1929 produced effects upon the national finances comparable to those of a major war. The efforts of Pres. Herbert Hoover's administration were largely centred on government loans to financially embarrassed railroads, banks, insurance companies and other business enterprises. By the time of Pres. Franklin D. Roosevelt's inauguration (March 4, 1933), however, the rapid spread of banking "holidays" that had been declared in a number of states during the preceding month threatened the imminent collapse of the whole financial machinery of the country President Roosevelt met this situation by an immediate nation-wide suspension of banking operations, followed very shortly by the reopening of all banks that appeared to merit public confidence. In order to achieve greater monetary flexibility, and among other things to stimulate a recovery in commodity prices and an expansion of credit at low interest rates, the operation of the gold standard in the form prevailing before 1933 was suspended, and later the gold content of the dollar was reduced. The pressing problems of farm debts and extremely low agricultural prices were attacked by a broad program of agricultural adjustment and an increase of credit facilities for farmers. The heavy burden of urban as well as farm debt was lightened through the establishment of new credit agencies and the stimulation of old ones. Meanwhile, recognizing the enormous expenditures required for unemployment relief, congress made a greatly increased volume of federal funds available for direct and work relief and as grants-in-aid to the states and their subdivisions for the construction of public works The establishment for the first time of a nation-wide relief system was followed in 1935 by the initiation of permanent measures to provide security against the hazards of unemployment and old age on a national scale.

TABLE I—*Budgetary Receipts, Expenditures and Surplus or Deficit of the Federal Government: 1789 to 1950**
(millions of dollars)

Yearly average of year ending June 30	Receipts				Expenditures				Surplus or deficit
	Total net receipts	Customs	Income and profits taxes	Other	Total expenditures	War and navy departments	Interest on the public debt	Other	
1789–1800	6	5	..	1	6	2	3	1	†
1801–10	13	12	..	1	9	3	4	2	+4
1811–20	21	16	..	5	24	15	5	4	−3
1821–30	22	20	..	2	16	7	4	5	+6
1831–40	30	20	..	10	24	13	†	11	+6
1841–50	29	26	..	3	32	22	2	8	−3
1851–60	60	54	..	6	60	28	3	30	†
1861–65	161	69	28	64	684	623	35	26	+523
1866–70	447	179	51	218	378	156	125	96	+70
1871–75	337	186	8	143	287	64	112	112	+49
1876–80	288	147	†	140	256	33	100	122	+33
1881–85	367	202	†	165	258	59	64	135	+109
1886–90	375	217	..	159	279	58	44	177	+96
1891–95	353	177	†	176	299	80	29	191	+53
1896–1900	435	185	..	250	457	150	38	268	−23
1901–05	559	260	..	299	536	220	28	288	+24
1906–10	679	321	21	337	639	282	23	335	+41
1911–15	710	289	50	371	720	333	23	362	−10
1916–20	3,484	225	1,052	2,306	8,065	4,095	375	3,595	−4,582
1921–25	4,307	604	2,111	1,731	3,579	968	974	1,637	+728
1926–30	4,069	589	2,245	1,235	3,183	745	738	1,700	+886
1931–35	2,771	323	1,116	1,332	5,215	810	606	3,798	−2,444
1936–40	5,044	380	2,269	2,455	8,273	1,348	902	6,023	−3,230
1941	7,227	392	3,470	3,365	13,387	6,252	1,111	6,024	−6,159
1942	12,696	389	7,960	4,347	34,187	22,906	1,256	10,027	−21,490
1943	22,202	394	16,004	5,784	79,622	63,474	1,808	14,400	−57,420
1944	43,892	431	34,655	8,806	95,815	75,076	2,609	16,130	−51,923
1945	44,792	395	35,173	9,224	92,703	73,537	3,617	15,549	−53,961
1946	40,027	435	30,885	8,707	60,703	43,148	4,772	12,784	−20,676
1947	40,043	494	29,306	10,243	39,289	14,760	4,928	19,602	+754
1948	42,211	422	31,171	10,618	33,701	11,983	5,211	16,507	+8,410
1949	38,246	384	29,489	8,380	40,057	13,981	5,320	20,757	−1,811
1950	37,045	423	28,263	8,359	40,167	13,440	5,750	20,977	−3,122

*Because of rounding, detail will not necessarily add to totals
†Less than $500,000

Taxation.—To finance as large a proportion of the increased costs of government through taxation as was compatible with economic recovery, numerous steps were taken to strengthen the tax system. At the same time tax measures were adopted in conjunction with the agricultural, old-age security and unemployment insurance programs.

In 1932 a gift tax, a large group of manufacturers' excise and other miscellaneous taxes were enacted. In 1933 the capital stock tax, the excess-profits tax and taxes on beer, and in 1934 the alcoholic beverage taxes were added. Rates of the estate and gift taxes were increased and exemptions were decreased.

Numerous changes were made in the income tax beginning in 1932 Personal exemptions were reduced Rates of both individual and corporation taxes were increased The corporation tax was converted from a flat percentage to a graduated tax. The earned income credit, the deduction of capital losses and the carry-over of losses were restricted or eliminated but later restored in whole or part Dividends were made subject to the personal normal tax even though they came from corporations that had paid corporation income taxes, and 15% of intercorporate dividends were made taxable Corporations filing consolidated returns were for a while subject to an additional tax, and later the privilege of filing such returns was limited to railroad and street and interurban railway corporations. With a view to rendering the individual income tax more effective, special taxes were imposed on personal holding companies, and the tax on corporations accumulating surplus to avoid surtax on shareholders was strengthened. In 1936 a tax was imposed on undistributed profits, reduced in 1938 and eliminated in 1939 The compensations of the officers and employees of the states and their political subdivisions became taxable under the individual income tax in 1939.

Under the Social Security act of 1935 taxes were imposed on both employers and employees for old-age insurance and unemployment compensation purposes

TABLE II.—*Amount of Interest-Bearing Public Debt Outstanding, the Computed Annual Interest Charge, and the Computed Rate of Interest*
(millions of dollars)

End of fiscal year	Interest-bearing debt	Computed annual interest charge	Computed rate of interest
June 30—			
1916	$ 971	$ 23	2.38
1920	24,061	1,016	4.23
1925	20,270	829	4.11
1930	15,922	606	3.82
1935	27,645	750	2.72
1940	42,376	1,004	2.38
1945	256,356	4,963	1.94
1950	255,209	5,613	2.20

Public Debt.—The successful management of the public debt became a matter of more than ordinary importance after 1932. By reason of the enormous emergency expenditures, the total gross public debt, which amounted to about $16,000,000,000 at its post-World War I low on Dec. 31, 1930, had risen to approximately $40,000,000,000 on June 30, 1939. The problem of arranging the maturities, interest rates and other terms of this large volume of new obligations was complicated by the great desirability of refunding more than $8,000,000,000 of Liberty Loan bonds which became callable during the period. Most of the First Liberty Loan bonds, outstanding in the amount of $1,933,000,000, were exempt from all surtaxes and this made their conversion into ordinary obligations the more desirable. The Fourth Liberty Loan bonds, outstanding in the amount of $6,268,000,000, bore interest at the rate of 4½%, and would have had to be redeemed by 1938 in any event The treasury was able not only to carry through the refunding program and to raise large sums of new money without difficulty, but also substantially to reduce the average rate of interest on the government debt. The reduction in the computed rate of interest that accompanied the growth in the interest-bearing debt between 1930 and 1939 is shown in Table II

Monetary Developments.—Major changes in the country's monetary and banking system took place in the years 1933 to 1935. The disastrous deflation of the period immediately preceding, coupled with the mounting tendency on the part of the public to hoard gold as well as other forms of currency, finally made necessary the temporary suspension of banking operations throughout the country on March 6, 1933. On March 9, congress passed the Emergency Banking act, whereunder it was quickly possible to reopen a large majority of the nation's banks. Confidence in the banking system was restored by the prompt action of the administration; money in circulation, which had mounted to a peak of about $7,500,000,000 in March in reflection of the hoarding movement, declined to about $5,600,000,000 by the end of August A repetition of such banking difficulties was made unlikely by the establishment of the Federal Deposit Insurance corporation pursuant to the Banking act of 1933. The first $5,000 of the commercial or savings deposits of any customer of an insured bank was guaranteed; and all member banks of the federal reserve system, as well as most other banks in the country, became insured banks.

Meanwhile, congressional and executive actions were taken to free the price level from the deflationary forces still conspicuous in gold-standard countries, through instituting a measure of deliberate management and control over the foreign exchange value of the currency The government took possession of and title to all gold coins, gold bullion and gold certificates, and all silver bullion held in the United States except that required for commercial purposes Dollar obligations providing for payment in gold were declared payable in any legal tender coin or currency, and all the outstanding coins and currencies of the country were made legal tender. In line with congressional measures authorizing the president to fix the weight of the gold dollar at not more than 60% and not less than 50% of the previous statutory weight ($25\frac{8}{10}$ grains nine-tenths fine), President Roosevelt, on Jan 31, 1934, proclaimed the weight of the gold dollar to be $15\frac{5}{21}$ grains nine-tenths fine, a reduction of 40 94% The dollar value of the gold held by the treasury was thereby increased by $2,811,000,000 Of this amount, $2,000,000,000 was allocated to a stabilization fund, under the control of the secretary of the treasury, to deal in gold, foreign exchange and other credit instruments for the purpose of stabilizing the exchange value of the dollar. The Gold Reserve act of 1934 prohibited further gold coinage, made the acquisition of gold for export or other purposes subject to regulations prescribed by the secretary of the treasury; and substituted gold certificates for gold coin in the reserve requirements of the federal reserve banks.

Meanwhile, pursuant to the Silver Purchase act of June 19, 1934, declaring it to be the policy of the United States to increase the proportion of silver to gold in the country's monetary stock to one-fourth, the treasury made large purchases of silver bullion at home and abroad By June 30, 1939, 284,000,000 fine ounces of newly mined domestic silver, 1,706,906,000 of foreign silver and 113,000,000 of silver in the United States prior to Aug. 9, 1934, had been purchased The price to be paid for domestic silver newly mined after July 1, 1939, was later increased from 64 to 71 cents per ounce

NATIONAL FINANCES 1940–50

The outbreak of war in Europe in Aug. 1939 ushered in the most spectacular decade thus far in the national finances of the United States. Government expenditures and receipts were raised to levels never before contemplated, not only in absolute terms but in proportion to the national product and income. The national debt, likewise, reached a height that previously would have been thought equivalent to national bankruptcy. In the years after World War II it was evident that government fiscal operations would remain a much more dominating factor in the nation's economy than before the war, even though the wartime levels were drastically curtailed.

Although initial steps to strengthen the nation's defenses were taken immediately after the outbreak of war in 1939, it was only with the fall of France in 1940 that the real threat to the nation and to the entire democratic world from nazi aggression was recognized. A large rearmament program was announced by President Roosevelt and the size of the program was steadily increased throughout the rest of 1940 and 1941.

Vigorous steps were taken to secure the economic mobilization of the nation and lay the groundwork for an overwhelming superiority of arms. As the nazi attack on Great Britain intensified, the lend-lease program was instituted under which assistance was given first to Britain and later to the USSR. when that country was attacked by Germany. President Roosevelt declared that the intention of the nation was to become the "arsenal of democracy and the production goals were made consistent with that aim Soon the U S was not only supplying war matériel to Great Britain but actually convoying the shipments to protect them from axis submarines.

Thus, when the attack on Pearl Harbor by Japan came on Dec 7, 1941, the nation had already made considerable progress toward rearmament and economic mobilization for war President Roosevelt announced a month later, in presenting his first wartime budget message to congress, that the goals for military production would be 50,000 planes per year and 8,000,000 tons of shipping Thereafter, the rapidity of total mobilization for war and the consequent increase in government armament expenditures were spectacular. It may be seen in Table III that total expenditures rose from a little less than $9,000,000,000 in 1939 to almost $99,000,000,000 in 1945 All of this increase grew out of wartime requirements even though, in the breakdown in Table III, it is partly shown under other categories of expenditures Outlays for direct national defense, including lend-lease and the required expansion of industrial capacity, increased to $84,569,000,000 in 1945 whereas they had been only a little more than $1,000,000,000 in 1939 The other large increases were for veterans' benefits transportation and communication and interest on the public debt all of which were an outgrowth of the war The item of transportation and communication is largely accounted for by the wartime merchant marine requirements, while the increase in interest on the public debt reflects the fact that so large a proportion of the government's outlays had to be financed by borrowing On balance there was a significant decline in the nonwar expenditures of the government primarily because the end of the depression of the 1930s under the stimulus of a wartime boom made it possible to curtail social welfare expenditures from almost $4,000,000,000 in 1939 to a little more than $1,000,000,000 in 1945

As soon as World War II ended, a rapid curtailment of war production and demobilization was begun By 1947 government expenditures had been reduced to approximately $40,000,000,000 and by the end of the decade, prior to the outbreak of war in Korea, they were still at that level.

Although national defense expenditures were curtailed much more drastically, it may be seen from the pattern of budget expenditures in 1949 that other activities had assumed a much larger place in the budget. Services and benefits to veterans required an expenditure of $6,669,000,000 in 1949, and while part of this was for such temporary purposes as education and peacetime training, it was apparent that the cost of veterans' benefits would remain high for many years to come Another significant increase shown in the 1949 pattern was for international affairs

TABLE III—*Budget Receipts and Expenditures of the Federal Government, by Function** (in millions of dollars; for years ending June 30)

Source and function	1939	1945	1949
Direct taxes on individuals	1,390	19,789	18,755
Direct taxes on corporations	1,277	16,309	11,554
Excise taxes	1,715	5,924	7,581
Employment taxes	746	1,703	2,467
Customs	359	385	384
Miscellaneous receipts	287	3,480	2,072
Deduct:			
Appropriation to federal old-age and survivors' insurance trust fund	503	1,310	1,690
Refunds of receipts (excluding interest)	61	1,679	2,838
Budget receipts, total	5,103	44,762	38,256
National defense	1,077	84,569	17,914
Veterans' services and benefits	559	2,694	6,669
International affairs and finance	19	617	6,461
Social welfare, health and security	3,042	1,046	7,097
Housing and community development	−154	−103	282
Education and general research	36	150	70
Agriculture and agricultural resources	1,198	1,610	2,512
Natural resources	228	243	1,512
Transportation and communication	498	3,367	1,622
Finance, commerce and industry	51	206	120
Labour	70	204	703
General government	360	955	1,170
Interest on the public debt	941	3,029	5,358
Adjustment to daily treasury statement basis	−63	+252	+272
Budget expenditures, total	8,966	98,703	40,057
Excess of budget expenditures	3,862	53,941	1,811

*Because of rounding, detail will not necessarily add to totals.
Source. Bureau of the Budget.

TABLE IV—*Individual Income Tax Liability under Revenue Acts of 1913–48, for Selected Income Groups**

Revenue act	Income year	Married Person, Two Dependents, with Net Income of									
		$600	$1,000	$2,000	$3,000	$5,000	$8,000	$10,000	$25,000	$100,000	$500,000
1913	1/1/13–12/31/15	.	.	.	.	$10	$40	$60	$260	$2,510	$25,010
1916	1916	.	.	.	.	20	80	120	470	3,020	42,020
1917	1917	.	.	.	$13	64	239	339	1,764	18,164	190,664
1918	1918	.	.	.	36	156	482	782	3,673	34,082	322,082
	1919–20	.	.	.	94	264	738	1,238	6,148	58,148	580,148
1921	1921	.	.	.	.	68	296	536	2,816	31,136	303,136
	1922	.	.	.	.	68	276	456	2,496	30,096	300,576
	1923	.	.	.	.	51	207	342	1,872	22,557	225,432
1924	1924	.	.	.	.	26	81	141	1,525	23,525	199,525
1926	1925–27	.	.	.	.	8	42	83	1,139	16,039	115,029
1928	1928, 1930–31	.	.	.	.	8	42	83	994	15,739	115,739
	1929	.	.	.	.	3	24	40	838	14,846	110,849
1932	1932–33	.	.	.	68	236	416	2,450	30,036	263,536	
1934	1934–35	.	.	.	48	184	343	2,337	30,150	263,364	
1936, 1938	1936–39	.	.	.	48	184	343	2,337	31,997	303,368	
1940	1940	.	.	.	75	246	440	3,571	42,048	329,037	
1941	1941	.	.	.	58	271	717	1,117	6,486	54,106	544,176
1942	1942	.	$13	191	502	1,322	1,914	8,814	63,470	413,384	
	1943	$5	$44	58	269	710	1,553	2,208	9,574	67,803	430,031
1944	1944–45	3	15	45	273	755	1,585	2,245	9,705	68,360	445,985
1945	1946–47	.	.	.	200	560	1,292	1,802	8,522	62,301	406,600
1948	1948	.	.	.	100	432	974	1,361	5,476	41,043	358,077

*Maximum earned net income assumed
Source U S. Department of the Treasury, Bureau of Internal Revenue

TABLE V—*Effective Percentage Rates of Individual Income Tax under Revenue Acts of 1913–48**

Revenue act	Income year	Married Person, Two Dependents, with Net Income of									
		$600	$1,000	$2,000	$3,000	$5,000	$8,000	$10,000	$25,000	$100,000	$500,000
1913	3/1/13–12/31/15	.	.	.	.	0 2	0 5	0 6	1 0	2 5	5.0
1916	1916	.	.	.	.	0.4	1 0	1 2	1 9	3 0	8 6
1917	1917	.	.	.	0 4	1 3	3 0	3 4	7.1	18.2	38 5
1918	1918	.	.	.	1 2	3 1	6 0	7.8	14 7	35 0	64 6
	1919–20	.	.	.	0 8	2 1	4 6	6 0	11 4	31 2	60 6
1921	1921	.	.	.	.	1 4	3 3	5 3	11.3	31 1	60 6
	1922	.	.	.	.	1 4	3 5	4 0	10 0	30 1	52 1
	1923	.	.	.	.	1 0	2 6	3 4	7 5	22.6	39 1
1924	1924	.	.	.	.	0 5	1 0	1.4	6 1	23 5	39 9
1926	1925–27	.	.	.	.	0 2	0 8	1 2	4.5	16 0	23 2
1928	1928, 1930–31	.	.	.	.	0 2	0 5	0 8	4 0	15.7	23 2
	1929	.	.	.	.	0 1	0 3	0 4	3.4	14 9	22 2
1932	1932–33	.	.	.	.	1 4	3 0	4.2	9.8	30 0	52 7
1934	1934–35	.	.	.	.	1 0	2 3	3 4	9.3	30 2	52 7
1936, 1938	1936–39	.	.	.	.	1 0	2 3	3 4	9.3	30 2	60 7
1940	1940	.	.	.	.	1 5	3 1	4 4	12 3	34.0	65 9
1941	1941	.	.	.	1 9	5 4	9 0	11 2	23 9	52 2	68 9
1942	1942	.	.	.	0 7	6 4	11 8	16 5	19 1	35 3	63 5	82.7
	1943	.	.	1 4	3 0	8 0	11 6	15 4	22 1	35 3	63 8	88.0
1944	1944–45	.	.	0 5	1 8	5 3	9 9	13 7	20 8	34.8	68 6	88.6
1945	1946–47	.	.	.	.	6 3	11 8	16 2	18.6	34 1	62 3	81 3
1948	1948	.	.	.	.	3.8	8 6	12 2	13 6	27 9	45 6	71 7

*Maximum earned net income assumed
Source: U S Department of the Treasury, Bureau of Internal Revenue.

and finance, with an expenditure of $6,462,000,000. The major part of this amount was utilized for economic assistance to foreign countries under the Marshall plan and for other types of foreign aid.

Taxation.—In order to meet the fiscal requirements of total war an extensive system of tax increases was instituted from 1940 to 1944. The detailed changes are too numerous to mention but the results of the various tax actions may be seen in the increase in government revenues from $5,103,000,000 in 1939 to $44,762,000,000 in 1945. The large revenue producers were the individual income tax and the taxes imposed on corporation profits, consisting of high wartime rates of surtaxes and a special wartime excess-profits tax. In addition, substantial excise taxes were imposed upon a wide range of luxury goods. Direct taxes on individuals produced almost $20,000,000,000 of revenues in 1945, while the corporation income and excess-profits taxes yielded more than $16,000,000,000. A perspective on the increase in the individual income tax over the years can be seen in Tables IV and V, which show the tax liability and the rate of tax for a typical family of four persons. It will be noted that as late as 1940 such families with incomes of $3,000 were untaxed whereas during World War II even families with as little as $600 had some tax liability. At the upper end of the income scale, the effective tax rate became as high as 88.6% and even in the middle-income brackets the tax rate ranged from 15% to almost 40%.

Taxes began to be lowered soon after the end of World War II. The excess-profits tax on corporations was abolished, income tax rates were generally

TABLE VII.—*Ownership of U.S. Government Securities, Direct and Fully Guaranteed** (in millions of dollars)

June 30	1940	1945	1950
Held by banks, total	18,566	105,990	84,031
Commercial banks	10,100	84,200	65,700
Federal reserve banks	2,466	21,792	18,331
Held by nonbank investors, total	29,030	153,123	174,346
Individuals	19,100	58,000	67,100
Insurance companies	6,500	22,700	20,100
Mutual savings banks	2,100	9,600	11,600
Other corporations and associations	2,800	31,800	38,900
State and local government	400	5,300	8,200
U S. government agencies and trust funds:			
Special issues	4,775	18,812	24,356
Public issues	2,305	6,718	5,474
Gross debt, total	48,496	259,115	257,377

*Detail will not add to totals because of rounding
Source: U S. Department of the Treasury

TABLE VI—*Public Debt of the United States* (in millions of dollars)

June 30	Total debt	Interest-bearing debt						Matured debt	Non-interest-bearing debt
		Total	U.S. savings bonds	Other bonds	Notes	Certificates of indebtedness, treasury bills	Special issues to govt agencies and trust funds		
1930	16,185	15,922	.	13,111	1,626	1,490	764	32	232
1935	28,701	27,643	62	24,874	10,023	2,053	633	231	825
1940	42,968	42,376	2,905	27,012	6,383	1,302	4,775	205	386
1945	258,682	256,357	45,586	107,140	33,053	51,177	18,812	269	2,057
1950	257,377	255,209	57,136	104,491	28,876	31,051	32,156	265	1,883

Sources U S. Department of the Treasury.

TABLE VIII —*Government Corporations and Credit Agencies*
*Principal Assets and Liabilities, June 30, 1950**
(in millions of dollars)

Corporation or agency	Assets, other than interagency items†								Liabilities, other than interagency items			U S government interest	Privately owned interest
	Total	Cash	Loans receivable	Commodities, supplies and materials	Investments: U S govt securities	Investments: Other securities‡	Land, structures and equipment	Other assets	Bonds, notes and debentures payable: Fully guaranteed by U S	Bonds, notes and debentures payable: Other	Other liabilities		
All agencies	24,128	474	12,502	2,186	2,101	3,483	2,924	450	18	774	1,446	21,679	202
Classification by agency													
Department of agriculture													
Farm Credit administration													
Banks for co-operatives	312	22	242	·	43	·	§	5	·	49	1	244	18
Federal intermediate credit banks	638	23	574	·	46	·	·	6	·	552	4	82	·
Production credit corporations	50	1	·	·	40	18	·	§	·	·	§	50	·
Agricultural Marketing act revolving fund	2	§	1	·	·	·	·	1	·	·	§	2	·
Federal Farm Mortgage Corp	51	3	46	·	·	·	·	1	1	·	1	50	·
Rural Electrification administration	1,467	27	1,421	·	·	·	§	18	·	·	§	1,467	·
Commodity Credit corporation	3,250	27	830	2,060	·	·	92	240	§	·	724	2,435	·
Farmers' Home administration	515	27	423	·	1	·	§	34	·	·	2	512	·
Federal Crop Insurance Corp	35	32	·	·	·	·	·	3	·	·	6	28	·
Housing and Home Finance agency													
Home Loan Bank board													
Federal home loan banks	756	23	443	·	288	·	§	2	·	172	324	56	183
Federal Savings and Loan Insurance Corp	195	§	·	·	190	·	·	4	·	·	7	188	·
Home Owners' Loan Corp	95	8	84	·	2	1	·	§	2	§	6	87	·
Public Housing administration¶	1,647	41	320	§	·	§	1,268	18	·	·	27	1,616	·
Federal Housing administration	314	30	20	·	215	§	1	30	16	·	150	148	·
Federal National Mortgage association	1,062	·	1,056	·	·	·	·	6	·	·	8	1,053	·
Reconstruction Finance corporation													
Assets held for U S treasury9	763	·	2	99	·	3	605	55	·	·	·	763	·
Others	1,053	17	913	·	75	1	47	97	·	·	36	997	·
Export-Import Bank	2,251	4	2,236	·	·	§	21	·	·	·	83	2,168	·
Federal Deposit Insurance Corp	1,282	1	§	§	1,276	§	5	·	·	·	5	1,277	·
Federal Works agency	160	§	89	·	·	·	60	11	·	·	7	153	·
Tennessee Valley authority	888	15	§	13	·	·	855	5	·	·	16	871	·
All other	7,425	144	3,812	14	§	3,385	42	19	·	·	22	7,402	·

*Based on compilation by U S department of the treasury
†Assets are shown on a net basis, r e , after reserve for losses
‡Includes U S. investment of $635,000,000 in stock of the International Bank for Reconstruction and Development and its subscription of $2,750,000,000 to the International Monetary fund
§Less than $500,000
¶Includes assets and liabilities of the Regional Agricultural Credit corporation, which were reported as "Disaster Loans, etc., Revolving Fund," after the dissolution of that corporation pursuant to public law 38, 81st congress
¶Includes Farm Security administration program, Homes Conversion program, Public War Housing program, Veterans' Re-use Housing program and Public Housing administration activities under the United States Housing act, as amended
9Assets representing unrecovered costs to the corporation in its national defense, war and reconversion activities, which are held for the treasury for liquidation purposes in accordance with provisions of public law 886, 80th congress.
‡Includes figures for Smaller War Plants Corp , which was being liquidated by the Reconstruction Finance Corp. in 1950.

reduced and the exemption limit was raised from $500 to $600 Further reductions were made in the Revenue act of 1948 when the split-income provision was instituted, allowing a man and wife to count their joint income as having been earned in equal parts by each partner for income tax purposes.

National Debt.—Although revenues were increased substantially during World War II, the level of the government expenditures was so high that a substantial portion had to be financed by borrowing. The result was a precipitous increase in interest-bearing from $42,376,000,000 in 1940 to $256,357,000,000 in 1945. A major part of the treasury's borrowing was accomplished through a series of war bond drives in which great emphasis was placed on the sale of bonds to individuals By 1945 the savings bonds outstanding, which was the main type of security used for this purpose, amounted to more than $45,000,000,000. Throughout its tremendous financing program, the treasury maintained a low interest policy and secured a substantial part of its financial requirements through notes and other short-term securities. In this regard, the World War II experience was much different from that of World War I Whereas the computed rate of interest on all outstanding debts rose to 4¼% by 1920, the interest rate during most of World War II was less than 2% This low rate of interest was partly accounted for by the very low yields of short-term securities.

In the immediate postwar period, the main trends in the government debt are shown in Tables VI and VIII These consist (1) of the shift of the debt from banks to nonbank investors; and (2) in the refinancing of short-term securities The latter shift was accomplished largely by the increase in the special issues to government agencies and trust funds.

As the decade closed the nation appeared once again to be entering a protracted period of rearmament. With the outbreak of war in Korea, government expenditures were increased Individual and corporation income taxes were raised, and a new excess-profits tax on corporate income was enacted. It appeared that further huge increases in the government budget were certain to come.

Government Corporations and Credit Agencies.—A significant development of the depression years and later of the World War II and postwar periods was the large growth of government corporations and credit agencies. Essentially these instruments were used for operations that were business in character such as lending, investing and buying and selling, but which could not be carried out by private business because of their risk or their special relation to the public interest.

In attacking the varied financial problems created by the depression, the federal government made large loans and investments, directly and through governmental corporations and credit agencies; and it guaranteed a large volume of obligations issued by governmental corporations. Through the establishment of the government-owned Home Owners' Loan corporation and Federal Farm Mortgage corporation, the government provided facilities for the emergency refinancing of mortgages on homes and farms These corporations, together with the federal land banks, the Federal Housing administration, the Federal Savings and Loan system and the Federal Savings and Loan Insurance corporation operated to stem the flood of foreclosures on farms and homes and to reduce rates of interest on mortgage loans. In addition, emergency aid was provided for railroads, banking, insurance, industrial and commercial corporations by the Reconstruction Finance corporation. Also, the corporation instrument was used for such purposes as the rural electrification program and the power and flood control program in the Tennessee valley

During World War II the Reconstruction Finance corporation was given broad authority to assure the required expansion of war production facilities and the output of scarce materials In the postwar period the Commodity Credit corporation engaged in large operations to stabilize the prices of farm products through

the credit facilities of the housing agency were utilized for housing purposes

From Table VIII, showing the assets and liabilities of government corporations and credit agencies as of June 30, 1950, it will be seen that the government interest in these agencies was $21,679,000,000 On June 30, 1939, the comparable figure was only a little more than $3,600,000,000, indicating the huge war and postwar growth of these operations. (M. Gt.)

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VII. INDUSTRY AND COMMERCE

Introduction.—The industry and commerce of the United States from the early 19th century to the middle of the 20th century were characterized by successive waves of growth and development, retarded periodically by crises and depressions. Normally the dates of these waves are fixed by the troughs of the depression, but the more significant activities are represented by the crests of the waves During this time there were approximately 11 periods of marked prosperity, during which trade and commerce increased by leaps and bounds The panic years most frequently mentioned are 1825, 1837, 1847, 1857, 1873, 1893, 1907, 1913, 1920 and 1929. In reviewing this sequence it appears that trade and commerce moved in approximately ten-year cycles except for the more profound disturbances caused by the Civil War and World Wars I and II.

In addition to the ten-year cycles there seemed to be longer swings in U.S industrial expansion during which certain industries developed with great rapidity and appeared to dominate the industrial activity of the country. From 1840 to 1860, for example, railroads, agriculture and the textile and iron industries spread over great areas of the country with remarkable rapidity Starting with 23 mi of railroads in operation in 1830, there was a rapid annual increase, to 2,818 mi in 1840, 9,021 mi. in 1850 and 30,626 mi. in 1860. Agricultural products practically doubled in volume during the 27 years between 1839 (when census crop statistics first became available) and 1866 (when regular crop reports were begun in the department of agriculture). The corn harvested for grain in 1839, for example, was 377,532,000 bu., and in 1866 corn production for all purposes was 730,814,000 bu The wheat harvested for grain in 1839 was 84,823,000 bu and in 1866 was 169,703,000 bu Oats harvested for grain in 1839 totalled 123,071,000 bu and in 1866 totalled 232,360,000 bu.

The textile industry had an equally rapid development during that period. Cotton production, despite the war years of 1861–65, held its own. In 1839 it totalled 1,654,000 bales, and in 1866 it was 1,948,000 bales. During that 27-year period, however, its best year was 1859, with a yield of 4,508,000 bales In the factories cotton was being spun into thread and cloth to the busy hum of spindles. In 1840 there were about 2,284,631 spindles preparing for consumer use 236,525 bales of cotton. In 1860 the number of spindles had practically doubled to 5,235,727, and these were busy at a more than tripled bale count of 845,410.

Pig iron production had kept pace. In 1840 the total was 321,331 tons; by 1860 it had almost tripled with 919,770 tons; and by 1866 it was 1,350,343 tons

From the end of the Civil War in 1865 to the beginning of World War I in 1914 the growth in trade and commerce continued to show astonishing progress Agricultural production in-

TABLE I.—*Federal Reserve Industrial Production Index*
(1935–39 average = 100)

Year	Index	Year	Index	Year	Index	Year	Index
1919	72	1927	95	1935	87	1943	239
1920	75	1928	99	1936	103	1944	235
1921	58	1929	110	1937	113	1945	203
1922	73	1930	91	1938	89	1946	170
1923	88	1931	75	1939	109	1947	187
1924	82	1932	58	1940	125	1948	193
1925	90	1933	69	1941	162	1949	176
1926	96	1934	75	1942	199	1950	200

Source Board of Governors of the Federal Reserve System

creased manyfold Cattle increased from 28,636,000 head, valued at $19 13 per head in 1867, to 59,461,000 head, valued at $38 97 per head in 1914. In 1867 hogs numbered 34,489,000 head, valued at $3.95 per head; in 1914 they numbered 52,853,000, valued at $10.51 per head In 1867 stock sheep numbered 44,997 head, valued at $2 40; in 1914 they numbered 38,059,000 head, valued at $3 91.

The production of grain likewise increased In 1867 corn produced for all purposes was grown on 32,116,000 ac and yielded

TABLE II.—*Index Numbers of Volume of Agricultural Production for Sale and Consumption in Farm Households*
(1935–39 average = 100)

Year	Index	Year	Index	Year	Index	Year	Index
1909	79	1920	92	1931	102	1942	124
1910	79	1921	83	1932	96	1943	129
1911	83	1922	91	1933	96	1944	137
1912	85	1923	94	1934	91	1945	134
1913	81	1924	98	1935	91	1946	137
1914	86	1925	97	1936	94	1947	138
1915	86	1926	100	1937	106	1948	138
1916	83	1927	98	1938	103	1949	140
1917	88	1928	102	1939	106	1950	137
1918	90	1929	99	1940	110		
1919	91	1930	98	1941	123		

Source U S Department of Agriculture, Bureau of Agricultural Economics

793,905,000 bu. By 1914 corn was grown on 97,796,000 ac and yielded 2,523,750,000 bu In 1867 wheat was grown on 16,738,000 ac. and yielded 210,878,000 bu.; in 1914 the acreage was 55,613,000 and the production 897,487,000 bu. In 1867 cotton was grown on 7,864,000 ac. and yielded 2,346,000 bales; corresponding 1914 figures were 35,615,000 ac and 16,112,000 bales.

Mineral and industrial products increased even more rapidly. Petroleum increased from an output of 3,591,000 bbl. in 1867 to 265,763,000 bbl. in 1914. Coal production (anthracite and bituminous) increased from 30,724,422 net tons in 1867 to 513,-

TABLE III.—*Gross Farm Income**
(in millions of dollars)

Year	Income	Year	Income without government payments	Income with government payments
1910	6,970	1933	6,338	6,469
1911	6,689	1934	7,423	7,870
1912	7,157	1935	8,415	8,988
1913	7,401	1936	9,712	10,041
1914	7,213	1937	10,265	10,656
1915	7,535	1938	8,980	9,462
1916	9,038	1939	9,121	9,630
1917	12,607	1940	9,618	10,384
1918	15,613	1941	12,651	13,327
1919	16,908	1942	17,100	17,857
1920	15,013	1943	21,597	22,269
1921	9,771	1944	22,581	23,365
1922	10,140	1945	23,776	24,545
1923	11,185	1946	27,488	28,260
1924	11,843	1947	31,709	33,423
1925	12,777	1948	33,480	33,747
1926	12,400	1949	30,651	30,816
1927	12,451	1950	30,100	30,400
1928	12,738			
1929	13,092			
1930	10,652			
1931	7,807			
1932	5,756			

*Includes (1) cash receipts from farm marketings and (2) value of home consumption.
Source. U.S. Department of Agriculture, Bureau of Agricultural Economics.

525,477 in 1914 Pig iron production totalled 1,461,526 net tons in 1867; in 1914, 26,132,113 net tons

But manufactured products set an even faster pace of development than any of the above Steel production figures—available for the first time in 1867—showed for that year an output of 19,643 long tons, in 1914, an output of 23,513,030 long tons. The output of cotton manufactures jumped from 796,616 bales in 1870 to 5,884,733 bales in 1914. A grand total value of all finished commodities, excluding construction materials, gives the financial picture of this growth In 1869 the value totalled $2,723,582,000, by 1914, the value totalled $14,231,028,000 and had increased more than fivefold

The period from the beginning of World War I through World War II saw two depressions: (1) a postwar depression striking its low in 1921, when the index of industrial production declined to 58 (it had been 72 in 1919); and (2) a country-wide depression reaching its low in 1932 with an identical index of 58. (*See* Table I) From 1933, however, when the index was 69, to 1943, when the index was 239, each year except 1938 saw an increase over the preceding year. In 1944 with an index of 235 it began taper-

TABLE IV—*National Income by Distributive Shares*
(in millions of dollars)

Year	Income	Year	Income	Year	Income	Year	Income
1919	64,200	1927	80,200	1935	56,780	1943	150,686
1920	74,200	1928	81,700	1936	64,710	1944	183,838
1921	59,400	1929	87,335	1937	73,627	1945	182,691
1922	60,700	1930	75,003	1938	67,375	1946	180,386
1923	71,000	1931	58,873	1939	72,520	1947	198,688
1924	72,100	1932	41,690	1940	81,347	1948	223,466
1925	76,000	1933	39,584	1941	103,834	1949	216,831*
1926	81,600	1934	46,613	1942	137,179	1950	235,000*

*Preliminary estimate
Source Figures for 1919 through 1938 from Simon Kuznets *et al*, *National Income and Its Composition, 1919–1938*, (National Bureau of Economic Research (1941). Figures for 1939 through 1949 from U S Department of Commerce, "Survey of Current Business" (July 1950)

ing off after the huge output of World War II, until in 1946 it had receded to a more normal 170. It then climbed to 187 in 1947, to 192 in 1948, receded to 176 in 1949 but reached 200 again in 1950

These industrial production index figures become more tangible when some of their elements are considered. To cite but one example, each census of manufactures taken from 1849 to 1947 (*see* Table V) furnishes figures for the value added by the manufacturers to the products which they processed. In 1914 this figure was $9,385,622,000 In 1919 it jumped to $23,841,-624,000. In 1921 it declined to $17,252,775,000, but by 1929 it reached a peak of $30,591,435,000. Ten years later in 1939, following a low of $14,007,540,000 in 1933, it had climbed to $24,487,304,000, and in 1947 had reached an all-time high of $74,425,825,000

The agricultural production index, begun in 1909 by the department of agriculture (*see* Table II) shows an interesting pattern with less fluctuation than does the industrial production index—a difference patently explainable by the very nature of agricultural and industrial production. From a 1914 figure of 86, the index reached 90 in 1918; and although it declined to 83 in 1921, it reached 100 by 1926. It stayed in the upper 90s or low 100s through 1933, dropped to 91 in 1935, began then to climb and by 1940 reached 110. The World War II years pushed it up and there it stayed in the postwar period. By 1949 it reached 140, declining to 137 in 1950

The gross farm income figures, which include (1) cash receipts from farm marketings and (2) value of home consumption, but which do not include income from any farm rentals, are shown in Table III for the years 1910 through 1950 The figure for 1914 was $7,212,000,000. It climbed steadily until 1919, when it reached a peak of $16,998,000,000, then fell to $9,717,000,000 in 1921, climbed slowly to $13,002,000,000 in 1929, fell off sharply to $5,756,000,000 by 1932, began to climb back through the next decade, but not till 1942, even with government payments which began in 1933, did the figure of $17,160,000,000 surpass the earlier peak of 1919. From then on it climbed steadily to a peak of $33,480,000,000 in 1948, receded to $30,631,000,000 in 1949 and again receded slightly to $30,100,000,000 in 1950.

National Income.—The department of commerce began to publish official national income figures for the years in 1929 From 1919 through 1938 Simon Kuznets in his *National Income and Its Composition, 1919–1938* (National Bureau of Economic Research), gave figures based on the original estimates of the National Bureau of Economic Research Table IV includes his figures for 1919 through 1928 and then picks up the official figures in 1929. Kuznets' figures indicated a post-World War I depression trough of $59,400,000,000 in 1921 and a climb to $81,600,000,000 in 1926; the official figures indicated a 1929

TABLE V.—*General Statistics for All Manufacturing Industries in the United States*
(money figures in thousands of dollars)

Year	Number of establishments	Production workers		Value added by manufacture*
		Number (average for the year)	Wages	
1849	123,025†‡	957,059	$ 236,755	$ 461,083*
1859	140,433	1,311,246	378,879	854,257
1869	252,148	2,053,996	620,4078	1,301,198
1879	253,852	2,732,505	947,954	1,973,736
1889	355,804	4,190,355	1,820,851	4,102,701
1899	399,400†	5,097,562	2,206,527	5,474,892
1904	213,644†	5,781,660	2,410,851	9,019,173*
1909	264,810	6,261,716	3,105,213	8,160,075
1914	268,491‡	6,602,287	3,782,322	9,385,622
1919	270,231	8,469,916	9,624,009	23,841,624
1921	192,050	6,475,474	7,451,190	17,252,775
1923	192,908	8,194,170	10,148,824	24,580,487
1925	183,877	7,877,409	9,070,649	25,667,624
1927	187,629	7,848,070	10,090,463	26,315,304
1929	206,663	8,360,705	10,881,019	30,591,435
1931	171,450	6,183,544	6,688,521	18,600,532
1933	130,325	5,787,611	4,940,246	14,007,540*
1935	167,026	7,303,704	7,311,320	18,559,553
1937	206,704	8,995,311	10,112,883	25,173,530
1939	173,302	7,808,205	8,097,515	24,487,304
1947	240,881	11,916,188	20,242,383	74,425,825

*Value of products less cost of materials, supplies, fuel, electricity and contract work For 1849–1933, cost of contract work was not subtracted from the value in calculating value added by manufacture
†From 1849 to 1899, inclusive, this table includes factories and hand and neighbourhood industries From 1904 on this table includes factories, but excludes hand and neighbourhood industries
‡Data for 1849–1914 include all establishments having products valued at $500 or more, from 1914 on, those having products at $5,000 or more
§Reduced to gold basis.
Source U S Department of Commerce, Bureau of the Census, 1947 "Census of Manufactures"

peak of $87,355,000,000 A yearly decline followed, to a low of $39,584,000,000 in 1933 Then came a steady climb, with a slight drop in 1938, until by 1941 the national income totalled $103,-834,000,000 Slight recessions occurred in 1945 and 1946, but 1948 marked a peak of $223,466,000,000, a figure surpassed only by an all-time high of approximately $235,000,000,000 in 1950 These national income figures include compensation of employees (both civilian and governmental), income of unincorporated enterprises (including business, professional and farming), rental income and net interest

On the basis of comparative 1949 figures released by the statistical office of the United Nations "for purposes of economic analysis," it becomes evident that the United States, with its $216,831,000,000 national income for 1949, provided for the average American the world's best annual income of $1,453. The average Russian was about one-fifth as well off with an annual income of $308, and the average Chinese was almost the world's poorest with $27 On the basis of total income, the ten "richest" nations in 1949 were as follows.

United States	$216,831,000,000
U S S R	59,300,000,000
United Kingdom	28,911,000,000
France	19,857,000,000
India	19,574,000,000
West Germany	13,300,000,000
China	12,384,000,000
Canada	11,797,000,000
Italy	10,800,000,000
Japan	8,260,000,000

Manufactures.—During the period 1849–1947 the number of manufacturing establishments almost doubled, from a total of 123,025 to 240,881. (*See* Table V.) During this same period the number of production workers in these establishments had multiplied 12 times from a total of 957,059 in 1849 to a total of 11,916,188 in 1947. The value added to the products processed

by manufacturers multiplied 160 times As reported by the 1947 "Census of Manufactures," this value in 1849 was $463,983,000 and in 1947 was $74,425,825,000 Wages paid the workers multiplied 128 times from an 1849 figure of $236,755,000 to a 1947 figure of $30,242,343,000.

Table VI shows that in number of establishments the middle Atlantic area led with 75,363 for 1947, the east north central area

TABLE VI—*Density of Manufacturing in the United States*
(money figures in thousands of dollars)

Region	Number of establishments		Value added by manufacture	
	1939	1947	1939	1947
New England	14,301	20,274	$ 2,413,068	$ 6,811,800
Middle Atlantic	53,226	75,363	7,308,760	20,790,620
East north central	38,013	50,570	7,744,496	21,473,363
West north central	14,966	17,403	1,348,167	4,110,409
South Atlantic	16,657	24,001	2,216,976	6,942,054
East south central	7,921	10,997	811,101	2,875,128
West south central	9,309	13,181	815,276	3,027,709
Mountain	1,787	3,049	169,187	839,029
Pacific	16 119	24,133	1,146,951	5,844,924
Total	173,802	240,881	24,487,312	74,495,825

Source: U.S. Department of Commerce, Bureau of the Census, 1947 "Census of Manufactures"

was second with 50,570; and the Pacific area was third with 24,133 From the measurement of value added by the manufacturer, the east north central area led with $23,473,563,000 for 1947; the middle Atlantic area was second with $20,790,626,000, and the south Atlantic area was third with $6,942,054,000.

In Table VII is shown a breakdown by industry groups for the years 1939 and 1947 on three items. the number of establishments, the number of production workers and the value added by manufacture

In the number of establishments, those manufacturing food and kindred products led all others with a count of 39,993 for 1947 In second place were establishments manufacturing apparel and related products with a 1947 figure of 30,960 and in third place were printing and publishing industries with 28,986 for 1947

In the number of production workers, establishments manufacturing nonelectrical machinery such as tractors, construction and mining machinery, machine tools and office equipment led with 1,244,135 for 1947. In second place were establishments manufacturing textile and mill products with 1,147,194, and in third place were establishments manufacturing food and kindred products, with a 1947 figure of 1,099,478

Establishments manufacturing food and kindred products also led in value added, with a 1947 figure of $9,024,912,000 In second place stood the nonelectrical machinery manufacture, with $7,812,455,000. In third place was the manufacture of transportation equipment, including among other items motor vehicles, aircraft, ships and railroad locomotives, with a 1947 figure of $5,869,196,000.

Wholesale Trade.—A comparative study of wholesale establishments for the years 1929 (with its first official "Census of Wholesale Distribution"), 1939 and 1948 shows a steady increase in the number of wholesale establishments In 1929 there were 168,262; in 1939, 199,726, an increase of almost 19% over 1929, and in 1948, 243,366, an increase of 22% over 1939 The sales of these establishments, however, showed more than a 17% decline from the 1929 figure of $66,739,607,000 to the 1939 figure of $54,888,480,000, but a sharp rise of 244% from this 1939 figure to the 1948 figure of $188,688,801,000

Included in the 243,366 wholesale establishments for 1948 were 146,518 merchant wholesalers (*see* Table VIII) with sales of $79,766,589,000, up 254% from the 1939 figure of $22,537,832,000; 23,768 manufacturers' sales branches and offices with sales of $52,738,577,000, up 270% from the 1939 figure of $14,253,609,000; 29,451 petroleum bulk stations with sales of $10,615,650,000, up 179% from the 1939 figure of $3,807,908,000; 24,361 merchandise brokers or agents with sales of $34,610,093,000, up 194% from the 1939 figure of $11,779,499,000, and 19,268 assemblers of farm products with sales of $10,957,893,000, up 337% from the 1939 figure of $2,509,632,000.

The number of employees in all wholesale establishments increased from 1,605,347 in 1939 to 2,382,789 in 1948, an increase of about 42% The pay roll for all wholesale establishments in 1948 amounted to $7,990,713,000.

Retail Trade.—The first complete measure of retailing was contained in the 1929 "Census of Retail Distribution." For that

TABLE VII—*Comparative Summary of Industry Groups*

Group	Number of establishments		Number of production workers		Value added by manufacture (in thousands of dollars)	
	1939	1947	1939	1947	1939	1947
Food and kindred products	43,667	39,993	802,133	1,099,478	$3,484,696	$9,024,912
Tobacco manufacture	761	1,086	87,325	103,289	350,152	641,356
Textile mill products	6,388	8,185	1,081,710	1,147,194	1,817,906	5,340,876
Apparel and related products	20,275	30,960	752,829	972,897	1,386,004	4,443,373
Lumber and products, except furniture	23,208	26,231	422,047	506,118	731,208	2,497,192
Furniture and fixtures	5,178	7,687	189,382	282,780	417,785	1,377,968
Paper and allied products	3,328	4,103	270,239	388,401	880,350	2,874,058
Printing and publishing industries	24,878	28,986	324,371	438,135	1,765,314	4,260,416
Chemicals and allied products	8,830	10,073	275,669	466,458	1,818,041	5,365,201
Petroleum and coal products	1,227	1,387	107,695	169,610	697,273	2,015,307
Rubber products	595	875	120,740	214,533	466,155	1,302,863
Leather and leather products	3,505	5,308	327,189	348,290	582,015	1,532,803
Stone, clay and glass products	6,678	11,650	267,094	405,755	836,321	2,306,480
Primary metal industries	3,512	5,363	672,438	1,010,055	2,168,809	5,765,434
Fabricated metal products	9,332	16,734	451,087	822,514	1,400,883	4,021,476
Machinery (except electrical)	8,860	17,906	536,082	1,244,135	2,036,965	7,812,455
Electrical machinery	1,079	3,073	247,030	639,147	941,469	3,894,115
Transportation equipment	2,012	3,711	544,553	987,142	1,772,573	5,869,196
Instruments and related products	1,292	2,297	84,867	181,030	333,409	1,080,336
Miscellaneous manufactures	8,084	14,132	241,725	327,570	629,094	2,000,168

Source: U.S. Department of Commerce, Bureau of the Census, 1947 "Census of Manufactures"

year the total sales of retail stores stemming from 1,543,158 establishments amounted to $49,114,653,000. The trough of the depression in retailing came in 1933, when sales dropped to $24,517,000,000 By 1935 from a total of 1,587,718 stores came sales of $32,791,212,000 and by 1939 from a total of 1,770,355 stores came sales of $42,041,790,000. Nine years later, however, in 1948, from a slightly lower number of stores—1,769,540—came a record sales figure of $130,520,548,000, an increase of more than 200% over 1939 Table IX shows in detail the kinds of business making up these sales figures for 1939 and 1948 The table includes figures not only for the retail outlets themselves but also for the warehouses, administrative offices and other auxiliary units serving these retail stores.

The 1948 annual pay roll for retail establishments represented about 11% of the estimated total paid to all wage earners and salaried employees in the United States for that year In 1939 to a total of 4,933,141 employees was paid the sum of $4,763,076,000; in 1948 to a total of 7,083,315 employees was paid the sum of $14,186,159,000. A comparative check of the two years shows an increase of almost 8% from 1939 to 1948 in the number of active proprietors, but virtually no change in the number of unpaid family members

It is interesting to note that about 56,000 fewer food stores were in operation in 1948 than in 1939 but about 41,000 more eating and drinking places and about 14,000 more liquor stores, the latter showing an increase of almost 75% over 1939.

The accelerated increase in population, in the building of new homes and in the migration of families was indicated in the 62% increase of 1948 over 1939 of furniture, furnishings and household appliance stores. In 1939 there were 52,827 such stores; in 1948 there were 85,585. The number of lumber, building and hardware stores likewise showed an increase over 1939, when

TABLE VIII.—*Comparative Summary of Merchant Wholesale Establishments*

Merchant wholesalers	Number of establishments			Sales for entire year (in thousands of dollars)			Number of paid employees*	
	1929	1939	1948	1929	1939	1948	1939	1948
Groceries, confectionery, meats	15,224	15,681	17,345	5,386,861	5,040,781	12,356,738	153,704	182,847
Farm products (edible)	5,072	10,045	13,530	3,061,240	2,170,766	7,590,041	94,122	155,933
Beer, wines, distilled spirits	†	9,252	7,195	†	1,249,524	4,060,726	45,111	61,837
Druzs, chemicals, allied products	2,376	2,908	4,071	947,962	1,170,215	3,382,230	20,426	36,042
Tobacco products (except leaf)	1,721	3,717	3,010	858,329	1,106,218	2,830,576	18,289	26,143
Dry goods, apparel	7,382	8,972	11,733	2,817,742	1,888,923	5,391,719	48,980	70,451
Furniture, home furnishings	1,750	2,214	3,823	494,777	373,494	1,314,945	18,815	32,187
Paper and its products	2,297	2,898	4,044	704,388	574,073	1,901,747	21,912	40,057
Farm products (raw material)	3,400	7,080	9,394	3,697,426	1,628,796	6,903,903	27,722	24,568
Automotive	3,431	7,818	14,603	1,883,057	1,085,387	4,007,560	67,380	136,129
Electrical goods	2,182	3,072	5,442	845,698	788,094	4,424,560	38,593	60,448
Hardware plumbing and heating	5,033	3,568	5,901	1,312,738	971,975	3,820,657	62,715	102,740
Lumber, construction, materials	3,773	3,302	3,890	1,282,801	804,390	3,914,756	37,420	87,064
Machinery, equipment, supplies	6,088	11,270	21,430	1,968,700	1,440,371	6,731,372	89,779	189,617
Metals, metal work (excluding scrap)	852	1,617	1,803	672,581	551,975	2,256,715	17,216	31,568
Waste materials	3,919	6,259	7,717	474,453	656,000	3,099,300	46,423	59,847
Other merchant wholesalers	17,032	10,508	15,688	4,004,250	2,030,874	8,413,740	88,501	138,532
Total	70,178	100,961	146,518	30,205,174	22,537,832	70,760,589	948,607	1,207,000

*Work week ended nearest to Nov 15 †Not available.
Source U S Department of Commerce, Bureau of the Census, 1948 "Census of Business"

TABLE IX.—*Comparative Summary of Retail Stores*
(money figures in thousands of dollars)

Stores	Number of establishments		Sales for entire year		Pay roll for entire year		Paid employees*	
	1939	1948	1939	1948	1939	1948	1939	1948
Food group	560,549	504,439	$10,164,967	$30,965,574	$ 760,762	$1,941,067	814,716	1,005,897
Eating and drinking places	305,388	346,556	3,530,052	10,883,324	565,585	1,040,907	830,063	1,337,186
General stores	30,688	21,527	870,342	1,139,361	47,376	65,785	62,433	41,444
General merchandise group	20,367	32,544	5,665,007	25,972,157	803,482	2,504,208	565,884	1,331,387
Apparel group	106,059	115,246	3,258,772	9,803,218	420,823	1,178,890	417,196	585,701
Furniture, furnishings, appliance group	52,827	55,585	1,731,577	6,914,179	180,542	915,623	129,959	376,311
Automotive group	60,132	86,162	5,528,687	20,504,054	507,047	1,886,370	400,106	613,553
Gasoline service stations	211,858	188,163	2,822,405	6,483,190	198,034	488,380	206,600	282,954
Lumber, building, hardware group	79,373	98,028	2,736,024	11,251,402	312,160	1,182,354	257,641	475,413
Drug and proprietary stores	37,003	55,796	1,562,502	4,013,231	179,733	408,485	192,296	282,891
Liquor stores	19,136	33,422	586,251	2,570,507	30,782	116,303	27,063	52,404
Secondhand stores	23,062	16,069	138,007	304,624	10,758	30,557	24,132	20,652
Other retail stores	174,115	164,023	3,496,437	10,383,218	407,609	1,031,162	362,444	460,306
Total	1,770,155	1,769,540	49,041,790	130,520,548	4,529,499	13,567,097	4,821,806	6,018,601
Warehouse, administrative offices, auxiliary units	3,579	1,777			233,577	618,162	111,333†	165,954
Total for all retail establishments	1,773,734	1,771,317	49,041,790	130,520,548	4,763,076	14,185,150	4,933,141	7,084,115

*Work week ended nearest to Nov. 15 †For work week of Oct 31, 1939, or other normal work week
Source U S Department of Commerce, Bureau of the Census, 1948 "Census of Business."

there were 79,313 such stores, in 1948 there were 98,038, an increase of more than 24%. Practically half of this increase was accounted for by farm equipment dealers.

There was a 22% decrease in the number of gasoline service stations from 1939, when there were 241,858, to 1948, when there were 188,253 such stores. The number of establishments in the automotive group, on the other hand, increased In 1939 there were 60,132; in 1948 there were 86,162, an increase of more than 44%

Service Trades.—In the nine years following 1939, the first year for which the census bureau issued figures on service trades, the country showed a slight decrease in the number of service establishments, from 570,057 in 1939 to 559,559 in 1948 (*See* Table X) Florida, however, showed a 43% gain in the number of establishments; Arizona a 40% gain, and New Mexico a 38% gain Furthermore, the number of business services such as advertising agencies and private employment agencies showed a gain of 22%, and automobile repair services and garages showed a gain of 21%.

Although the number of establishments decreased, the receipts did not Service trades reported receipts for 1948 of $8,578,162,000, an increase of 188% over the 1939 figure of $2,973,593,000 New Mexico was first, reporting a gain of 345%; Florida second with 305%; and Alabama third with 300%. Employment also increased during the period. For the work week ended nearest to Nov. 15, 1939, the count was 936,271; for the comparable 1948 period it was 1,342,496.

For the country as a whole, the annual pay roll more than tripled, increasing from a 1939 figure of $911,248,000 to a 1948 figure of $2,861,214,000.

Mineral Products.—From 1880 to 1948 the total value of all mineral products in the United States multiplied about 42½ times. The total value in 1880 was $367,463,000; in 1948 it was an estimated $15,620,000,000. (*See* Table XI.) From 1900 through 1910, with minor declines in 1904 and 1908, the total climbed from $1,108,936,000 to $1,987,844,000. By 1920, with minor declines in 1911, 1914 and 1919, the total climbed to $6,981,340,000. Beginning the next decade with a decline in 1921, there were four others. 1924, 1927, 1928 and a 1930 decline to $4,764,800,000 Beginning the next decade with a decline in 1931, which carried over to 1932, and another in 1938, the 1940 figure climbed to a total of $5,613,900,000. Through 1944 the total climbed, receded in 1945 and hit an estimated $12,393,000,000 in 1947 to achieve a high in 1948.

Of the 1948 totals, $3,690,000,000 represented the value of the production of metallic minerals, some of which are listed in Table XIII; $11,930,000,000, the value of the production of nonmetallic products, and $10,180,000,000 the value of fuels. Table XIII shows that for 1947 the most valuable metallic mineral was pig iron, with a valuation of $1,770,659,000, and the most valuable nonmetallic mineral was petroleum, with a 1947 figure of

TABLE X.—*Comparative Summary of Service Trades*
(money figures in thousands of dollars)

Kind of service store	Number of establishments		Receipts for entire year		Pay roll for entire year		Paid employees*	
	1939	1948	1939	1948	1939	1948	1939	1948
Personal services	380,726	351,085	$1,821,584	$4,440,189	$571,610	$1,580,533	651,072	851,094
Business services	26,188	32,007	486,912	1,630,513	109,464	691,226	141,491	249,982
Automobile repair services and garages	78,881	95,544	440,892	1,561,109	97,514	355,368	96,424	151,576
Miscellaneous repair services	75,262	80,923	224,205	947,351	42,660	232,088	43,284	91,914
Total	570,057	559,559	2,973,593	8,578,162	911,248	2,861,214	936,271	1,342,496

*Work week ended nearest to Nov. 15
Source: U.S. Department of Commerce, Bureau of the Census, 1948 "Census of Business."

TABLE XI.—*Value of Mineral Products of the United States* (in thousands of dollars)

Year	All mineral products	Metallic	Nonmetallic		
			Total	Fuels*	Other
1880	367,403	190,881	176,582	120,041	56,541
1890	615,429	303,937	311,492	230,962	80,530
1900	1,208,928	514,739	694,704	566,376	128,328
1910	2,087,824	750,027	1,337,817	828,313	509,504
1920	6,081,340	1,765,675	4,315,665	4,091,916	1,024,755
1930	4,764,800	985,760	3,779,010	2,754,500	1,024,510
1935	3,659,000	733,130	2,916,870	2,330,000	586,870
1940	5,013,000	1,679,600	3,033,300	3,210,500	818,800
1945	8,141,000	1,975,000	6,166,000	5,213,000	954,000
1946†	8,896,000	1,825,000	7,071,000	5,760,000	1,311,000
1947†	12,393,000	9,975,000	9,478,000	7,843,000	1,635,000
1948†	15,600,000	3,890,000	11,930,000	10,180,000	1,750,000

*Includes coal, natural gas, natural gasoline and allied products and petroleum
†Figures subject to later revision.
Source U S Department of the Interior, Bureau of Mines.

$3,548,266,000, followed by coal, with a 1947 total of $2,975,394,000.

It is interesting to note that in 1880 (*see* Table XI) the value of fuels—including coal, natural gas, natural gasoline and allied products and petroleum—made up only 33% of the total value of all mineral products, but in 1948 the value of fuels made up 65% of the total. A glance at the petroleum value figures given in Table XII for selected years will explain one element entering into the fuels value. For example, the 1947 petroleum figure of $3,548,266,000 (*see* Table XIII) constituted 28% of the entire value of mineral production for that year, amounting to $12,393,000,000 (*see* Table XI).

In the matter of employment, there was a 37% decrease from 1911 to 1947. In 1911 there were engaged in quarries and related industries 110,954 production workers; in coal mines 728,348; and in mines other than coal 165,979, a total of 1,005,281 production workers in mineral products. In 1947 the comparable group figures were 80,300 for quarry and related industries, 469,100 for coal mines and 84,000 for mines other than coal, a total of 633,400. In 1947 wages and salaries paid to workers in the mining industries were estimated at $2,920,000,000.

Shifts in Occupations.—In 1820 the population of the continental United States was 9,638,453; of this number 6,487,875 were ten years old or more. Within this age group 2,881,000, or 44.4%, were gainfully occupied. In 1940 the United States had a population of 131,669,275, of whom 110,443,129 were ten years old or more Within this age group, 52,148,251, or 47.2%, were gainfully occupied.

While the percentage figure had increased only slightly during this 120-year period, the accelerated production and distribution of agricultural, industrial and mineral products had brought about important changes in the occupations of U.S. workers. Perhaps nowhere was this occupational change more marked than in agriculture. In 1820, for example, 71.8% of the gainfully occupied persons were engaged in agricultural pursuits. By 1880 the percentage had decreased to 49.4%, by 1900 to 34.9%, by 1920 to 25.9%, by 1940 to 22.7% and by 1948, with a labour force of 62,748,000 and with 7,973,000 engaged in agricultural pursuits, the percentage had dropped to 12.7%.

The trend in manufacturing, as would be supposed, was the opposite In 1820 only 12.2% of gainfully occupied persons were engaged in manufacturing, hand trades and construction By 1880 the percentage had increased to 18.5% By 1900, with the quickened pace of commodity processing and marketing, not only had employment in manufacturing increased, but employment in the wholesale, retail and service trades had become an important factor. In these three categories and for the period between 1900 and 1940 (*see* Table XII) manufacturing stood first in the number of employees. The figure of 6,090,000 in 1900 accounted for 22.2% of all gainfully occupied persons, and the 1940 figure of 11,288,000 accounted for 24.3% of total employment. For a comparison of the number of production workers in the various manufacturing groups for the years 1939 and 1947 *see* Table VII.

Employment in the service trades stood second to that of manufacturing, rising steadily from 1900 with 3,942,000, or 14.4% of the total, to 1940 with a high of 10,432,000, or 22.4% of the total The group including trade, distribution and finance was third, increasing from the 1900 figure of 3,224,000, or 11.7% of the total, to the 1940 figure of 7,631,000, or 16.4% of the total.

Within the larger several groupings, there were of course employment variations for individual occupations The same was true for the years 1939 to 1948 In the wholesale trade area, for example, total employees of the dairy and poultry products establishments numbered 52,342 in 1939 but 103,476 in 1948. Employment figures for these same years in furniture and home furnishing establishments rose from 18,817 to 32,187; in automotive establishments from 67,380 to 136,329; in electrical goods establishments from 38,592 to 90,448, and in hardware, plumbing and heating wholesale houses from 62,715 to 102,740. On the other hand, employment decreased in general dry goods establishments, wallpaper stores and in establishments selling farm products (raw materials).

In the retail field, women's ready-to-wear stores employment rose during this nine-year period from 143,985 to 228,881, but millinery stores employment fell from 24,569 to 11,374 Household appliance stores employment increased from 69,818 to 118,176 but that for grocery stores not selling meat decreased from 131,543 to 89,043 Radio stores employment increased from 5,783 to 14,399 and hardware stores from 57,998 to 113,165.

In the service trades for this period, there were also employment shifts In personal service shops as a whole there was increased employment, from 653,072 in 1939 to 851,024 in 1948; but there was a decline in employment both in barber and in beauty shops. Employment in cleaning and dyeing plants rose from 87,421 to 210,026. Laundries and laundry services increased employment from 266,528 to 329,728, but shoe repair shops, shoeshine parlours and hat cleaning shops decreased employment from 23,447 to 22,900.

From 1910 to 1940 the percentage of professional persons to the *total* number of employed persons increased from 4.4 to 6.5, that of proprietors, managers and officials decreased from 13.0 to 11.8; that of clerks and kindred workers increased from 10.2 to 17.2; that of skilled workers was the same at 11.7; that of semi-skilled workers increased from 14.7 to 21.0; and that of unskilled workers (there were 13,457,151 in 1940) decreased from 36.0 to 25.9.

Not only was there a shifting in occupations, but more women were employed in various jobs throughout the country. In 1890 there was a total of 3,596,615 employed women In 1940 the total was 13,770,000, an increase of 282.8%. In each age group there was a proportionate increase. In 1890 there were 2,986,668 women employed whose ages ranged from 16 to 44; in 1940 there were 10,710,000, an increase of 258.6%. In the age group from 45 to 64 the rise was from 493,750 in 1890 to 2,750,000 in 1940,

TABLE XII.—*Gainful Workers in the United States, Ten Years and Over, by Occupations** (in thousands of persons)

Occupations	1900	1910	1920	1930	1940
Agriculture .	9,522	11,610	10,728	11,172	10,580
Per cent of total	35.9	31.9	27.0	24.8	22.7
Forestry and fishing	166	214	236	241	208
Per cent of total	0.7	0.6	0.6	0.5	0.4
Extraction of minerals	653	1,168	1,232	1,033	736
Per cent of total	2.4	3.1	3.0	2.1	1.6
Manufacturing	6,090	8,990	11,613	9,770	11,288
Per cent of total	22.2	23.9	26.7	21.2	24.2
Construction	1,639	2,192	1,382	1,842	1,907
Per cent of total	6.0	5.8	3.8	4.2	4.2
Transportation	1,353	2,013	2,603	2,287	1,948
Per cent of total	4.9	5.4	6.2	5.0	4.2
Public utilities	276	615	932	1,151	956
Per cent of total	1.0	1.6	2.3	2.5	2.0
Trade, distribution and finance	3,224	4,622	5,643	7,800	7,631
Per cent of total	11.7	12.3	13.6	16.9	16.4
Service industries .	3,942	5,467	6,552	8,017	10,432
Per cent of total	14.4	14.5	15.8	19.3	22.4
Miscellaneous	281	702	828	945	978
Per cent of total	1.1	1.9	2.0	2.1	2.0
All occupations	27,378	37,580	41,339	46,080	46,684
Per cent of total	100	100	100	100	100

*Figure does not agree with that in text because of differing concepts of "gainful workers" and "gainfully occupied"
Source Labour force figures: U S Department of Commerce, Bureau of the Census, "Historical Statistics of the United States"

TABLE XIII—*Quantity and Value of Certain Mineral Products of the United States*
(value in thousands of dollars)

Minerals	1930	1935	1940	1945	1946	1947
Metallic						
Aluminum						
Quantity (1,000 lb)	229,037	279,295	472,560	900,120	810,260	1,143,500
Value	50,961	52,070	75,792	140,864	115,812	161,926
Bauxite						
Quantity (long tons)	330,512	233,012	434,988	981,009*	1,104,054*	1,302,021*
Value	1,928	1,557	2,579	5,501*	6,893*	6,885*
Chromite						
Quantity (long tons)	80	515	2,662	12,476	3,666	846
Value	2	6	29	332	105	†
Copper (sales)‡						
Quantity (short tons)	697,195	381,904	909,084	782,726	599,636	862,872
Value	182,271	63,195	205,433	184,7315	172,701§	360,6885
Ferroalloys						
Quantity (short tons)	728,269	663,337	1,192,660	1,661,657	1,557,624	1,841,682
Value	51,900	48,892	128,128	210,510	176,274	220,022
Gold‖						
Quantity (1,000 troy oz)	2,286	3,609	6,003	929	1,462	2,165
Value	47,948	126,325	210,109	32,511	51,182	75,786
Iron, pig						
Quantity(1,000 short tons)	33,494	33,720	46,059	53,965	45,076	58,368
Value	572,105	358,145	840,442	1,172,435	1,103,029	1,770,659
Lead						
Quantity (short tons)	608,588	324,164	516,648	443,467	338,000	440,047
Value	60,609	25,023	51,663	56,764	36,801	126,111
Manganese Ore						
Quantity (short tons)	75,080	20,599	44,938	182,337	140,635	131,627
Value	2,437	557	1,169	7,320	4,811	4,201
Mercury						
Quantity (flasks, 76 lb net)	21,553	17,518	37,727	30,763	25,348	23,244
Value	2,479	1,201	6,682	4,150	2,490	1,946
Molybdenum						
Quantity (1,000 lb)	3,759	10,892	25,329	33,683	16,787	22,190
Value	2,068	7,261	17,189	23,976	11,529	15,178
Nickel						
Quantity (short tons)	308	260	554	1,155	352	646
Value	214	130	†	†	†	†
Platinum¶						
Quantity (troy oz)	43,502	43,060	47,339	33,592	30,237	17,442
Value	2,049	1,444	1,986	1,543	1,802	990
Silver9						
Quantity(1,000 troy oz)	50,748	45,024	69,586	29,063	21,103	38,387
Value	19,538	33,008	49,483	20,607	19,100	34,923
Tungsten ore§						
Quantity (short tons)	702	2,395	5,319	5,534	5,793	5,004
Value	509	1,921	6,576	7,093	6,283	4,350
Zinc‡						
(sales value)						
Quantity (short tons)	489,361	412,184	580,988	467,084	459,205	510,058
Value	46,079	36,272	74,338	80,3385	81,7385	109,1525
Nonmetallic						
Barite						
Quantity (short tons)	234,932	225,111	400,353	696,062	724,362	834,682
Value	1,538	1,251	2,897	5,349	5,243	6,172
Cement						
Quantity(1,000 bbl , 376 lb net)	169,816	76,244	139,864	207,833	179,101	190,420
Value	251,249	114,810	193,465	275,431	226,552	261,978
Clay (raw)*						
Quantity(1,000 short tons)	3,063	2,923	4,701	18,628	30,265	33,270
Value	12,521	10,824	18,162	39,795	57,160	69,623
Coal						
(bituminous)*						
Quantity(1,000 short tons)	467,226	372,373	460,772*	577,617	533,922	619,000
Value	792,483	638,063	879,327*	1,798,204	1,835,539	2,362,372

Minerals	1930	1935	1940	1945	1946	1947
Coal (Pa anthracite)						
Quantity(1,000 short tons)	69,385	52,150	51,485	54,034	60,507	57,790
Value	354,574	210,131	205,490	323,044	413,417	443,019
Coke						
Quantity(1,000 short tons)	47,072	35,142	57,072	67,308	58,408	73,446
Value	209,137	176,853	273,832	508,540	486,790	776,406
Feldspar(crude)						
Quantity (long tons)	171,388	189,150	290,763	373,054	508,280	459,010
Value	1,067	1,005	1,272	2,022	2,504	2,412
Gypsum						
Quantity (1,000 short tons)	3,472	1,904	3,699	3,822	5,629	6,208
Value	27,052	18,860	5,228	6,984	12,442	16,230
Helmme						
Quantity (1,000,000 cu ft)	9,806	10,218	9,431	128,441	63,403	63,190
Value	140	124	83	937	479	541
Lime						
Quantity(1,000 short tons)	3,388	2,987	4,887	5,921	5,003	6,779
Value	25,816	21,749	33,950	45,928	51,033	63,820
Magnesite (crude)						
Quantity (short tons)	129,320	177,154	333,166	336,458	324,620	375,903
Value	1,253	1,192	2,388	2,325	2,296	2,597
Natural gas**						
Quantity (1,000,000 cu. ft)	1,045,421	1,016,595	1,660,222	3,018,686	4,030,605	4,444,663
Value	216,090	229,374	377,930	837,854	885,878	1,031,200
Natural gasoline and cycle products						
Quantity (1,000 gal)	2,210,491	1,651,986	2,330,400	3,290,040	3,451,688	3,654,320
Value	128,160	70,040	68,162	145,570	146,102	218,800
Petroleum						
Quantity(1,000 bbl , 42 gal)	898,021	906,506	1,353,274	1,713,655	1,733,039	1,836,107
Value	1,070,200	961,440	1,285,440	2,094,250	2,449,550	3,146,266
Phosphate rock						
Quantity(1,000 long tons)	3,916	3,042	4,003	5,807	6,861	9,087
Value	23,027	19,052	22,333	23,952	31,044	47,462
Potassium salts (K2O)						
Quantity (short tons)	56,610	224,721	303,068	870,370	928,374	1,053,366
Value	2,086	4,093	22,562	30,314	32,176	34,716
Pyrites						
Quantity (long tons)	347,512	514,192	626,640	722,596	813,372	940,652
Value	2,693	2,583	2,920	2,700	3,228	4,070
Salt						
Quantity(1,000 short tons)	8,054	7,927	10,360	15,304	15,132	16,138
Value	25,009	21,838	26,475	43,914	44,033	52,276
Sand and gravel††						
Quantity(1,000 short tons)	195,903	121,798	235,548	190,842	240,282	289,328
Value	111,566	58,242	105,600	120,463	161,845	205,474
Silica (quartz)						
Quantity (short tons)	13,156	17,178	31,865	57,764	73,179	73,347
Value	121	112	176	237	294	369
Slate						
Quantity (short tons)	463,610	330,200	473,450	551,800	750,770	876,010
Value	7,912	3,650	5,738	5,659	8,844	11,686
Stone						
Quantity(1,000 short tons)	126,906	83,150‡‡	153,735‡‡	253,405‡‡	278,852‡‡	307,555‡‡
Value	178,949	87,844‡‡	180,044‡‡	179,308‡‡	234,339‡‡	289,344‡‡
Sulphur						
Quantity(1,000 long tons)	1,000	1,635	2,559	3,833	4,128	4,828
Value	35,800	29,300	40,900	61,300	66,100	85,000

*Represents dried bauxite equivalent. †Not available ‡Product from domestic ores only §Value does not include premium paid to miners by the government. ‖According to the bureau of the mint, valued at $20.67+ per ounce through 1930, at $35 per ounce in 1935 and subsequent years ¶Value, New York City. 9According to the bureau of the mint 66⅔ concentrates *Sold by producers **Includes brown coal and lignite and anthracite mined elsewhere than in Pennsylvania. *Quantities as reported by the bituminous coal division, department of the interior, values include selling expense. *Optimum fmished for 1940 and subsequent years; value of crude at mine, for earlier years, value as sold (crude and calcined) ††Figures cover fiscal year ending June 30 of year stated **Valued at point of consumption. ††Not including glass sand ‡‡Includes soapstone used for dimension stone

Source. U S Department of Commerce, Bureau of the Census, *Statistical Abstract of United States.*

an increase of 458 6%. In the age group of 65 and over, the increase was from 98,158 in 1890 to 310,000 in 1940, or 216 2%.

Wages and Salaries.—Of the 1942 total of income from all private industry, $120,436,000,000, almost 55%, or $65,788,000,000 was paid out in wages and salaries. Of the 1949 total of income, $194,529,000,000, 58%, or $113,733,000,000, was paid out in wages and salaries.

In 1949 this average of more than 50% held true for seven of the nine classifications listed in Table XIV. Transportation payments were highest, with 77.5% of income paid out in wages and salaries. Manufacturing came next, with 69.8%, and was followed in turn by contract construction with 66.7%, mining with 66.1%, communications and public utilities with 61.2%, wholesale and retail trade with 60.9% and services with 51%. The two

TABLE XIV.—*National Income by Industrial Origin and Wages and Salaries by Industry*
(in millions of dollars)

Industry	1942	1943	1944	1945	1946	1947	1948	1949
Agriculture, forestry and fisheries								
Income	12,875	14,561	14,830	15,642	18,251	19,424	21,825	17,388
Wages and salaries	1,786	2,192	2,398	2,526	2,798	3,109	3,354	3,204
Mining								
Income	2,509	2,727	2,950	2,769	3,031	4,350	5,277	4,442
Wages and salaries	1,769	1,983	2,197	2,173	2,368	2,920	3,340	2,938
Contract construction								
Income	6,625	5,551	4,375	4,571	6,651	8,550	10,458	10,431
Wages and salaries	4,670	3,919	2,888	2,951	4,412	5,825	7,093	6,958
Manufacturing								
Income	45,239	58,104	60,456	51,918	48,905	59,159	67,272	61,870
Wages and salaries	30,922	40,883	42,913	38,229	36,476	45,590	49,455	43,885
Wholesale and retail trade								
Income	19,055	23,361	25,137	27,909	34,137	37,324	42,870	42,665
Wages and salaries	11,802	14,501	15,016	16,538	19,529	22,818	25,318	25,989
Finance, insurance, real estate								
Income	11,952	12,937	13,688	13,278	14,696	15,666	17,172	17,678
Wages and salaries	2,606	2,725	2,875	3,142	3,925	4,292	4,759	5,028
Transportation								
Income	8,462	10,672	11,707	10,495	10,182	11,481	12,751	11,994
Wages and salaries	5,260	6,547	7,525	7,888	8,478	9,045	9,661	9,907
Communications and public utilities								
Income	3,659	3,952	4,200	4,283	4,850	5,537	5,942	6,501
Wages and salaries	1,778	1,886	1,994	2,109	2,824	3,286	3,809	4,043
Services								
Income	16,870	15,993	13,268	14,735	16,614	18,315	19,823	20,461
Wages and salaries	6,039	5,817	7,643	8,344	9,767	11,015	11,867	12,161
Total of all private industries								
Income	120,436	142,188	140,401	145,110	157,337	170,756	203,390	194,529
Wages and salaries	65,788	78,814	83,449	82,101	90,577	106,803	115,859	113,733

Source U S Department of Commerce, "Survey of Current Business" (July 1950)

categories that paid out less than 50% of their income in wages and salaries were finance, insurance and real estate with 28 6% and agriculture, forestry and fisheries with 18 4%

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(W. L. Wil., I R Wil.)

COMMERCE OF THE UNITED STATES

Early Traces.—The commerce of the United States, as a sepa-

TABLE XV.—*Index Numbers of Average Weekly Earnings, Cost of Living, and Real Earnings in Manufacturing Industries of the United States*
(1935–39 = 100)

Year	Average weekly earnings	Cost of living	Real earnings
1925	108 7	125 4	86 7
1926	109 9	126 4	86 9
1927	110 3	124 0	89 0
1928	111 1	122 6	90 9
1929	111 6	123 5	91 1
1930	103 7	119 4	86 9
1931	91 1	106 7	85 6
1932	76 0	97 6	77 9
1933	74 6	92 4	80 7
1934	82 1	98 7	83 8
1935	89 8	98 1	91 5
1936	97 1	99 1	98 0
1937	107 3	103 7	103 4
1938	99 5	100 8	98 7
1939	106 4	99 4	107 0
1940	112 4	100 2	112 2
1941	131 0	103 2	125 4
1942	165 5	110 5	149 3
1943	192 4	123 6	155 7
1944	201 5	125 5	160 7
1945	198 0	128 4	154 2
1946	195 7	130 3	149 1
1947	210 7	139 2	138 0
1948	237 1	171 2	138 5
1949	244 8	169 1	144 8

Source: U S Department of Labor, Bureau of Labor Statistics.

rate nation, had its genesis in Colonial trade, of which it was in fact but a continuation under altered political auspices The early commerce of the United States was largely water-borne and consisted of coastwise traffic and trade with foreign lands. Internal commerce was decidedly primitive and confined to certain wholesaling activities of importers, the business of fur trading posts and the distribution of a limited variety of manufactures, often on a barter basis in exchange for the crude produce of the frontier, by general stores or itinerant merchants There were in existence as late as 1929, according to the "Census of Distribution," a half dozen wholesale grocers who could trace the lineage of the businesses they operated back to these early times, one having been established in 1787.

While few statistics are available on the extent of the early commerce of the United States, it appears quite certain that by far the greater portion of the total commerce was foreign trade until well into the 19th century The transition from a predominately foreign trading nation to one in which domestic trade accounted for nine-tenths or more of the total, as it did by mid-20th century, was gradual, a transition attuned closely to the waves of westward migration which settled and developed the American continent

Estimates of Total Commerce.—It is difficult to find adequate quantitative measures of the total U.S. commerce. It has been estimated that the total value at point of production or importation of all goods marketed at wholesale in the United States amounted to slightly in excess of $15,000,000,000 in 1899. The total had nearly doubled by 1910, redoubled by 1916 and reached a high point of nearly $98,000,000,000 in 1920. The depression following World War I brought the total down to less than $54,000,000,000 in 1921 The 1929 level showed recovery to nearly $84,000,000,000, after which there was a steady drop to $35,000,000,000 in 1932, the low point of the great depression of the 1930s Recovery carried the total up to more than $72,000,000,000 in 1935 but the following year saw a recession to $60,000,000,000 By 1939 the figure had grown to $67,534,000,000 World War II carried it to extreme heights By 1948 it was $215,848,000,000.

The dollar value figures are somewhat misleading because they conceal the influence of price changes When allowance is made for the price factor, much of the fluctuation is reduced. An index of the physical volume of goods marketed at wholesale in the United States stood at 36.7 at the turn of the 20th century (1935–39 = 100). Instead of doubling in ten years as the dollar value figures indicated, the physical volume index did not double until after 1916. The index stood at 78, the World War I high, in 1917, dropped to 69 7 in 1921 and rose to 111.8 in 1929. The

physical volume of goods marketed fell off to 69.1 in 1932 (or to about the same low point reached in 1921). This was a much less serious decline than was recorded by the unadjusted value figures. From 1932 the index revealed steady progress upward to 106.7 in 1937 and to 111.1 in 1939. At the World War II peak it reached 216.7 (1943). Following that war the index climbed steadily to 176 in 1948, after falling to 159.8 in 1946.

FOREIGN COMMERCE OF THE UNITED STATES

Comparison with Domestic Commerce.—It is difficult to make an adequate and equitable comparison between U.S. domestic and foreign commerce. At best, statistics are likely to mislead because of the failure to include all necessary qualifications. A few comparisons are hazarded, nevertheless, as throwing some light on this phase of United States commerce.

Since many commodities produced in the United States cannot enter export trade at all, estimates have been made of the proportion of movable goods exported Estimates of the proportion of movable goods exported for selected years after 1899 suggest an average of a little less than 10%.

A more equitable comparison lies in the figures for individual commodities because the over-all figures conceal the great importance of export markets for some of the more important products of the United States. Thus in 1933, prior to World War II, 66% of all raw cotton produced in the United States was exported. This ratio had fallen to 30% by 1938. In the latter year exports of the gum rosin production amounted to 38% In 1937, 43% of the prunes, 29% of the sardines, 19% of the production of tractors and parts, 43% of the borax and 36% of all dried

TABLE XVI.—*International Transactions of the United States*
(in millions of dollars)

Item	1943	1944	1945	1946	1947	1948
Receipts, total	21,716	24,486	19,787	16,319	21,434	18,373
Goods and services, total	19,134	21,438	16,723	14,666	19,741	16,791
Goods	15,113	16,669	12,473	11,874	16,056	13,445
Income on investments	508	572	589	820	1,074	1,165
Other services	3,511	3,897	3,511	2,972	2,611	2,083
Unilateral transfers*	2,137	2,967	2,922	362	503	451
Long-term capital, total	445	640	592	1,182	1,088	1,131
Movements of U.S. capital invested in U S	402	466	541	1,181	1,039	1,092
Movements of foreign capital invested in U S	43	174	51	1	50	109
Payments, total	23,733	26,154	22,258	15,191	20,177	18,689
Goods and services, total	8,096	8,980	10,232	7,167	8,643	10,581
Goods	5,497	5,589	5,666	5,168	6,071	7,697
Income on investments	155	161	231	216	237	291
Other services	2,514	3,236	4,335	1,783	2,165	2,593
Unilateral transfers*	15,044	16,549	10,035	3,239	3,085	4,860
Long-term capital, total	592	625	1,991	4,785	8,450	3,248
Movements of U S capital invested abroad	486	500	1,836	4,437	8,005	3,073
Movements of foreign capital invested in U S	106	59	155	348	104	175
Excess of receipts (+) or payments (−), total	+2,016	−1,669	−2,471	+1,129	+1,257	−316
Goods and services	+11,038	+12,458	+6,491	+7,499	+11,098	+6,210
Unilateral transfers*	−12,907	−14,142	−7,113	−2,877	−2,582	−4,409
Net goods and services and unilateral transfer	−1,869	−1,684	−622	+4,622	+8,516	+1,801
Long-term capital	−147	+21	−1,399	−3,603	−7,741	−2,117
Net inflow (+) or outflow (−) of funds on gold and short-term capital account, total	+1,982	+1,706	+2,163	−1,474	−2,161	−926
Net increase (−) or decrease (+) in gold stock	+757	+1,350	+548	−623	−2,163	−1,530
Net movement of U S short-term capital abroad	−13	−151	−274	−735	−299	+220
Net movement of foreign short-term capital in U S	+1,222	+500	+1,189	−676	+301	+475
Errors and omissions	+34	−37	−68	−155	+1,004	+1,241

*Unilateral transfers indicate amount of contributions in kind or in cash through lend-lease, United Nations Relief and Rehabilitation administration, personal and institutional remittances and similar channels. Thus, payments or receipts under unilateral transfers in most cases effect exports or imports, respectively, of goods and services for which present or future compensation is not required
Source: U S Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States, 1949*, p 845

TABLE XVII.—*U.S. Exports and Imports of Merchandise**
(in thousands of dollars)

Yearly average or year	Exports			Imports			Total exports and imports
	Total	Domestic	Foreign	Total	Free	Dutiable	
1790–1800	44,350	—	—	55,805	—	—	100,251
1801–10	74,534	38,178	36,354	92,700	—	—	167,298
1811–20	58,089	46,270	12,719	80,812	—	—	138,801
1821–30	69,441	51,921	16,200	79,049	4,215	66,734	148,370
1831–40	103,550	88,168	15,382	119,520	45,478	74,042	223,070
1841–50†	122,820	114,894	7,727	121,123	63,246	57,877	243,743
1851–60	248,887	231,483	16,804	284,475	44,730	239,745	533,362
1861–65	187,811	170,708	17,613	255,439	28,918	226,491	443,250
1866–70	330,849	307,696	13,216	408,205	57,818	350,487	739,054
1871–75	591,841	486,128	15,713	577,873	109,486	472,587	1,070,714
1876–80	665,760	643,650	13,111	497,570	154,683	339,887	1,163,331
1881–85	791,802	774,007	17,285	667,142	204,735	462,407	1,459,034
1886–90	738,379	723,685	12,694	737,231	241,351	495,880	1,475,610
1891–95	869,148	850,236	16,095	785,137	262,363	522,774	1,654,285
1896–1900	1,157,318	1,136,030	21,270	741,519	342,125	399,394	1,898,837
1901–05	1,451,803	1,417,220	26,763	1,134,472	464,536	669,936	2,586,275
1906–10	1,778,607	1,750,986	27,727	1,344,858	614,495	730,363	3,123,535
1911–15	2,170,539	2,131,848	38,691	1,717,319	961,439	755,880	3,887,858
1913–20‡	6,521,109	6,416,513	104,677	3,338,354	2,298,608	1,039,717	9,879,545
1921–25	4,397,020	4,310,221	86,809	3,459,103	2,060,303	1,389,800	7,847,149
1921	4,378,348	4,272,248	106,103	2,509,428	1,569,493	946,856	6,904,179
1922	3,831,777	3,765,091	66,686	3,112,747	1,871,917	1,240,830	6,944,524
1923	4,167,493	4,090,715	76,778	3,792,568	2,138,041	1,654,526	7,960,059
1924	4,590,984	4,497,699	93,285	3,609,363	2,060,296	1,549,067	8,200,347
1925	4,818,722	4,720,689	98,033	4,020,186	2,151,266	1,868,920	8,838,908
1926	4,808,660	4,711,721	96,939	4,430,888	2,853,441	1,577,447	9,239,548
1927	4,865,378	4,758,864	106,513	4,181,744	2,691,875	1,562,869	9,047,122
1928	5,020,099	4,920,171	98,258	4,091,440	2,610,639	1,475,205	9,219,800
1929	5,240,095	5,157,083	83,012	4,390,361	2,843,354	1,550,007	9,640,356
1930	3,843,182	3,781,172	62,009	3,060,868	2,051,110	1,009,758	7,004,089
1931	2,424,289	2,377,962	46,327	2,090,633	1,382,435	709,199	4,514,922
1932	1,611,010	1,576,151	34,859	1,322,774	879,643	443,131	2,933,790
1933	1,674,994	1,647,220	27,774	1,449,550	878,700	577,450	3,124,551
1934§	2,132,800	2,100,135	32,665	1,656,003	991,161	664,842	3,788,803
1935	2,282,674	2,243,081	39,593	2,038,001	1,205,987	832,018	4,321,770
1936	2,455,078	2,418,069	37,009	2,423,977	1,384,493	1,039,484	4,879,055
1937	3,240,167	3,198,270	50,838	3,009,852	1,765,246	1,244,605	6,250,019
1938	3,094,440	3,057,160	37,271	1,949,624	1,182,960	766,939	5,044,064
1939	3,177,343	3,142,243	53,814	2,276,099	1,397,280	878,819	5,453,475
1940	4,021,146	3,934,181	86,965	2,540,656	1,648,965	891,691	6,561,802
1941	5,147,154	5,019,877	127,277	3,221,984	2,080,919	1,141,065	8,369,138
1942	8,078,988	8,002,113	75,875	3,769,988	1,787,592	1,001,693	10,848,973
1943	12,064,906	12,841,542	223,364	3,389,951	2,292,702	1,197,249	16,254,857
1944	14,256,702	14,161,544	97,158	3,877,695	2,708,391	1,169,304	18,136,397
1945	9,805,032	9,584,682	220,941	4,080,022	2,737,281	1,342,756	13,891,642
1946	9,130,482	9,302,553	230,069	4,792,129	2,897,669	1,894,441	14,551,092
1947	14,490,747	14,252,385	177,462	5,666,321	3,454,647	2,211,674	20,066,068
1948	12,653,288	12,533,098	120,365	6,077,302	4,174,521	2,017,709	19,245,090
1949	12,030,977	11,914,408	114,569	5,591,720	3,883,164	1,708,456	17,631,697
1950 (6 mo)	4,889,591	4,830,898	58,693	3,777,029	2,119,955	1,657,063	8,666,610

*Figures are for fiscal years ended Sept. 30, 1790, to 1842, and June 30, 1843, to 1915, subsequently for calendar years, gold and silver are included prior to 1821. †Period beginning Oct 1, 1841, and ending June 30, 1850 ‡Period July 1, 1915, to Dec 31, 1920. §Beginning with 1934 import figures are the imports for consumption, prior to that time they are general imports
Source: U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce.

fruits were exported Furthermore, industries exporting only a small fraction of their total output sometimes found that foreign sales enabled them to step up production to a higher point with resulting reductions in unit costs of production Export sales may indeed account for a substantial part of the net earnings of a company, even though they make up only a fraction of total sales During and after World War II, however, normal foreign trade patterns were so distorted that such figures were of little value

Balance of Payments.—Widespread misunderstanding of foreign commerce arises from the overemphasis placed on exports and imports of commodities Tangible merchandise transactions are more easily observed than are other perhaps equally or even more important but less obvious transactions, which are fully as much a part of foreign commerce as is the traffic in physical goods. When service items, capital transfers and gold and silver movements as well as commodity trade are taken into account, the resulting balance of payments, as distinguished from the balance of trade, shows necessarily an equality between total export, or credit, items and total import, or debit, items Thus, in 1948 exports of goods amounted to $13,445,000,000 and imports of goods came to $7,697,000,000, while total receipts for all goods, services, capital transfers and investments were $18,373,000,000 and total payments were $18,689,000,000 Exact equality is difficult to achieve because of errors and omissions in the basic statistics. (*See* Table XVI)

One reason for the widespread ignorance of the true nature of international trade was the fact that adequate data formerly were unavailable. Estimates of the balance of international payments for the United States were compiled only from 1919, and other nations were generally behind the United States in the issuance of similar data. The United Nations attempted to fill the gap. In sharp contrast were the statistics on merchandise exports and imports, which, for the United States, were first compiled in 1790 and became available in great detail thereafter

Merchandise Trade.—Exports of merchandise from the United States averaged $42,000,000 annually during the last decade of the 18th century. By the corresponding period of the 19th century, the average approached $1,000,000,000, and that figure was exceeded in each of the three last years of that century. A rapid expansion followed which carried the total value of exports of commodities to $8,228,000,000 in 1920, a figure, however, which reflected a wartime price inflation. The $5,240,995,000 value for exported goods in 1929 probably represented a larger physical volume of merchandise, since the price level in 1920 was about 62% above that prevailing in 1929 The depression years which followed saw exports drop sharply to $1,611,016,000 in 1932 with 1933 showing very little improvement. Thereafter a steady recovery was registered to $3,349,167,000 for 1937, followed by a setback in 1938 to $3,094,440,000. The upward trend was resumed in 1939 By 1941, the year in which World War II struck sumed in 1939 By 1941, the year in which World War II struck with the products and services of other lands. The United States is ordinarily no exception Merchandise imports usually follow the trend of exports, varying with the cycles of business and of war, but expanding with the progress of the national economy Average yearly imports of merchandise were valued at $55,895,000 during the decade 1790–1800. They had doubled in value by the fourth decade of the 19th century, more than doubled again in the ten years before the Civil War and doubled a third time in the 1870s The $1,000,000,000 mark was first reached in 1903 and $5,278,000,000 was achieved in 1920. Between 1925 and 1929 merchandise imports exceeded $4,000,000,000 each year. The depression which began in late 1929 saw imports of merchandise fall off to less than $1,323,000,000 in 1932. Recovery began in 1933 and continued through 1937, when commodity im-

TABLE XVIII—*U S Imports of Leading Commodities**
(values in millions of dollars)

Commodity	Unit	Quantity								Value							
		1926–30 average	1931–35 average	1936–40 average	1941–45 average	1946	1947	1948	1949	1926–30 average	1931–35 average	1936–40 average	1941–45 average	1946	1947	1948	1949
Meat products	Million lb.	141	67	149	147	43	57	263	213	29 0	12 3	28 8	26 8	16 4	22 0	90 5	71 8
Fish, shellfish and products	Million lb.	347	289	337	330	473	407	472	469	58 7	24 5	30 6	46 1	84	82 9	111 0	112 4
Hides and skins, raw	.	.	.	.	.	.	.	.	.	118 0	39 2	59 6	77 8	85	107 8	85	72 6
Furs and manufactures	.	.	.	.	.	.	.	.	.	113 9	43 3	69 0	107 8	238 0	235 0	164 5	190 0
Fruits, nuts and preparations	.	.	.	.	.	.	.	.	.	84 7	48 3	59 9	63 3	124 2	136 3	167 3	145 8
Cocoa, cacao beans and shells	Million lb.	422	484	619	562	595	500	559	632	45 5	21 5	33 0	37 8	56 7	152 4	193 7	134 5
Coffee	Million lb.	1,482	1,602	1,698	2,299	2,738	2,501	2,774	3,023	281 7	144 1	237 7	365 6	472 2	1,060 5	1,057	795 5
Tea	Million lb.	90	88	91	84	94	68	91	95	27 0	15 7	20 1	27 9	34 2	27 5	45 1	46 0
Cane sugar	Million lb.	7,871	5,981	5,066	6,493	5,283	8,330	6,307	7,457	207 3	113 4	138 0	179 0	196 8	419 5	353 5	372 1
Beverages	.	.	.	.	.	.	.	.	.	17 2	8 2	6 3	7 5	9 6	6 7	8 6	9 2
Whisky	Million proof gal	†	6‡	12	9	21	12	12	12	†	27 1‡	4 6	3 8	4 3	4 9	6 2	6 2
Rubber, allied gums and mfg	.	.	.	.	.	.	.	.	.	77 9	22 1	16 5	23 5	32 8	32 6	32 0	25 3
Rubber, milk of, or latex	Million lb	2,047	2,015	52	25	19	40	73	67	290 0	74 6	9 2	5 6	1 8	9 8	18 3	15 0
Other rubbers, crude	Million lb.	.	.	1,211	707	853	1,554	1,574	1,413	.	.	107 2	146 2	251 4	308 4	290 8	225 3
Oilseeds	.	.	.	.	.	.	.	.	.	66 0	26 6	40 2	40 6	52 6	130 3	150 7	95 2
Flaxseed	Thousand 56-lb. bu	19,771	13,615	17,123	22,003	3,361	289	1,066	248	36 8	12 7	22 1	19 5	7 0	1 9	6 2	0 8
Copra	Million lb.	235	465	492	275	769	1,355	895	856	22 6	8 6	9 9	7 3	30 3	107 4	120 3	69 1
Tobacco and manufactures	Million lb.	80	65	79	87	83	91	85	88	64 5	30 2	38 4	54 2	89 6	93 2	80 1	75 5
Cotton manufactures	.	.	.	.	.	.	.	.	.	31 0	18 7	16 2	12 4	24 0	45 4	43 2	43 2
Cotton cloth	Million sq. yd.	56	42	103	38	44	16	32	20	14 6	6 4	9 1	8 0	15 1	70	13 9	9 4
Jute and manufactures	.	.	.	.	.	.	.	.	.	91 7	33 9	47 1	63 3	96 0	139 9	171 7	140 0
Burlap	Million lb.	606	404	533	410	536	542	507	447	72 2	26 2	35 7	50 1	76 9	109 0	131 3	103 1
Flax, hemp, ramie and mfg.	.	.	.	.	.	.	.	.	.	48 8	25 2	27 4	12 6	33 6	28 8	33 0	33 7
Wool—unmanufactured	Million lb.	253	141	259	866	1,063	644	761	441	78 8	30 3	61 3	247 9	289 7	308 9	307 7	122 2
Wool—manufactured	.	.	.	.	.	.	.	.	.	56 8	15 0	19 6	16 1	31 6	33 2	54 8	46 8
Silk—raw	Million lb.	75	70	54	5	73	2	6	3	118 7	108 7	82 7	12 7	13 7	13 4	7 4	7 3
Sawmill products	Million bd ft	1,574	441	658	1,164	1,238	1,315	1,880	1,574	44 2	10 6	18 8	50 3	78 4	101 6	152 0	113 2
Paper base stocks	.	.	.	.	.	.	.	.	.	112 5	60 0	93 4	101 2	163 2	193 6	215 7	219 9
Chemical wood pulp	Thousand tons	1,340	1,405	1,726	1,220	1,549	2,028	1,881	1,550	70 4	32 1	74 1	73 3	124 2	238 1	253 6	170 3
Paper and manufactures	.	.	.	.	.	.	.	.	.	251 2	95 4	133 9	144 8	253 6	363 1	437 7	452 6
Newsprint	Million lb.	4,279	4,908	5,488	5,480	6,984	7,016	8,790	9,270	134 2	54 8	112 1	136 6	241 0	343 2	413 2	437 6
Petroleum and products	.	.	.	.	.	.	.	.	.	132 9	50 6	47 6	94 1	150 4	250 5	417 8	477 7
Crude petroleum	Million bbl	68	38	33	40	89	129	155	158	77 4	22 6	40 2	40 2	101 2	161 2	285 1	341 2
Refined oils	Million bbl	24	24	31	48	57	63	60	84	51 8	23 3	22 2	52 9	57 0	87 1	129 5	133 0
Diamonds	Million carats	1	1	3	19	6	5	22	7	53 1	7 8	30 1	70 1	181 1	190 6	188 8	80 3
Ferroalloys, ores and metals	.	.	.	.	.	.	.	.	.	78 5	29 0	39 1	59 7	58 3	65 8	80 8	76 5
Copper and manufactures	.	..	..	..	..	..	..	..	..	108 2	30 2	47 6	164 8	86 2	175 8	202 2	224 3
Tin	.	..	..	..	..	..	..	..	..	89 1	43 8	80 2	69 9	45 4	63 6	135 5	122 3
Chemicals and related products	.	.	.	.	.	.	.	.	.	139 8	64 9	79 7	130 7	99 4	105 1	112 0	106 8
Coal tar products, industrial chemicals, medicines	.	.	.	.	.	.	.	.	.	53 9	30 0	39 4	46 5	52 8	53 5	47 0	37 4
Fertilizers and fertilizer materials	Million tons	2	1	2	1	1	1	1	1	67 5	28 4	35 3	31 7	35 1	43 5	56 8	62 7

*General Imports 1926–33, imports for consumption 1934–49 †Not shown separately 1926–33 ‡Two-year average
Source: U.S. Department of Commerce, *Monthly Summary of Foreign Commerce* Dec 1927–49.

ports were valued at $3,009,852,000 By 1941 imports had climbed to $3,221,954,000. During World War II they ranged from $2,769,285,000 in 1942 to slightly more than $4,000,000,000 in 1945 After the war imports continued to expand steadily, exceeding $7,000,000,000 in 1948 By 1950 the differential between merchandise exports and merchandise imports had been reduced to the lowest level in many years For the month of August imports of goods actually exceeded exports in value by $58,000,000 Changes in the price level explained a part of the shifts recorded in these figures, as was noted for the export data (*See* Table XVII.)

A further consideration of importance is the fact that merchandise imports are divided into the sheep and the goats, those which are admitted into the country free and those upon which customs duties are levied Many shifts took place in the relative proportion of these two classes during the history of the United States Less than 6% of all merchandise imports on the average were free of duties in the decade 1821–30, while more than 38% came in duty free during the following ten years. At the close of the 19th century about 46% of total imports came in on the free list, while 61% were free by 1920, a ratio which held with minor variations up to the depression era of the 1930s By 1933 the ratio of free imports to the total was 63%, while by 1936 it had fallen to 57% By 1938 it had recovered to 60%. Following World War II it remained close to 60%.

The chief significance of these shifts in the proportion of duty-free imports to the total lies in the fact that they reflected changes in the structure of the economy of the United States. The upward trend in the proportion of duty-free imports paralleled a trend in commercial policy toward higher import duties Thus the explanation lies in the shifts in the kinds of goods imported rather than in any liberalization of the import restrictions

Principal Imported Commodities.—With the shift in emphasis from an agrarian to a manufacturing nation, the composition of the imports of the United States underwent extensive changes Manufactured goods gave way to raw materials and semimanufactures The expanding wealth of the country also stimulated importation of such products as coffee, tea, spices, sugar, bananas and many luxury items such as diamonds and other precious stones The discovery of new processes and the foundings of new industries were reflected in the statistics of imports and explained such items as the tremendous expansion in crude rubber imports and, later, the downward drift in silk imports.

A selected group of 27 leading commodity classifications (Table XVIII) made up more than 72% of total merchandise imports in 1949 Coffee was first on the list that year with 2,923,000,000 lb. imported, valued at $795,500,000 Petroleum and petroleum products ranked second at $477,700,000, followed in order of size by paper and paper manufactures, cane sugar, rubber and allied products and copper and copper manufactures. The rank of these items contrasted with those which predominated 20 years earlier. Raw silk was definitely the leader then, followed in order by crude rubber, coffee, cane sugar, newsprint, petroleum and products, hides and skins, furs and manufactures and fruits and nuts Fluctuations in raw silk imports illustrated what was happening continuously in a dynamic economy for many other commodities The United States imported 24,000,000 lb. of raw silk on the average in the years 1910–14 By the period 1921–25, the average had risen to 52,000,000 lb., a trend which carried the average to 75,000,000 lb. for the years 1926–30 The depression years 1931–35 reduced this average very little to 70,000,000 lb. but after 1935 there was a steady shrinkage to 60,000,000 lb in 1936, 58,000,000 lb. in 1937 and 55,000,000 lb. in 1938. By 1949 only 3,000,000 lb were imported The appearance of nylon and its wide acceptance by consumers made the future of raw silk imports look black indeed.

Leading Commodity Exports.—The trend of merchandise exports reflects the same dynamic forces continuously reshaping the contour and content of the economy of the United States In the years 1910–14 unmanufactured cotton was the number one item on the list of merchandise exports Machinery was second in rank, followed by packing-house products, petroleum and products thereof and wheat and flour. Just before the depression of the 1930s cotton continued in first place, but petroleum and its products had taken second place from machinery, which occupied third place, followed by automobiles, parts and accessories, wheat and flour and packing-house products The outstanding change in this period was the rise of the automotive industry Exports from this industry, which averaged only $24,000,000 between 1910 and 1914, had risen to $406,000,000 on the average for the years 1926–30. The postdepression year 1937, a year of business strength generally, showed exports of machinery in first place with petroleum and its products in second position. Cotton had dropped to third place with exports of $369,000,000, less than half of the 1926–30 average Automobiles, parts and accessories were in fourth place, followed by iron and steel mill products. World War II altered this pattern, and the postwar emphasis on reconstruction of Europe and Asia through the Marshall plan, combined with relief shipments, caused shifts in U S. exports. Thus, in 1949 machinery was by far the largest single export group with total sales in excess of $2,000,000,000 Grain and grain products (more than half flour) ranked second with a volume of nearly $1,500,000,000 Third in rank was unmanufactured cotton, with exports valued at $874,200,000. With more than $750,000,000, chemicals and related products ranked fourth, but very little above automobiles, parts and accessories Following close in sixth place were iron and steel mill products, valued at $732,100,000. (*See* Table XIX.)

The outstanding fact revealed by analysis of the merchandise export statistics of the United States was the growing shift in emphasis from agricultural products to manufactured products. This shift, exactly opposite to that noted in the import statistics, reflected the movement of the underlying economic structure and the increasing industrialization of the national economy.

Sources and Destination of Foreign Trade.—A study of the geographical sources of imports and destination of exports illuminates still more the changing character of U.S. foreign trade In the years between 1876 and 1880 more than half of United States imports of merchandise originated in Europe, while 83.1% of all exports went to Europe Other countries on the North American continent supplied 23.5% of U.S. imports of commodities and absorbed 19.4% of all merchandise exports. South and Middle America supplied the United States with 31.4% of all commodities imported and purchased 8.7% of all exports. Asia was a source of supply for 11.3% of all merchandise imports but took only 1.7% of all goods exported by the United States in those years. After that period, Europe became a less important source of supply relatively and a comparatively smaller market for United States exports of merchandise U S imports from Europe, which averaged 49.5% of the total in the five-year period immediately preceding World War I, had fallen to 30.3% by 1929, to 29.5% by 1932 and to 27.3% in 1937. Exports to Europe fell even more in proportion. Averaging more than three-quarters of the total by 1900, they were 62.3% in 1910–14, 44.7% in 1929 and 40.6% in 1937. This trend continued after World War II. By 1949 Europe took 34.3% of U.S. exports and supplied but 14% of total imports.

Canada (including Newfoundland) continued to take about 15% of U.S. exports, the average for the years 1926–40 being 16.5% and the post-World War II (1946–49) average being 15.3% Imports from this area trended upward from an average of 13.5% of total U S imports (1926–40) to 21% on the average following World War II and to 23.4% in 1949. Slight increases in percentages of both exports and imports were registered by North American countries south of the Rio Grande. South America, which took less than 10% of U S exports in the years between World Wars I and II, averaged 14% in the years 1946–49. Imports from South America rose from an interwar average of less than 14% of U.S. totals to more than 22% following World War II (1946–49). Exports to Asia, which had been rising prior to World War II, averaged only little above the interwar rate after 1945. Imports from Asia fell from a prewar level of about 30% of U.S. totals to an average of about 18% for 1946–49.

Apart from World Wars I and II, these geographical shifts

TABLE XIX.—*U.S Exports (Domestic) of Leading Commodities*
(values in millions of dollars)

Commodity	Value							
	1926-30 average	1931-35 average	1936-40 average	1941-45 average	1946	1947	1948	1949
Meat products	76.4	28.7	26.4	379.8	541.8	129.3	56.8	51.6
Animal oils and fats, edible	110.0	34.5	17.1	108.8	92.8	97.0	72.1	92.8
Lard, including neutral	98.3	31.4	16.3	95.5	89.2	90.9	70.4	69.4
Dairy products	16.8	6.3	7.9	180.9	992.1	239.8	210.0	174.1
Grains and preparations	318.6	54.6	40.0	174.0	789.0	1,279.6	1,705.1	1,436.0
Corn	19.5	2.0	28.9	13.7	28.1	166.8	43.0	208.5
Wheat	152.1	19.5	3.8	38.1	350.9	439.1	909.1	835.2
Wheat flour (wholly U S wheat)	78.5	17.6	12.6	35.9	198.6	454.4	482.9	248.2
Fruits, nuts and preparations	121.9	84.8	76.1	93.9	172.1	198.0	194.1	155.7
Fruits, dried and evaporated	33.3	23.2	19.9	35.5	47.8	46.2	60.7	28.6
Oranges	14.1	9.8	11.0	20.6	54.9*	28.9*	20.2*	20.3*
Apples	29.0	19.7	10.4	2.5	11.5	16.1	7.0	6.2
Grapes	2.1	1.3	2.6	3.9	8.7	9.0	6.1	7.5
Canned fruits	25.6	19.6	19.5	8.9	20.1	31.9	10.5	12.0
Peanuts	0.4	0.1	0.1	1.9	10.9	35.3	77.9	50.6
Rubber, allied gums and manufactures	67.1	23.9	33.3	118.6	581.4	211.2	132.4	114.4
Tires, tire casings and tubes	35.6	11.9	18.6	57.5	80.6	132.2	77.3	69.2
Tobacco—leaf	144.1	102.9	109.3	137.7	450.7	260.6	211.6	251.6
Cotton—unmanufactured	765.7	366.3	283.1	131.7	536.2	423.4	510.9	874.2
Cotton—semimanufactured	21.2	9.0	13.2	14.6	20.6	103.6	43.7	41.2
Cotton—manufactured	102.9	36.4	47.7	170.0	354.7	748.9	452.6	344.9
Cloth, duck and tire fabric	72.3	26.3	31.0	112.1	223.2	525.1	313.5	222.2
Synthetic fibres and manufactures	6.0	3.6	12.4	49.2	141.3	307.7	230.7	201.7
Sawmill products	93.9	37.5	42.1	39.7	59.4	120.2	64.0	59.9
Lumber	76.6	31.2	34.8	31.6	33.3	82.5	44.8	49.2
Wood manufacture including box shooks	34.7	13.7	18.3	39.6	40.7	74.3	40.0	31.1
Paper, related products and manufactures	38.8	18.4	35.5	72.2	107.5	143.5	110.3	93.6
Coal and related fuels	122.8	51.7	66.7	164.5	315.9	632.8	491.3	397.9
Petroleum and products	524.4	241.2	343.9	573.5	435.6	649.4	636.9	561.4
Crude petroleum	30.9	18.2	87.0	37.0	74.1	98.7	116.8	98.4
Refined oils	462.7	176.0	230.3	490.9	306.3	449.9	447.6	376.5
Iron and steel mill products	155.5	69.3	86.5	543.8	447.9	824.7	650.1	719.1
Tinplate	27.4	9.7	31.6	49.2	41.7	85.5	96.0	100.5
Iron and steel manufactures	71.2	27.2	30.3	116.4	155.8	265.7	211.6	183.4
Copper and manufactures	150.0	40.0	87.7	79.3	286.0	120.5	113.1	87.8
Machinery	490.2	213.3	404.6	1,073.5	1,367.7	2,264.3	2,253.1	2,047.4
Electrical machinery and apparatus	120.6	69.9	103.6	258.4	301.3	387.7	490.6	470.2
Industrial machinery	219.9	96.3	281.9	675.6	842.0	1,336.0	1,268.8	1,319.9
Agricultural machinery and implements	109.0	46.8	68.0	118.3	178.4	317.7	361.0	128.4
Auto, parts, equipment and accessories	405.1	146.2	273.1	1,731.7	1,586.6	1,116.0	930.3	750.5†
Passenger cars, trucks, new	274.8	121.4	172.9	381.2	353.6	777.0	634.9	714.4†
Aircraft, parts and accessories	4.9	10.8	111.9	1,603.3	113.3	172.1	153.6	112.8†
Chemicals and related products	134.9	88.6	154.4	400.7	500.1	782.8	775.4	774.1
Coal tar products, industrial chemicals and medicines	60.7	42.7	69.5	205.9	302.2	457.7	468.2	399.8
Pigments, paints and varnishes	23.3	13.6	20.6	25.3	50.6	85.5	80.3	76.4
Chemical specialties	21.0	11.8	30.3	66.7	92.4	153.8	156.6	160.8
Fertilizers and fertilizer materials	17.9	11.5	17.7	17.5	22.4	35.6	27.7	92.2
Soap and toilet preparations	15.0	7.1	9.0	15.7	36.9	41.3	25.9	19.5
Photographic and projection goods	4.2	13.8	19.5	22.4	26.8	50.6	39.6	33.7
Books, maps and other printed matter	24.3	14.1	21.8	32.6	69.2	73.6	67.0	58.0

*Includes tangerines †Exclusive of "special category" ‡Prior to July includes motor vehicles of specified class manufactured to military specifications
Source: U S Department of Commerce *Monthly Summary of Foreign Commerce* (Dec 1937–49)

stemmed from the same causes which accounted for shifts in commodity content of the foreign trade of the United States The relative decline of Europe as both a market and a supplier is explained by the fact that the industrial growth of the United States paralleled that of Europe although with a time lag As the United States became an exporter of more and more manufactured goods, markets had to be sought in Asia, Latin America and Canada, since Europe had its own industrial products. Similarly, as the United States expanded industrially it had less need for European manufactures and more need for raw materials (*See* Table XX.)

Commercial Policy.—Entwined with the economic changes just discussed, and exerting a varying degree of influence upon them, were the changes in the political policy of the United States government toward its foreign trade Between 1839 and 1951, approximately 15 tariff acts were passed by the U.S. congress.

The policy of a protective tariff on some U.S products was well established by 1820. Textile products and some metals, for example, were definitely protected by that time. In 1824 duties were increased on cotton and woollen goods from 25% to 33½%. The duty on raw wool, however, reduced the protection on woollens to about 18%. The Tariff act of 1828, which was definitely protective along many lines, made a bitter issue out of the tariff, which continued intermittently thereafter. The Tariff act of 1832 continued the protective principle of the previous act. On an average, rates of duty on dutiable articles in this act were about 33% ad valorem. In the act of 1833 provision was made for a graduated reduction in duties down to a uniform rate of 20%, which was reached in 1842. Within two months after the base rate was reached, however, the Tariff act of 1842 was passed and high duties were re-enacted

The act of 1846 was moderate in its rates; most of the controversial articles paid 30% duty Cotton textiles were dutiable at 25%. This act remained in force until 1857, when still further reductions in the duties were made The rates on most articles were reduced to 24% This act continued in force until the Civil War

During the Civil War period the customs tariffs were used as one of the many means of raising revenue. The necessity for revenue backed up by the protective principle established tariff rates on a plateau that continued without a substantial decline for 50 years. Although the customs duties on imports were enacted during the Civil War, partly as compensation for internal taxes on most domestic products, the excise taxes were quickly removed after the war on most important products, leaving the tariff rates highly protective after the need for the revenue had declined

The Civil War tariffs continued with minor revisions until the general revision of 1883. This act increased the duties on some products and reduced them on others The general average of the rates, however, was not greatly changed. Under the act of 1890 the protective system was greatly extended; duties were increased and many products were removed from the free list. Compound or mixed duties were freely used, and the duties on many products were higher than ever before.

The high protective duties in the McKinley act of 1890 were strongly contested in the political campaign of 1892 and after a change of administration with the election of Grover Cleveland, congress set about revising the tariff downward. Substantial changes were made in the act of 1894 but it was far from being a free-trade bill.

In 1896 the administration changed again and a highly protective act was passed in 1897. This continued in effect for an unusually long period; namely, until 1909 when duties were increased on the average still further.

TABLE XX —*U.S. Foreign Trade by Continents and Great Trade Regions** (values in millions of dollars)

Yearly average or year	Total	North America				South America		Europe		Asia		Oceania		Africa	
		Northern		Southern											
		Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Exports															
1876-80	677	34	5 0	36	5 4	22	3.3	362	53 1	11	1 7	7	1.1	4	0 6
1881-85	792	43	5 4	45	5 7	28	3 6	442	55 8	18	2 2	13	1 6	4	0 5
1886-90	738	30	5 2	43	5 8	32	4 3	386	52 3	20	2 8	18	2 5	3	0 5
1891-95	892	49	5 5	61	6 8	33	3.7	709	79 5	21	2 3	14	1 6	5	0 6
1896-1900	1,117	86	7 6	56	5 0	36	3 2	887	79 7	45	4 0	26	2 3	17	1 5
1901-05	1,454	125	8 6	98	6 7	46	3 2	1,051	72 3	77	5 3	30	2 0	28	1 9
1906-10	1,779	161	9 0	155	8 7	82	4 6	1,233	68 2	97	5 5	32	1 8	18	1 0
1911-15	2,377	337	14 2	189	7 7	82	3 0	1,517	64 0	133	5 6	32	1 3	27	1 1
1915-20†	6,591	780	12 0	503	7 7	361	5 5	4,124	63 2	562	8 6	100	1 7	82	1 3
1921-25	4,307	627	14 3	445	10 1	297	6 8	2,318	53 7	400	11 1	142	3 2	70	1 6
1926-30	4,777	830	17 4	403	8 4	448	9 4	2,236	46 8	573	12 0	177	3.7	110	2 3
1931-35	3,025	336	11 8	168	5 9	121	4 0	960	47 4	350	17 3	49	2 4	62	3 1
1936-40	3,320	592	16 2	291	9 0	317	9 9	1,533	47 4	535	16 6	80	2 7	139	4 2
1941	3,147	1,022	19 7	508	9 9	527	10 2	1,847	35 9	621	12 1	103	2 4	320	9 8
1942	5,035	1,230	20 8	471	7 9	570	9 7	2,600	43 6	688	11 5	361	6 5	816	10 1
1943	12,905	1,463	12 3	544	4 2	411	3 2	7,833	58 9	838	6 5	560	4.4	1,307	11 6
1944	14,259	1,561	10 2	606	4 4	540	3 8	9,364	65 7	996	7 0	410	2 9	861	6 0
1945	9,806	1,295	12.2	724	7 4	645	6 6	5,515	56 2	849	8 7	354	3.6	524	5 3
1946	9,739	1,484	15 0	1,099	11 0	1,150	11 8	3,189	32.8	1,882	19 8	117	1 2	488	5 0
1947	14,430	2,115	14 7	1,715	11.9	2,354	16 3	5,187	35 9	1,048	7 3	320	2 2	821	5.7
1948	17,653	3,048	15 4	1,451	11 5	1,912	15 1	4,270	33.8	2,330	18 8	233	1 8	384	3 2
1949	12,800	1,958	15 3	1,340	11 2	1,359	11 0	4,115	34 3	2,218	18 5	195	1 6	616	5 1
1950‡	4,890	927	19 0	669	13 7	638	13 0	1,570	32 3	894	18.2	74	1 5	179	3.7
Imports															
1876-80	493	28	5.6	87	17 6	68	13 8	248	50 3	56	11.3	5	0 9	2	0 5
1881-85	667	42	6 3	96	14 4	76	11 4	368	55 1	70	10 5	12	1 7	4	0 6
1886-90	727	49	6 7	90	12 3	82	11 3	402	56 0	74	10 4	16	2 3	3	0 5
1891-95	785	36	4 6	128	16 3	117	14 9	398	50 6	85	10 8	16	2 1	5	0 6
1896-1900	742	37	5 0	76	10 3	98	13 2	392	52 8	108	14 6	23	3.1	10	1.3
1901-05	972	53	5 4	130	13 3	122	12 5	498	51 3	150	15 4	9	0 9	11	1 1
1906-10	1,345	80	5 9	180	13 4	157	11 7	699	52 3	205	15 2	17	1 2	17	1 3
1911-15	1,712	131	7 7	249	14 5	220	12 8	798	46 6	272	15.8	19	1 1	24	1 4
1915-20†	3,258	425	13 1	538	17 5	391	17 0	882	20 3	910	27 7	70	2 1	91	2 7
1921-25	3,420	397	11 5	514	14 9	411	12 2	1,049	30 4	943	27 3	54	1 6	71	2 1
1926-30	4,033	480	11 9	466	11 4	546	13 5	1,207	29 9	1,196	29 7	53	1 3	91	2 3
1931-35	1,713	236	13 8	177	10 3	244	14 3	516	30 1	491	28 7	16	0 9	33	1 9
1936-40	2,242	360	14 8	246	9 9	338	13 6	627	28 3	768	31 6	36	1 6	81	3 3
1941	3,245	571	17 1	411	12 3	674	20 2	581	8 4	1,088	32 5	159	4 8	102	4 8
1942	2,795	733	26 7	381	13 9	639	23 3	220	8 0	338	12 3	251	8 4	204	7 4
1943	3,381	1,041	30 8	622	19 0	776	22 9	240	7 1	335	9 9	245	7 3	303	9 0
1944	5,030	1,776	35 6	758	19 3	923	23 5	189	7 4	321	8 3	139	3 5	221	5 6
1945	4,147	1,245	29 6	733	18 2	965	23 3	409	9 0	497	9 8	171	4 1	296	7 1
1946	4,900	910	18 5	732	14 9	1,095	22.3	882	18 0	1,102	22 5	183	3 7	196	4 0
1947	5,733	1,128	19 7	1,016	17 7	1,237	21 6	820	14 3	1,050	18 3	156	2 7	327	5 7
1948	7,734	1,594	20.4	946	12 2	1,560	21.0	1,122	15 7	1,346	18.9	164	2 3	394	5 5
1949	6,626	1,552	23 4	942	14 2	1,502	22 7	925	14 0	1,241	18 7	125	1 9	33	5 1
1950‡	5,816	882	15 2	555	11.6	814	21 3	544	14 3	694	18.2	101	2 6	225	5 9

*Figures cover fiscal years to and including 1915; calendar years thereafter Turkey is with Asia beginning 1926; the U S S R is with Europe beginning 1924.
†Period July 1, 1915, to Dec. 31, 1920. ‡6 months ending June.
Source U S Department of Commerce, Bureau of Foreign and Domestic Commerce

With another change of administration in 1913, a new and lower tariff act was passed which continued in effect until 1922, at which time duties were again increased all along the line in the tariff act of that year. The act of 1930 still further increased the duties on most dutiable products.

Reciprocity in Foreign-Trade Policy.—On June 12, 1934, Pres F. D. Roosevelt approved an act of congress which amended the Tariff act of 1930 and empowered him for a period of three years: "(1) to enter into foreign trade agreements with foreign governments or instrumentalities thereof, and (2) to proclaim such modifications of existing duties and other import restrictions, . . as are required or appropriate to carry out any foreign trade agreement that the President has entered into hereunder." No reduction or increase in rate of duty was permitted beyond 50 per centum, nor could any item be transferred from or to the dutiable and free lists. The importance of this act, which was extended for additional three-year periods by successive congresses, lay in the radical departure from congressional tariff making to what was called scientific tariff making. The law provided that, before concluding any trade agreement, the president should seek information and advice from the United States tariff commission, the departments of state, agriculture and commerce and such other sources as he might deem appropriate. An interdepartmental committee, headed by the department of state, was established to work out the details of the program and to prepare the basis upon which the United States was willing to enter into agreements with other nations Aid and suggestions from industry were also sought and utilized

The underlying purpose of reciprocity was to offer inducements to individual foreign nations to co-operate in a program of mutual reduction of trade barriers in the form of lower United States tariffs on items which others wished to sell, in exchange for concessions from other nations on items which the United States sought to sell. A reduction of tariff barriers generally was sought by recourse to the most-favoured-nation formula hitherto applied Originally negotiations were conducted by the U.S. with individual nations. Later the principle of multilateral negotiations was applied. Under this approach the U.S. undertook to work out reciprocally advantageous trade arrangements with several nations at the same time

The principal purpose upon the foreign trade of the United States were difficult to appraise because of the many conflicting forces at work in the world. A comparison of the statistics of U S trade with countries which entered into reciprocal agreements and those which did not indicated that the program had beneficial results.

Foreign-Trade Zones.—A further significant change in U S. foreign-trade policy dated from 1934, when congress passed "an Act to provide for the establishment, operation, and maintenance of foreign trade zones in ports of entry of the United States, to encourage foreign commerce, and for other purposes" This act was designed to encourage imports for re-exporting after sorting, grading and manipulating. No provision was made in the original act for manufacturing or exhibiting. In 1950, manufacturing and exhibiting in foreign-trade zones were authorized.

Foreign-trade zone 1 was approved Jan. 30, 1936, for New York city. This zone had a successful history, although World War II interfered with its normal activity. Apart from a shortlived zone 2 at Mobile, Ala , approved Sept 23, 1937, and revoked April 14, 1939, no other zone was established until 1946. On July 16 of that year New Orleans, La., was granted foreign-trade zone 2 Four additional zones were later approved. Foreign-trade zone 3 at San Francisco, Calif., on March 10, 1948, 4 at

Los Angeles, Calif., and 5 at Seattle, Wash., both on June 27, 1949, and 6, the first privately operated and the first inland zone, at Municipal airport, San Antonio, Tex., Nov. 29, 1949.

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VIII. DEFENSE

ARMY

When George Washington took command, on July 3, 1775, of the lines of colonial militia besieging Boston, Mass., the United States army was born. Although it was still a year and a day before the Declaration of Independence, the event marked the union of the forces of the 13 separate Colonies under one head. These men were largely militia and minutemen of local communities, given to going home whenever a particular danger was past. In Jan. 1776 the Continental Congress wisely decided that the troops it had directly raised and equipped should be separate in organization from those of local communities. These "Continentals" were enlisted for longer terms, were trained more thoroughly and thereafter provided Washington with a small, but comparatively more stable, nucleus to work with, and they proved his chief reliance in the dark hours of the war. They were the beginning of a regular army.

Washington's force varied from 8,000 troops in the operations around New York to as low as 4,000 after the winter at Valley Forge and as high as 26,000 in Nov. 1779. Other generals seldom had more than 6,000 men at their command, while some of the most important work of the war was done by bands of a few hundred under Thomas Sumter or the Catawba, Francis Marion in the Peedee swamps and George Rogers Clark in the northwest.

When peace was declared, congress ordered the disbandment of the entire army except "twenty-five privates to guard the stores at Ft. Pitt and fifty-five to guard the stores at West Point." Indian disturbances on the frontier soon caused an increase, and, when Washington was inaugurated president, the number of men in service was 595.

Until 1812 the army passed through swift periods of rise and fall, an index of national fear. From a bare single regiment when the constitution went into force, it changed to 2 in 1779, 3 in 1792, 6 in 1796, 9 in 1798, 6 in 1800, 3 in 1802, 11 in 1808, though the number authorized was always much higher than the number actually in service. Under stress of the War of 1812 the army increased from 21 regiments in Jan. 1812 to a paper strength of 51 regiments a year later, though it is doubtful if a sixth of the authorized 58,000 men were ever recruited. Counting militia and local combatants, possibly 60,000 men at the most served during the war.

The regular army was reduced to 6,600 by 1820, the artillery stationed largely in the coast fortifications and the infantry in the northern, western and southern frontier posts. Just before the Mexican War the army had shrunk to an actual strength of 5,300 men, occupying more than 100 posts. When war was declared, the regular army was recruited to war strength, and about 20,000 volunteers responded to the call, many of whom had to be sent home again because they could not be outfitted. About 20,000 troops took part in the war altogether, Winfield Scott having about 10,500 with him in the Valley of Mexico.

In 1848 the troops were reduced to 8,000, scattered over the immense area to which the country had grown. The task of dealing with the Indians in the far west increased the army to a strength of 12,698 men by 1855, which it retained up to the Civil War.

Civil War to World War I.—Enlistments in the Federal army during the Civil War numbered 2,898,304, including re-enlistments. The number in service at one time was probably a little more than 1,500,000. Estimates of the men in Confederate service varied from 700,000 to 885,000. Reduction on the usual scale in the regular army was impossible after the Civil War because of the large number of troops (about 19,000) stationed in the south to support the military governments of the Reconstruction period, because of the threat of Maximilian in Mexico which sent Philip Sheridan to the border with a large command, and because of increased Indian outbreaks in the west during the Civil War and immediately afterward.

The act of 1866 provided for a regular army of 54,000 men paper strength. The actual strength was 38,540 men, which decreased until in 1878 the effective strength was less than 20,000 men. The force was well trained, however, because it saw almost constant service against the Indians in the west. At the beginning of 1896 the army numbered slightly less than 25,000 men, the smallest force in proportion to the total U.S. population at any time since the Revolutionary postwar period.

Calls for volunteers in the Spanish-American War increased the army to 216,029 men on Aug. 31, 1898. An act in 1899 authorized the president to keep the strength of the regular army at a maximum of 65,000, and in 1901 the allowable maximum was raised to 100,000 (X)

Following the Spanish-American War the army launched upon a slow but increasingly accelerated struggle to bring itself up to the forefront as a military organization. To what extent this goal was achieved was demonstrated upon the entrance of the United States into World War I in the spring of 1917. While modernization of equipment and specialized training of troops had much to do with the army's progress, two radical changes in the military organization during the first decade and a half of the 20th century had a lasting effect upon the defense establishment. The first was the establishment of a general staff corps in 1903 which provided for a policy-making group of officers to co-ordinate the specialized activities of infantry, artillery and other arms and services, and to act as a liaison organization between the field soldiers and the secretary of war and members of his civilian staff. The second, occurring in 1914, was congressional authorization for an aviation section of the U.S. army signal corps. This was the beginning of the United States air force, a sister service holding comparable rank with its historic predecessors, the army and the navy.

World Wars I and II.—After the experiences gained by the concentration of a big segment of the regular army and the mobilization of the National guard for duty on the Mexican border in 1916, and in view of the threatening aspects of the war in Europe, which had been in progress since the summer of 1914, the U.S. government realized the necessity of building up its military strength as rapidly as possible. On June 3, 1916, congress passed a national defense act which raised the authorized strength of the regular army to 287,846 officers and enlisted men and provided for a reorganized military establishment which included the national guard, the organized reserve corps and a volunteer, or emergency, army.

The dress rehearsal for the army's participation in World War I started with the mobilization of the bulk of the regular establishment and the national guard in 1916. During the war the army grew from 100,000 officers and men to 4,000,000—up until then a high-water mark of U.S. military manpower. Approximately 2,000,000 soldiers went to France under the leadership of Gen. John J. Pershing and joined forces with the French, English and other Allies to crush the Central Powers in a struggle that was primarily a trench war of relatively fixed positions. At the same time, however, these troops participated in the combat de-

velopment of effective aircraft, tanks and other fighting equipment that was destined to change the tactics, strategies and doctrines of warfare

After World War I, the U.S army experienced the usual contraction that had followed in the wake of every other conflict in which it had taken part. In World War I approximately 75% of the personnel requirements of the army were met through conscription as provided by the Selective Service act of May 18, 1917.

Another big percentage came from the citizen soldiers who comprised the national guard and those who enlisted "for the duration." With the advent of World War II, the army again went through the process of expanding from a force of about 200,000 regulars and a national guard of about the same size to an organization of more than 8,000,000 at peak strength. Its main component parts were the army ground forces, the army air force and the army service forces. The latter group was comprised of the administrative and technical services, such as the quartermaster corps, the adjutant general's department and other supply and procurement services

World War II experiences, from the outset, pointed out new lessons as well as new experiences for the U S people; and the combined political, economic, industrial, diplomatic and military representatives of the nation began to make adjustments and rearrangements in the over-all defense organization even before the war drew to a close Technological progress, electronic developments, atom- and hydrogen-bomb advancements, guided-missile inventions, aircraft perfection and other world-shaping factors contrived to "shrink" the U.S.'s protecting oceans on the east and the west. Previously, the army's history had been one of great expansion in time of emergency upon a mainland protected from attack by two wide water areas and supported by friendly neighbours, only to contract after each national crisis had been met and overcome World War II pointed up the fact that homeland security could no longer depend entirely on the protection of geography, nor could national interests remain centred exclusively in its particular section of the North American continent.

The new era of fast intercontinental transportation imposed upon the nation's military leaders a new concept of security which called for plans that would effect an extremely rapid mobilization of a strong, well-trained, modernly equipped army, as well as a full industrial and civilian mobilization to back up the fighting forces

The Army at Mid-20th Century.—Forced into an accelerated program of implementing its revised plans and policies by the large burden assumed by the United States in the United Nations' intervention in Korea, the mission of the Army at mid-20th century was threefold in its major aspects

The first was constant preparation to maintain by timely and effective military action on land the security of the continental United States, its possessions abroad and other areas vital to its interests.

Second was the formulation of workable plans for organizing, training and combining with Allied forces for land operations.

Third was the development of organization, tactics, techniques and equipment for use by army personnel in amphibious and airborne operations. These were the missions enumerated by the National Security act of 1947, the Key West and Newport agreements among the armed forces and the National Security act amendments of 1949.

Under the provisions of the Armed Services Unification act of July 26, 1947, the air force was established as a separate organization and was divorced from the control of the United States army The same act created the national military establishment (later called the department of defense), in which the secretaries of the army and the navy relinquished presidential cabinet status and, along with the secretary of the air force, reported to the secretary of defense instead of directly to the president.

At mid-century the U.S. army was reorganized in accordance with the provisions of public law 581 passed by the 81st congress on June 28, 1950. This law, known as the Army Organization Act of 1950, established the civilian control, the military directorate and the component elements of the nation's ground fighting service

Under the act, the army's civilian head is the secretary for the army His immediate assistants are an undersecretary of the army and two assistant secretaries The military head is the chief of staff He is the chief of the general staff and reports directly to the secretary of the army. On the immediate staff of the chief is a vice-chief and an allowable maximum of three deputy chiefs

In addition, there are four assistant chiefs of staff, each having supervision over a major element of the army organization. The assistant chief of staff, G-1, is in charge of personnel. Reporting to him are chiefs of the administrative services. the adjutant general, the provost marshal general and the chief of chaplains G-2 directs military intelligence activities. G-3 heads planning and operations G-4 is the logistics chief and reporting to him are the heads of the technical services, which include the chemical, medical, quartermaster, ordnance, transportation, engineer and signal corps.

The administrative and technical services listed above were included in the army service forces during World War II. While the signal corps and the corps of engineers are generally considered to be technical services, they are also classified as an arm, or combat branch, because they carry out missions as combat troops as well as engage in procurement, development and research

Each of the three combat arms provided for under the reorganization act—infantry, artillery and armour—is especially equipped and trained for its specific type of work Training of troops in the field is the responsibility of the chief, army field forces In the training programs emphasis is placed on teamwork with other arms and with elements of the sister services The results of the training are tested in combined manoeuvres and exercises held at frequent intervals

Territorial Organization.—The continental area of the United States at mid-20th century was divided into six army areas, plus the military district of Washington (D.C.), as follows:

(1) 1st army, with headquarters at Governor's Island, N.Y., and consisting of the New England states, New York and New Jersey.

(2) 2nd army, with headquarters at Ft. George G. Meade, Md., including Delaware, Pennsylvania, Maryland, Virginia, West Virginia, Kentucky and Ohio.

(3) 3rd army, with headquarters at Ft McPherson, Ga., and including North and South Carolina, Georgia, Florida, Tennessee, Mississippi and Alabama

(4) 4th army, with headquarters at Ft Sam Houston, Tex., and including Texas, New Mexico, Louisiana, Arkansas and Oklahoma.

(5) 5th army, with headquarters at Chicago, Ill., and including Illinois, Michigan, Indiana, Wisconsin, Minnesota, Iowa, Nebraska, Kansas, Missouri, Wyoming, Colorado and North and South Dakota.

(6) 6th army, with headquarters at the Presidio of San Francisco, Calif., and including California, Oregon, Washington, Montana, Idaho, Utah, Nevada and Arizona

Outside the continental limits of the United States the army had specific missions carried out by the following commands: U.S. army, Caribbean; European command; far east command; U.S forces, Austria; U.S. troops, Trieste; U.S. army, Alaska; and U.S army, Pacific.

Combat Organization.—The basic combat organization in the field is the division. It is the smallest fighting team that contains representation of all the arms and most of the services and is capable of sustaining itself over an extensive period of time in combat. Divisions are of three types—infantry, air-borne and armour—depending on the type of troops that make up the main element of the organization. An infantry division, for example, consisted at mid-century of three infantry regiments (the major element) augmented by five battalions of artillery, a tank battalion and an engineer combat battalion, a reconnaisance company, a signal company and the necessary service and supporting units.

The United States's strong military leadership and participation in the United Nations' action in Korea, which began in the latter part of June 1950, provided a realistic combat test for the organizational setup as well as the equipment and techniques of the country's land warfare establishment—just as the mobilization of the army along the Mexican border in 1916 provided a

proving ground for the evaluation of the national strength prior to World War I In view of the practical experiences gleaned from the Korean campaign, further readjustments in the make-up and mission of the army were made from time to time to keep it in combat readiness for every foreseeable emergency.

(M. B H.)

NAVY

"The genesis of the United States Navy is to be found in the maritime origins and early development of the country," wrote Commodore Dudley W. Knox in *History of the U S. Navy* (G P Putnam's Sons), recording that 2,342 U S -built vessels were included in the total of 7,694 engaged in the commerce of Great Britain in 1775. The earliest sea battles of the American Revolution were fought by small vessels armed for service by 9 of the 13 Colonies, after the battle of Lexington, and intended for the protection of local water-borne commerce

When Washington took command of the Continental army before Boston, Mass., in July 1775, he found his troops without ammunition and arranged for a ship of the Rhode Island navy to go to Bermuda for powder Soon afterward, Washington fitted out seven small vessels and manned them with seagoing troops in order to interfere with British supply ships Commodore John Manly directed this force and commanded the most successful of the vessels, capturing in one British ship a quantity of munitions which was equivalent to the manufacturing capacity of the Colonies for about 18 months On Oct 13, 1775, the Continental Congress voted to fit out ships, and the marine committee, later appointed, sent the first Continental squadron to the Bahamas for the purpose of capturing munitions The ships came back with 71 cannon, 15 brass mortars and considerable powder.

Congress declared all British vessels subject to capture and authorized privateering.

In the aggregate, the Continental navy comprised about 60 ships and made an impressive showing Among the former merchant seamen who commanded the ships, Esek Hopkins, John Paul Jones, John Barry, Lambert Wickes, Nicholas Biddle, Joshua Barney, Samuel Nicholson, Gustavus Conyngham, Henry Johnson and Abraham Whipple were especially competent. Jones was the hero of the most notable exploit, and his reply, "I have not yet begun to fight," gave the navy an imperishable tradition. In addition to cruising against enemy merchantmen and British blockaders, the Continental vessels were required to make many voyages carrying diplomatic representatives and essential cargoes Arrangements for the administration of the Continental vessels were not efficient, and the shortage of money imposed severe handicaps. Privateering offered much better financial inducements, and made recruiting difficult

Together the Continental navy and the privateers touched the pocketbook-nerve of British merchants and each one of the many petitions to the king praying for ending of the war stressed the severe losses which the English mercantile community was suffering

In 1776, after their retreat from Canada, Benedict Arnold and his troops built a flotilla of small vessels on Lake Champlain Ships of the royal navy in the St. Lawrence river contributed trained men and enabled the British to outbuild Arnold and to destroy his vessels off Valcour Island, in Oct. 1776, in the only "fleet" action involving Americans during the war Arnold had so delayed the British, however, that they were unable to advance southward until 1777, by which time Washington and the Continental Congress were able to assemble the army which captured Gen. John Burgoyne at Saratoga, N Y. This victory led to the alliance with France.

The royal navy enabled the British army to reduce Savannah, Ga., Charleston, S.C., and Wilmington, N.C.; it ravaged the coast of Connecticut, burned Norfolk, Va., Falmouth, Me., and other coastal towns while enabling the British army to strike at will along the seaboard. By 1778 Washington realized that he needed a superior French fleet to enable him to inflict a truly decisive defeat on the British, and thereafter he constantly urged on Benjamin Franklin in Paris the need for ships rather than French troops In the battle of the Capes of Virginia, Sept. 5, 1781, a powerful British fleet was defeated by the comte de Grasse. The presence of the French fleet prevented the royal navy from rescuing the British from the Yorktown peninsula, and Washington forced the surrender of Lord Cornwallis.

After the Revolution the Continental navy was disbanded and the vessels sold The first congress, under the constitution, provided for an army but decided that a navy was not necessary. Destruction of U.S commerce by the Barbary States caused congress to authorize the building of six frigates in 1794 and to establish the navy department in 1798.

Successes in the quasi war with France in 1798 and in the Barbary Wars gave Thomas Truxtun, Edward Preble and Stephen Decatur national reputations and provided the young navy with experience and self-confidence

The War of 1812 grew out of British impressment of U.S. seamen and other grievances connected with U.S. commerce New England was not enthusiastic about the war, while the whole country was disappointed by the U S army's failure to occupy Canada The overwhelming size of the British navy made possible a damaging blockade of all principal ports, enabled the British to capture and burn Washington, D.C, to attack Baltimore, Md., New Orleans, La., and various coastal towns, while driving U.S shipping from the seas U S. victories in a number of frigate actions were helpful in keeping up the national spirit; they added to the prestige of the navy and to the reputations of John Rodgers, Charles Stewart, Isaac Hull and David Porter. Thomas Macdonough defeated a British squadron on Lake Champlain and prevented an invasion. Oliver Hazard Perry captured a British naval force on Lake Erie, thus forcing British troops out of Ohio and Detroit, and preserving the states to the westward These timely naval victories on the lakes made possible the favourable peace terms of the treaty of Ghent In the battle of New Orleans, Andrew Jackson acted on sound advice from Commodore Daniel T. Patterson and employed naval forces in a decisive manner.

Between 1815 and 1861 the U.S. navy appeared in seaports all over the world, assisted commerce, made treaties in the near east and far east, explored and surveyed unfamiliar areas, conducted many scientific expeditions and had a major share in ending piracy as well as suppressing the slave trade. The Naval academy was established in 1845 by George Bancroft, the historian, then secretary of the navy.

In the Mexican War, 1846–47, the navy took over California and administered the government, besides escorting and landing the army at Vera Cruz for the capture of Mexico City.

When the Civil War began in 1861, the navy had about 10,000 officers and men and 90 ships. Only 42 of these ships were in commission and only 12 in the home squadron. Many able and experienced officers "went south" and built the Confederate navy, with the assistance of about 2,000 guns and 11 ships captured with the Norfolk navy yard On April 19, 1861, Pres. Abraham Lincoln proclaimed a blockade of all southern ports To many it seemed absurd to propose to blockade 3,000 mi. of seacoast with a small navy. Secretary of the Navy Gideon Wells, ably seconded by Gustavus Fox, assistant secretary, started immediately at the mouth of the James river, and before the end of Dec 1861, more than 150 ships had been captured in attempting to evade the blockade In November, Adm Samuel du Pont took Port Royal sound and established a base for blockading vessels. The blockade isolated the Confederate states, cut off overseas supplies of munitions, and was the most decisive factor in the Union victory. On Nov. 7, 1861, Mississippi river gunboats assisted in a victory at Belmont, Mo., and close co-operation between Commodore Andrew Foote of the navy and Gen. Ulysses S. Grant began The navy closed the Mississippi to Confederate use and cut off the southern states west of the river. David G Farragut distinguished himself in the capture of New Orleans, in operations on the lower Mississippi and at Mobile bay. He became the first rear admiral and later the first admiral David D. Porter, S. F du Pont, S. P. Lee and others also distinguished themselves in a navy which grew enormously before the war's end in 1865.

On March 8, 1862, the steam frigate "Merrimac," converted by the Confederates into an ironclad, appeared in Hampton Roads, Va., and sank two Union vessels, the "Cumberland" and the "Congress." For a time it was feared that the "Merrimac" could destroy the blockade, but on the very next day she was met by the "Monitor" in an epic fight, and she did not attack again Southern cruisers and privateers did not destroy large numbers of Union vessels, but the actual destruction combined with the very high insurance rates ruined the U.S. merchant marine, which never recovered its previous prosperity

Although the Union navy had been the decisive element in the Civil War, it was neglected for many years In spite of naval stagnation the U.S. Naval institute was established in 1873, for the advancement of professional, literary and scientific knowledge in the navy. The Naval War college was established by Commodore Stephen B Luce in 1885, and, in 1890, a member of its staff, Capt. Alfred Thayer Mahan, published *The Influence of Sea Power upon History, 1660–1783* Mahan's writings brought him academic honours at home and abroad, and the presidency of the American Historical association in 1902.

In 1883 congress appropriated money for building four steel warships and the navy took the radical step of insisting that the steel be of domestic manufacture, thus requiring the production of better steel in the United States. The navy assisted in two notable arctic expeditions, "Jeannette" and "Greely," and continued to foster overseas commerce. In the Spanish-American War, 1898, Adms. William Sampson and W. S. Schley defeated the Spanish fleet outside Santiago de Cuba, while Commodore George Dewey won a complete victory over another Spanish fleet in Manila bay. These two naval victories, at a cost of one man killed, practically ended the war.

The U S navy grew steadily in power and efficiency between 1898 and 1917. Pres. Theodore Roosevelt provided much of the impetus for the growth and aided in the national popularity of the service He ordered a cruise around the world in 1907–08 which improved efficiency and had valuable diplomatic effects. In 1915 the office of the chief of naval operations was established, and in 1916 an important shipbuilding program, influenced largely by Japanese actions, was begun. During World War I, U S. naval vessels did not participate in any sea battles, but the navy was expanded eightfold and performed many important duties. The sea power of Great Britain, seconded by French and Italian fleets, had prevented a German victory in spite of the successes of the German armies. In April 1917, just after the U S entry into the war, German submarines were sinking Allied merchantmen at an alarming rate, but the assistance of U.S destroyers, the adoption of the convoy system and a huge shipbuilding program in the U S. overcame this threat. The navy laid an enormous anti-submarine mine field in the North sea, sent a battleship division to join the British grand fleet and a second division to Bantry bay to guard against heavy raiders, sent a naval aviation bombing squadron to France, provided a battery of heavy guns on railway carriages for the western front and transported more than 1,000,000 troops to France.

World War II.—After the beginning of World War II in 1939, the U S. navy began a huge building program of planes, warships, merchant ships, landing craft and various special types. A patrol was instituted in the Atlantic in 1939, Iceland was occupied in 1941 and the escort of convoys began in 1941. After the disastrous Pearl Harbor attack of Dec. 7, 1941, the U.S. navy helped seize French Morocco in Nov. 1942, and landed U.S. troops in Morocco and Algiers. It furnished sea and naval air strength for the seizure of Sicily, Salerno, Anzio and southern France . While combatting German undersea warfare in the Atlantic, the navy furnished convoy escorts and special search groups including aircraft carriers, planes, destroyers and special anti-submarine vessels. In the Normandy landings of June 1944, the navy supplied large numbers of amphibious ships, landing craft, etc., as well as combat ships for fire support for troops. German Gens Erwin Rommel and Karl von Rundstedt reported, at the time, that the close fire support delivered by war vessels was decisive in aiding U S. troops to seize and hold positions. After the Pearl Harbor attack, Japanese amphibious forces made landings in Malaya, the Philippines, South Pacific islands, New Guinea and the Netherlands Indies. Early in 1942 the Japanese were building up Rabaul as a great base and on May 8, 1942, in the battle of the Coral sea, fought by carrier planes, the U S navy checked the Japanese in their expansion southeastward On June 4, 1942, the decisive battle of Midway was fought Japanese battleships, cruisers, destroyers and submarines, as well as amphibious vessels, were in the area, and U.S. cruisers, destroyers and submarines; but the heavy blows were struck by carrier planes, and Japan lost its four best carriers together with all their planes and almost all their pilots The U S navy suffered heavy casualties among carrier pilots and lost one of three carriers present, but to the Japanese the result was devastating.

Both the U.S. and Japanese navies had done far more than other navies in integrating aviation in their fleets Japan began the war with excellent carriers and well-trained carrier pilots The heavy losses in pilots at Coral sea and Midway were augmented in the battle of Santa Cruz and by misusing carrier pilots on shore at Rabaul later on In consequence, Japan never replaced its "first team" of carrier pilots. In Aug. 1942 the U.S. marines landed on Guadalcanal in the Solomons, and this area became a battleground for six months. The naval battles of Savo Island, eastern Solomons, Cape Esperance, Santa Cruz, Guadalcanal and Tassafarongo were costly to the U.S. navy but even more costly to the Japanese Later, the U.S navy, with amphibious, carrier task forces and gunfire support forces, fought westward through the Solomons, Bismarcks, Admiralty Islands, Marshall Islands and Carolines, while Gen Douglas MacArthur's troops were working westward on New Guinea On June 15, 1944, Adm. R. A. Spruance struck the inner ring of Japanese defenses by landing marines on Saipan, and on June 19 fought the battle of the Philippine sea, which resulted in a further heavy loss of Japanese carrier pilots and planes, as well as two Japanese carriers sunk by submarines In anticipation of heavy attacks by planes coming from the westward, Spruance placed battleships, cruisers and destroyers in position many miles from his more vulnerable carriers, under Adm. Marc S. Mitscher, and suffered only minor damage to his ships. Other important battles, involving large forces, were fought at Lingayen gulf, Iwo Jima and Okinawa The battle for Leyte gulf, fought Oct. 25, 1944, and involving three important separate engagements, was one of the decisive naval victories of the war, along with Midway and the Philippine sea. Sea power was decisive in the Pacific, bringing Japan to impotency by destroying its merchant marine through submarine warfare, destroying its fleet and leaving great bases like Rabaul and Truk with large garrisons to die on the vine, throttled by U S. naval control of the seas and the air above them. Adms. E. J. King, C. W. Nimitz, W. F. Halsey, R A. Spruance, H. K. Hewitt, T. C. Kinkaid and R. K. Turner gained fame by their successes (*see* also WORLD WAR II).

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(J. B. HN.)

AIR FORCE

For the history and development of the U.S. air force, *see* AIR FORCES and AIR WARFARE.

IX. CONSTITUTION AND GOVERNMENT

The following pages contain the constitution of the United

States and the 22 amendments (with dates declared effective)

CONSTITUTION OF THE UNITED STATES OF AMERICA

PREAMBLE

We the People of the United States, in Order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defence, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America.

Article. I.

Section. 1. All legislative Powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives

Section. 2. The House of Representatives shall be composed of Members chosen every second Year by the People of the several States, and the Electors in each State shall have the Qualifications requisite for Electors of the most numerous Branch of the State Legislature.

No Person shall be a Representative who shall not have attained to the Age of twenty five Years, and been seven Years a Citizen of the United States, and who shall not, when elected, be an Inhabitant of that State in which he shall be chosen.

Representatives and direct Taxes shall be apportioned among the several States which may be included within this Union, according to their respective Numbers, which shall be determined by adding to the whole Number of free Persons, including those bound to Service for a Term of Years, and excluding Indians not taxed, three fifths of all other Persons The actual Enumeration shall be made within three Years after the first Meeting of the Congress of the United States, and within every subsequent Term of ten Years, in such Manner as they shall by Law direct. The Number of Representatives shall not exceed one for every thirty Thousand, but each State shall have at Least one Representative; and until such enumeration shall be made, the State of New Hampshire shall be entitled to choose three, Massachusetts eight, Rhode Island and Providence Plantations one, Connecticut five, New York six, New Jersey four, Pennsylvania eight, Delaware one, Maryland six, Virginia ten, North Carolina five, South Carolina five, and Georgia three.

When vacancies happen in the Representation from any State, the Executive Authority thereof shall issue Writs of Election to fill such Vacancies

The House of Representatives shall chuse their Speaker and other Officers; and shall have the sole Power of Impeachment.

Section. 3. The Senate of the United States shall be composed of two Senators from each State, chosen by the Legislature thereof, for six Years; and each Senator shall have one Vote

Immediately after they shall be assembled in Consequence of the first Election, they shall be divided as equally as may be into three Classes. The Seats of the Senators of the first Class shall be vacated at the Expiration of the second Year, of the second Class at the Expiration of the fourth Year, and of the third Class at the Expiration of the sixth Year, so that one third may be chosen every second Year; and if Vacancies happen by Resignation, or otherwise, during the Recess of the Legislature of any State, the Executive thereof may make temporary Appointments until the next Meeting of the Legislature, which shall then fill such Vacancies.

No Person shall be a Senator who shall not have attained to the Age of thirty Years, and been nine Years a Citizen of the United States, and who shall not, when elected, be an Inhabitant of that State for which he shall be chosen.

The Vice President of the United States shall be President of the Senate, but shall have no Vote, unless they be equally divided.

The Senate shall chuse their other Officers, and also a President pro tempore, in the Absence of the Vice President, or when he shall exercise the Office of President of the United States

The Senate shall have the sole Power to try all Impeachments. When sitting for that Purpose, they shall be on Oath or Affirmation When the President of the United States is tried, the Chief Justice shall preside. And no Person shall be convicted without the Concurrence of two thirds of the Members present.

Judgment in Cases of Impeachment shall not extend further than to removal from Office, and disqualification to hold and enjoy any Office of honor, Trust or Profit under the United States· but the Party convicted shall nevertheless be liable and subject to Indictment, Trial, Judgment and Punishment, according to Law

Section. 4. The Times, Places and Manner of holding Elections for Senators and Representatives, shall be prescribed in each State by the Legislature thereof; but the Congress may at any time by Law make or alter such Regulations, except as to places of chusing Senators.

The Congress shall assemble at least once in every Year, and such Meeting shall be on the first Monday in December, unless they shall by Law appoint a different Day.

Section. 5. Each House shall be the Judge of the Elections, Returns and Qualifications of its own Members, and a Majority of each shall constitute a Quorum to do Business; but a smaller Number may adjourn from day to day, and may be authorized to compel the Attendance of absent Members, in such Manner, and under such Penalties as each House may provide.

Each House may determine the Rules of its Proceedings, punish its Members for disorderly behaviour, and, with the Concurrence of two thirds, expel a Member

Each House shall keep a Journal of its Proceedings, and from time to time publish the same, excepting such Parts as may in their Judgment require Secrecy; and the Yeas and Nays of the Members of either House on any question shall, at the Desire of one fifth of those Present, be entered on the Journal

Neither House, during the Session of Congress, shall, without the Consent of the other, adjourn for more than three days, nor to any other Place than that in which the two Houses shall be sitting

Section. 6. The Senators and Representatives shall receive a Compensation for their services, to be ascertained by Law, and paid out of the Treasury of the United States They shall in all Cases, except Treason, Felony and Breach of the Peace, be privileged from Arrest during their Attendance at the Session of their respective Houses, and in going to and returning from the same; and for any Speech or Debate in either House, they shall not be questioned in any other Place.

No Senator or Representative shall, during the Time for which he was elected, be appointed to any civil Office under the Authority of the United States, which shall have been created, or the Emoluments whereof shall have been increased during such time, and no Person holding any Office under the United States, shall be a Member of either House during his Continuance in Office.

Section. 7. All Bills for raising Revenue shall originate in the House of Representatives; but the Senate may propose or concur with Amendments as on other bills.

Every Bill which shall have passed the House of Representatives and the Senate, shall, before it becomes a Law, be presented to the President of the United States; If he approve he shall sign it, but if not he shall return it, with his Objections to that House in which it shall have originated, who shall enter the Objections at large on their Journal, and proceed to reconsider it. If after such Reconsideration two thirds of that House shall agree to pass the Bill, it shall be sent, together with the Objections, to the other House, by which it shall likewise be reconsidered, and if approved by two thirds of that House, it shall become a Law. But in all such Cases the Votes of both Houses shall be determined by yeas and Nays, and the Names of the Persons voting for and against the Bill shall be entered on the Journal of each House respectively If any Bill shall not be returned by the President within ten Days (Sundays excepted) after it shall have been presented to him, the Same shall be a Law, in like Manner as if he had signed it, unless the Congress by their Adjournment prevent its Return, in which Case it shall not be a Law.

Every Order, Resolution, or Vote to which the Concurrence of the Senate and House of Representatives may be necessary (except on a question of Adjournment) shall be presented to the President of the United States; and before the Same shall take Effect, shall be approved by him, or being disapproved by him,

shall be repassed by two thirds of the Senate and House of Representatives, according to the Rules and Limitations prescribed in the Case of a Bill

Section. 8. The Congress shall have Power To lay and collect Taxes, Duties, Imposts and Excises, to pay the Debts and provide for the common Defence and general Welfare of the United States; but all Duties, Imposts and Excises shall be uniform throughout the United States;

To borrow Money on the credit of the United States;

To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes;

To establish an uniform Rule of Naturalization, and uniform Laws on the subject of Bankruptcies throughout the United States;

To coin Money, regulate the Value thereof, and of foreign Coin, and fix the Standard of Weights and Measures;

To provide for the Punishment of counterfeiting the Securities and current Coin of the United States;

To establish Post Offices and Post Roads;

To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries;

To constitute Tribunals inferior to the supreme Court;

To define and punish Piracies and Felonies committed on the high Seas, and Offences against the Law of Nations;

To declare War, grant Letters of Marque and Reprisal, and make Rules concerning Captures on Land and Water;

To raise and support Armies, but no Appropriation of Money to that Use shall be for a longer Term than two Years;

To provide and maintain a Navy;

To make Rules for the Government and Regulation of the land and naval Forces;

To provide for calling forth the Militia to execute the Laws of the Union, suppress Insurrections and repel Invasions;

To provide for organizing, arming, and disciplining the Militia, and for governing such Part of them as may be employed in the Service of the United States, reserving to the States respectively, the Appointment of the Officers, and the Authority of training the Militia according to the discipline prescribed by Congress;

To exercise exclusive Legislation in all Cases whatsoever, over such District (not exceeding ten Miles square) as may, by Cession of particular States, and the Acceptance of Congress, become the Seat of the Government of the United States, and to exercise like Authority over all Places purchased by the Consent of the Legislature of the State in which the Same shall be, for the Erection of Forts, Magazines, Arsenals, dock-Yards, and other needful Buildings;—And

To make all Laws which shall be necessary and proper for carrying into Execution the foregoing Powers, and all other Powers vested by this Constitution in the Government of the United States, or in any Department or Officer thereof

Section. 9. The Migration or Importation of such Persons as any of the States now existing shall think proper to admit, shall not be prohibited by the Congress prior to the Year one thousand eight hundred and eight, but a Tax or duty may be imposed on such Importation, not exceeding ten dollars for each Person.

The Privilege of the Writ of Habeas Corpus shall not be suspended, unless when in Cases of Rebellion or Invasion the public Safety may require it.

No Bill of Attainder or ex post facto Law shall be passed.

No Capitation, or other direct, Tax shall be laid, unless in Proportion to the Census or Enumeration herein before directed to be taken

No Tax or Duty shall be laid on Articles exported from any State.

No Preference shall be given by any Regulation of Commerce or Revenue to the Ports of one State over those of another: nor shall Vessels bound to, or from, one State, be obliged to enter, clear, or pay Duties in another.

No Money shall be drawn from the Treasury, but in Consequence of Appropriations made by Law, and a regular Statement and Account of the Receipts and Expenditures of all public Money shall be published from time to time

No Title of Nobility shall be granted by the United States. And no Person holding any Office of Profit or Trust under them, shall, without the Consent of the Congress, accept of any present, Emolument, Office, or Title, of any kind whatever, from any King, Prince, or foreign State.

Section. 10. No State shall enter into any Treaty, Alliance, or Confederation, grant Letters of Marque and Reprisal, coin Money; emit Bills of Credit; make any Thing but gold and silver Coin a Tender in Payment of Debts; pass any Bill of Attainder, ex post facto Law, or Law impairing the Obligation of Contracts, or grant any Title of Nobility.

No State shall, without the Consent of the Congress, lay any Imposts or Duties on Imports or Exports, except what may be absolutely necessary for executing its inspection Laws and the net Produce of all Duties and Imposts, laid by any State on Imports or Exports, shall be for the Use of the Treasury of the United States; and all such Laws shall be subject to the Revision and controul of the Congress

No State shall, without the Consent of Congress, lay any Duty of Tonnage, keep Troops, or Ships of War in time of Peace, enter into any Agreement or Compact with another State, or with a foreign Power, or engage in War, unless actually invaded, or in such imminent Danger as will not admit of delay.

ARTICLE. II.

Section. 1. The executive Power shall be vested in a President of the United States of America He shall hold his Office during the Term of four Years, and, together with the Vice President, chosen for the same Term, be elected, as follows

Each State shall appoint, in such Manner as the Legislature thereof may direct, a Number of Electors, equal to the whole Number of Senators and Representatives to which the State may be entitled in the Congress, but no Senator or Representative, or Person holding an Office of Trust or Profit under the United States, shall be appointed an Elector

The Electors shall meet in their respective States and vote by Ballot

[illegible]

tinct[illegible] the States, and a Majority of that[illegible] shall be necessary to a Choice In every Case, after the Choice of the President, the Person having the greatest Number of Votes of the Electors shall be the Vice President. But if there should remain two or more who have equal Votes, the Senate shall chuse from them by Ballot the Vice President.

The Congress may determine the Time of chusing the Electors, and the Day on which they shall give their Votes, which Day shall be the same throughout the United States.

No Person except a natural born Citizen, or a Citizen of the United States, at the time of the Adoption of this Constitution, shall be eligible to the Office of President; neither shall any Person be eligible to that Office who shall not have attained to the Age of thirty five Years, and been fourteen Years a Resident within the United States.

In Case of the Removal of the President from Office, or of his Death, Resignation, or Inability to discharge the Powers and Duties of the said Office, the Same shall devolve on the Vice President, and the Congress may by Law provide for the Case of Removal, Death, Resignation or Inability, both of the President and Vice President, declaring what Officer shall then act as President, and such Officer shall act accordingly, until the Disability be removed, or a President shall be elected.

The President shall, at stated Times, receive for his Services, a Compensation, which shall neither be encreased nor diminished during the Period for which he shall have been elected, and he shall not receive within that Period any other Emolument from the United States, or any of them

Before he enter on the Execution of his Office, he shall take the following Oath or Affirmation —"I do solemnly swear (or affirm) that I will faithfully execute the Office of President of the United States, and will to the best of my Ability, preserve, protect and defend the Constitution of the United States."

Section. 2. The President shall be Commander in Chief of the Army and Navy of the United States, and of the Militia of the several States, when called into the actual Service of the United States; he may require the Opinion, in writing, of the principal Officer in each of the executive Departments, upon any Subject relating to the Duties of their respective Offices, and he shall have Power to grant Reprieves and Pardons for Offences against the United States, except in Cases of Impeachment

He shall have Power, by and with the Advice and Consent of the Senate, to make Treaties, provided two thirds of the Senators present concur, and he shall nominate, and by and with the Advice and Consent of the Senate, shall appoint Ambassadors, other public Ministers and Consuls, Judges of the supreme Court, and all other Officers of the United States, whose Appointments are not herein otherwise provided for, and which shall be established by Law: but the Congress may by Law vest the Appointment of such inferior Officers, as they think proper, in the President alone, in the courts of Law, or in the Heads of Departments.

The President shall have Power to fill up all Vacancies that may happen during the Recess of the Senate, by granting Commissions which shall expire at the End of their next Session.

Section. 3. He shall from time to time give to the Congress Infor-

mation of the State of the Union, and recommend to their Consideration such Measures as he shall judge necessary and expedient; he may, on extraordinary Occasions, convene both Houses, or either of them, and in Case of Disagreement between them, with Respect to the Time of Adjournment, he may adjourn them to such Time as he shall think proper; he shall receive Ambassadors and other public Ministers, he shall take Care that the Laws be faithfully executed, and shall Commission all the Officers of the United States

Section. 4. The President, Vice President and all civil Officers of the United States, shall be removed from Office on Impeachment for, and Conviction of, Treason, Bribery, or other high Crimes and Misdemeanors.

ARTICLE. III

Section. 1. The judicial Power of the United States shall be vested in one supreme Court, and in such inferior Courts as the Congress may from time to time ordain and establish The Judges, both of the supreme and inferior Courts, shall hold their Offices during good Behavior, and shall, at stated Times, receive for their Services, a Compensation, which shall not be diminished during their Continuance in Office.

Section. 2. The judicial Power shall extend to all Cases, in Law and Equity, arising under this Constitution, the Laws of the United States, and Treaties made, or which shall be made, under their Authority;—to all Cases affecting Ambassadors, other public Ministers and Consuls;—to all Cases of admiralty and maritime Jurisdiction;—to Controversies to which the United States shall be a Party;—to Controversies between two or more States;—between a State and Citizens of another State,—between Citizens of different States,—between Citizens of the same State claiming Lands under Grants of different States, and between a State, or the Citizens thereof, and foreign States, Citizens or Subjects

In all Cases affecting Ambassadors, other public Ministers and Consuls, and those in which a State shall be Party, the supreme Court shall have original Jurisdiction In all the other Cases before mentioned, the supreme Court shall have appellate Jurisdiction, both as to Law and Fact, with such Exceptions, and under such Regulations as the Congress shall make

The Trial of all Crimes, except in Cases of Impeachment, shall be by Jury; and such Trial shall be held in the State where the said Crimes shall have been committed, but when not committed within any State, the Trial shall be at such Place or Places as the Congress may by Law have directed

Section. 3. Treason against the United States, shall consist only in levying War against them, or in adhering to their Enemies, giving them Aid and Comfort No Person shall be convicted of Treason unless on the Testimony of two Witnesses to the same overt Act, or on Confession in open Court

The Congress shall have power to declare the Punishment of Treason, but no Attainder of Treason shall work Corruption of Blood, or Forfeiture except during the Life of the Person attainted

ARTICLE. IV.

Section. 1. Full Faith and Credit shall be given in each State to the public Acts, Records, and judicial Proceedings of every other State. And the Congress may by general Laws prescribe the Manner in which such Acts, Records and Proceedings shall be proved, and the Effect thereof

Section. 2. The Citizens of each State shall be entitled to all Privileges and Immunities of Citizens in the several States

A person charged in any State with Treason, Felony, or other Crime, who shall flee from Justice, and be found in another State, shall on Demand of the executive Authority of the State from which he fled, be delivered up, to be removed to the State having Jurisdiction of the Crime.

No Person held to Service or Labour in one State, under the Laws thereof, escaping into another, shall, in Consequence of any Law or Regulation therein, be discharged from such Service or Labour, but shall be delivered up on Claim of the Party to whom such Service or Labour may be due.

Section. 3. New States may be admitted by the Congress into this Union; but no new State shall be formed or erected within the Jurisdiction of any other State; nor any State be formed by the Junction of two or more States, or Parts of States, without the Consent of the Legislatures of the States concerned as well as of the Congress.

The Congress shall have Power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States, and nothing in this Constitution shall be so construed as to Prejudice any Claims of the United States, or of any particular State.

Section. 4. The United States shall guarantee to every State in this Union a Republican Form of Government, and shall protect each of them against Invasion; and on Application of the Legislature, or of the Executive (when the Legislature cannot be convened) against domestic Violence.

ARTICLE. V

The Congress, whenever two thirds of both Houses shall deem it necessary, shall propose Amendments to this Constitution, or, on the Application of the Legislatures of two thirds of the several States, shall call a Convention for proposing Amendments, which, in either Case, shall be valid to all Intents and Purposes, as Part of this Constitution, when ratified by the Legislatures of three fourths of the several States, or by Conventions in three fourths thereof, as the one or the other Mode of Ratification may be proposed by the Congress; Provided that no Amendment which may be made prior to the Year One thousand eight hundred and eight shall in any Manner affect the first and fourth Clauses in the Ninth Section of the first Article; and that no State, without its Consent, shall be deprived of its equal Suffrage in the Senate

ARTICLE. VI.

All Debts contracted and Engagements entered into, before the Adoption of this Constitution, shall be as valid against the United States under this Constitution, as under the Confederation

This Constitution, and the Laws of the United States which shall be made in Pursuance thereof, and all Treaties made, or which shall be made, under the Authority of the United States, shall be the supreme Law of the land; and the Judges in every State shall be bound thereby, any Thing in the Constitution or Laws of any State to the Contrary notwithstanding

The Senators and Representatives before mentioned, and the Members of the several State Legislatures, and all executive and judicial Officers, both of the United States and of the several States, shall be bound by Oath or Affirmation, to support this Constitution, but no religious Test shall ever be required as a Qualification to any Office or public Trust under the United States

ARTICLE. VII.

The Ratification of the Conventions of nine States shall be sufficient for the Establishment of this Constitution between the States so ratifying the Same

done in Convention by the Unanimous Consent of the States present[1] the Seventeenth Day of September in the Year of our Lord one thousand seven hundred and Eighty-seven and of the Independence of the United States of America the twelfth In Witness whereof We have hereunto subscribed our Names,

	Go Washington—Presidt and deputy from Virginia
New Hampshire	John Langdon Nicholas Gilman
Massachusetts	Nathaniel Gorham Rufus King
Connecticut	Wm. Saml. Johnson Roger Sherman
New York	Alexander Hamilton
New Jersey	Wil: Livingston David Brearley. Wm Paterson. Jona: Dayton
Pennsylvania	B Franklin Thomas Mifflin Robt Morris Geo. Clymer Thos FitzSimons Jared Ingersoll James Wilson Gouv Morris
Delaware	Geo: Read Gunning Bedford jun John Dickinson Richard Bassett Jaco: Broom
Maryland	James McHenry Dan of St. Thos Jenifer Danl Carroll.
Virginia	John Blair— James Madison Jr.
North Carolina	Wm. Blount Richd Dobbs Spaight. Hu Williamson
South Carolina	J. Rutledge Charles Cotesworth Pinckney Charles Pinckney Pierce Butler.
Georgia	William Few Abr Baldwin

[1] Rhode Island sent no delegates to the federal convention.

AMENDMENTS TO THE CONSTITUTION OF THE UNITED STATES

"*Resolved*, By the Senate and House of Representatives of the United States of America, in congress assembled, two-thirds of both Houses concurring, that the following articles be proposed to the Legislatures of the several States, as amendments to the Constitution of the United States, all or any of which articles, when ratified by three-fourths of the said Legislatures, to be valid to all intents and purposes, as part of the said Constitution, namely "

THE TEN ORIGINAL AMENDMENTS
(Dec. 15, 1791)

Article I—Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech or of the press, or the right of the people peaceably to assemble, and to petition the Government for a redress of grievances

Article II—A well-regulated militia being necessary to the security of a free State, the right of the people to keep and bear arms shall not be infringed

Article III—No soldier shall, in time of peace, be quartered in any house without the consent of the owner, nor in time of war, but in a manner to be prescribed by law

Article IV—The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

Article V—No person shall be held to answer for a capital or other infamous crime unless on a presentment or indictment of a grand jury, except in cases arising in the land or naval forces, or in the militia, when in actual service, in time of war or public danger, nor shall any person be subject for the same offence to be twice put in jeopardy of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law, nor shall private property be taken for public use without just compensation

Article VI—In all criminal prosecutions, the accused shall enjoy the right to a speedy and public trial, by an impartial jury of the State and district wherein the crime shall have been committed, which districts shall have been previously ascertained by law, and to be informed of the nature and cause of the accusation; to be confronted with the witnesses against him, to have compulsory process for obtaining witnesses in his favor, and to have the assistance of counsel for his defence.

Article VII—In suits at common law, where the value in controversy shall exceed twenty dollars, the right of trial by jury shall be preserved, and no fact tried by a jury shall be otherwise re-examined in any court of the United States than according to the rules of the common law

Article VIII—Excessive bail shall not be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted

Article IX—The enumeration in the Constitution of certain rights shall not be construed to deny or disparage others retained by the people.

Article X—The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

Article XI—(Jan 8, 1798)—The judicial power of the United States shall not be construed to extend to any suit in law or equity, commenced or prosecuted against one of the United States, by citizens of another State, or by citizens or subjects of any foreign state.

Article XII—(Sept 25, 1804)—The electors shall meet in their respective States and vote by ballot for President and Vice President one of whom, at least, shall not be an inhabitant of the same State with themselves; they shall name in their ballots the person voted for as President, and in distinct ballots the person voted for as Vice President, and they shall make distinct lists of all persons voted for as President, and of all persons voted for as Vice President, and of the number of votes for each, which lists they shall sign and certify, and transmit sealed to the seat of the government of the United States, directed to the President of the Senate;—The President of the Senate shall, in the presence of the Senate and House of Representatives, open all the certificates and the votes shall then be counted;—The person having the greatest number of votes for President, shall be the President, if such number be a majority of the whole number of electors appointed; and if no person have such majority, then from the persons having the highest numbers not exceeding three on the list of those voted for as President, the House of Representatives shall choose immediately, by ballot, the President. But in choosing the President, the votes shall be taken by States, the representation from each State having one vote; a quorum for this purpose shall consist of a member or members from two-thirds of the States, and a majority of all the States shall be necessary to a choice. And if the House of Representatives shall not choose a President whenever the right of choice shall devolve upon them, before the fourth day of March next following, then the Vice President shall act as President, as in the case of the death or other constitutional disability of the President.—The person having the greatest number of votes as Vice President, shall be the Vice President, if such number be a majority of the whole number of electors appointed, and if no person have a majority, then from the two highest numbers on the list the Senate shall choose the Vice President; a quorum for the purpose shall consist of two-thirds of the whole number of Senators, and a majority of the whole number shall be necessary to a choice. But no person constitutionally ineligible to the office of President shall be eligible to that of Vice-President of the United States.

Article XIII—(Dec. 18, 1865)—1. Neither slavery nor involuntary servitude, except as a punishment for crime whereof the party shall have been duly convicted, shall exist within the United States, or any place subject to their jurisdiction.

2. Congress shall have power to enforce this article by appropriate legislation

Article XIV—(July 28, 1868)—1. All persons born or naturalized in the United States, and subject to the jurisdiction thereof, are citizens of the United States and of the State wherein they reside No State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty, or property without due process of law, nor deny to any person within its jurisdiction the equal protection of the laws

2. Representatives shall be apportioned among the several States according to their respective numbers, counting the whole number of persons in each State, excluding Indians not taxed But when the right to vote at any election for the choice of electors for President and Vice-President of the United States, Representatives in Congress, the executive and judicial officers of a State, or the members of the Legislature thereof, is denied to any of the male members of such State, being of twenty-one years of age, and citizens of the United States, or in any way abridged, except for participation in rebellion or other crime, the basis of representation therein shall be reduced in the proportion which the number of such male citizens shall bear to the whole number of male citizens twenty-one years of age in such State.

3 No person shall be a Senator or Representative in Congress, or elector of President and Vice-President, or hold any office, civil or military, under the United States, or under any State, who, having previously taken an oath, as a member of Congress, or as an officer of the United States, or as a member of any State Legislature, or as an executive or judicial officer of any State, to support the Constitution of the United States, shall have engaged in insurrection or rebellion against the same, or given aid and comfort to the enemies thereof But Congress may, by a vote of two-thirds of each House, remove such disability

4. The validity of the public debt of the United States, authorized by law, including debts incurred for payment of pensions and bounties for services in suppressing insurrection and rebellion, shall not be questioned. But neither the United States nor any State shall assume or pay any debt or obligation incurred in aid of insurrection or rebellion against the United States, or any claim for the loss or emancipation of any slave, but all such debts, obligations, and claims shall be held illegal and void.

5. The Congress shall have power to enforce by appropriate legislation the provisions of this article.

Article XV—(March 30, 1870)—1. The right of the citizens of the United States to vote shall not be denied or abridged by the United States or by any State on account of race, color, or previous condition of servitude

2 The Congress shall have power to enforce the provisions of this article by appropriate legislation.

Article XVI—(Feb 25, 1913)—The Congress shall have power to lay and collect taxes on incomes, from whatever sources derived, without apportionment among the several States, and without regard to any census or enumeration.

Article XVII—(May 31, 1913)—1 The Senate of the United States shall be composed of two Senators from each State, elected by the people thereof, for six years; and each Senator shall have one vote. The electors in each State shall have the qualifications requisite for electors of the most numerous branch of the State Legislatures

2. When vacancies happen in the representation of any State in the Senate, the executive authority of such State shall issue writs of election to fill such vacancies: Provided, That the Legislature of any State may empower the Executive thereof to make temporary appointment until the people fill the vacancies by election as the Legislature may direct

3. This amendment shall not be so construed as to affect the election or term of any Senator chosen before it becomes valid as part of the Constitution.

Article XVIII—(Jan. 29, 1919)—1. After one year from the ratification of this article the manufacture, sale, or transportation of intoxicating liquors within, the importation thereof into, or the exportation thereof from the United States and all territory subject to the jurisdiction thereof for beverage purposes is hereby prohibited.

2. The Congress and the several States shall have concurrent power to enforce this article by appropriate legislation

3 This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by the Legislatures of the several

States, as provided in the Constitution, within seven years from the date of the submission hereof to the States by the Congress

Article XIX—(Aug 18, 1920)—1. The right of citizens of the United States to vote shall not be denied or abridged by the United States or by any State on account of sex.

2. The Congress shall have power by appropriate legislation to enforce the provision of this article.

Article XX—(Feb. 6, 1933)—1. The terms of the President and Vice-President shall end at noon on the 20th day of January, and the terms of Senators and Representatives at noon on the 3rd day of January, of the years in which such terms would have ended if this article had not been ratified, and the terms of their successors shall then begin.

2. The Congress shall assemble at least once in every year, and such meeting shall begin at noon on the 3rd day of January, unless they shall by law appoint a different day.

3. If, at the time fixed for the beginning of the term of the President, the President elect shall have died, the Vice-President elect shall become President. If a President shall not have been chosen before the time fixed for the beginning of his term, or if the President elect shall have failed to qualify, then the Vice-President elect shall act as President until a President shall have qualified, and the Congress may by law provide for the case wherein neither a President elect nor a Vice-President elect shall have qualified, declaring who shall then act as President, or the manner in which one who is to act shall be selected, and such person shall act accordingly until a President or Vice-President shall have qualified

4. The Congress may by law provide for the case of the death of any of the persons from whom the House of Representatives may choose a President whenever the right of choice shall have devolved upon them, and for the case of the death of any of the persons from whom the Senate may choose a Vice-President whenever the right of choice shall have devolved upon them.

5. Sections 1 and 2 shall take effect on the 15th day of October following the ratification of this article.

6 This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by the legislatures of three-fourths of the several States within seven years from the date of its submission

Article XXI—(Dec. 5, 1933)—1. The Eighteenth Article of amendment to the Constitution of the United States is hereby repealed.

2 The transportation or importation into any State, Territory, or possession of the United States for delivery or use therein of intoxicating liquors, in violation of the laws thereof, is hereby prohibited

3. This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by conventions in the several States, as provided in the Constitution, within seven years from the date of the submission hereof to the States by the Congress.

Article XXII—(Feb 26, 1951)—1 No person shall be elected to the office of the President more than twice, and no person who has held the office of President, or acted as President, for more than two years of a term to which some other person was elected President shall be elected to the office of the President more than once But this Article shall not apply to any person holding the office of President when this Article was proposed by the Congress, and shall not prevent any person who may be holding the office of President, or acting as President, during the term within which this Article becomes operative from holding the office of President or acting as President during the remainder of such term.

2. This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by the legislatures of three-fourths of the several States within seven years from the date of its submission to the States by the Congress.

GOVERNMENT

An account of the governmental system of the United States must be largely descriptive of the organization of national and state governments But it must also analyze certain of the fundamental characteristics that distinguish the United States government from other governments. Bearing this twofold object in mind, it will be convenient to discuss the general characteristics first, and to follow with a description of governmental organization. Under this plan, the discussion of the constitution and government of the United States is organized on the following plan:

(1) Federal system; (2) written constitutions; (3) judicial construction of written constitutions; (4) separation of powers; (5) presidential system of executive organization; (6) national government; (7) state governments; (8) local government in the states; (9) elections and political parties.

1. FEDERAL SYSTEM

By the Declaration of Independence in 1776, the 13 American colonies of Great Britain expressed their action as that of "these united colonies," but the terms of the declaration implied that each became an independent state. The 13 united in declaring independence and in the conduct of war, though their co-operation was largely ineffective The Articles of Confederation, adopted in 1781, constituted a legal symbol of union, but the central government under these articles had no coercive power over the states and no power whatever capable of exercise directly upon the citizens of the states The national constitution, framed in 1787 and put into effect in 1789, was intended to remedy this situation by creating a central government with large powers and with authority to exercise these powers, not merely upon the states, but directly upon all citizens of the country When the first congress of the United States under the constitution of 1787 assembled in New York in April 1789, the union had a membership of 11 states North Carolina and Rhode Island soon joined their sisters of the original 13 states

Share of States in the Government of the Nation.—Under the federal principle in the United States, the states, as such, are constitutionally guaranteed their territorial integrity and are expressly recognized as units in the organization of national government They have equal representation in the United States senate. They are treated as units in the election of president and vice-president and of members of the federal house of representatives. They have a decisive share in the amendment of the constitution of the United States.

When the national government was being formed, a sharp conflict of interests arose between the small states and the large states The smaller states contended for complete equality among the states in the organization of the national government, and the larger states contended for influence in proportion to population A compromise was reached by which the states are equally represented in the United States senate, irrespective of population, and in proportion to their population in the house of representatives By the terms of the constitution no state may without its consent be deprived of its "equal suffrage in the Senate"

Representation in the national house of representatives is based upon population. Under the constitution, each ten years, after the decennial federal census, the congress of the United States determines how many members will constitute the house of representatives. This number is then divided into the total population of the 48 states. In this manner a ratio of representation is obtained. Each state is entitled to as many representatives as this ratio is contained in its population, although each state, no matter how small its population, is entitled to at least one representative. After the division of the representative ratio into the population of each of the states, large fractions of population may remain; and the states having the largest remainders received additional representatives, as long as the number agreed upon was not exceeded. The problem of fractions presented difficulties. A method known as the method of major fractions was used in 1910; choice of several methods of computation was provided by an act of 1929; and by act of 1941 the method known as the method of equal proportions was adopted No apportionment was made after the census of 1920, and provision was made in 1929 for automatic reapportionment of the existing number of representatives in case congress did not enact an apportioning act within 60 days after receiving the decennial statistical information on which apportionment is based. By act of 1941 automatic decennial reapportionment was provided without change in the existing number of representatives. The number of representatives and the method of apportionment are subject to change by congress

In the election of the president and vice-president of the United States, the framers of the national constitution provided for so-called electoral colleges. Each state chooses a number of presidential electors equal to the number of its members in the national house of representatives, plus its two senators The plan of the constitution was that these electors should actually exercise a choice as to who should be president. However, almost since the beginning of the government, candidates for the presidency and vice-presidency have been nominated by the great political parties of the country in advance of the choice of electors. These political parties also nominate within each state their candidates for presidential electors. The candidates of any party for electors are definitely pledged in advance to vote for the candidates nominated by that party for president and vice-president. For this

reason, everybody knows who will be president immediately after the November election, at which the electors themselves are chosen In this respect, unwritten law, developed by usage, has altered the operation of the written text of the constitution In recognition of the fact that presidential electors are merely a device for casting a certain number of votes allotted to the state, at least one-third of the states now provide for a direct vote for candidates for president and vice-president and omit from their ballots the names of candidates for presidential electors. Although each state has power to appoint its presidential electors in such a manner as the legislature thereof may direct, each state has, except in a few cases, chosen such electors by popular vote, its electoral vote then being cast for the presidential candidate with the larger popular vote in the state, even though such vote may not have been a majority.

A constitutional amendment submitted by Sen. Henry Cabot Lodge of Massachusetts would alter this plan By it, for example, if a state having eight house members together with two senators (constituting ten electoral votes) had 400,000 votes for presidential candidates, 200,000 for one candidate, 160,000 for another and 40,000 for another, the whole electoral vote would not go for the first candidate. Instead, the first candidate would receive five electoral votes, the second four and the third one.

The great political parties nominate candidates in national nominating conventions, which usually meet in June or July preceding the November election for the choice of presidential electors These conventions are composed of delegates chosen either by primary elections or by party conventions in the states. In the Democratic convention each state is represented by a number of delegates equal to twice the number of the state's combined representation in the senate and house of representatives of the United States. In the national Republican convention the representation of the states in the two houses of congress is also taken as a basis. But additional representation is given in each convention for favourable popular voting in the preceding presidential election The states may, however, properly be regarded as units in the machinery for nominating party candidates. And in the nomination of presidential candidates, a populous state wields a large influence—an influence greatly magnified if the state is both populous and politically doubtful

Two methods are provided for amending the constitution of the United States An amendment may be proposed by two-thirds of the members of both houses of congress and goes into effect when ratified by the legislatures of three-fourths of the states, or by conventions in three-fourths of the states, as congress shall determine Congress is required by the constitution to call a convention for proposing amendments, on the application of the legislatures of two-thirds of the several states No such convention has ever been called, and until 1933 congress always provided for the ratification of federal amendments by state legislatures rather than by conventions called for this purpose. In 1933 congress chose the alternate method of ratification by state legislatures and submitted the question of repealing the 18th amendment to state conventions Adopted later in the year, this proposal became the 21st amendment.

The states as governmental units still have a decisive influence with respect to any change in the national constitution. In other respects, so far as they influence the organization and government of the nation, they have tended to become merely units for national election purposes. The state has to a large extent lost its political individuality as a unit in the government of the nation. The decreased political importance of the state as a unit in national affairs was caused mainly by the development of rapid means of travel and of communication. The constant shifting of population from one state to another prevented the newer states from developing the solidarity possessed by the original 13. The very increase in the number of states also reduced the importance of each as a unit in the national government.

Not only this, but, since the establishment of the federal system, national politics has dominated. The ambitious political leader looks to advancement from state to national office. Nominations for the presidency are the most conspicuous prizes in the political organization. The popular election of United States senators by each state under the 17th amendment itself tended to reduce emphasis upon the state as a political unit and to treat it as merely an electoral area in the organization of the national government While the states still determine affirmatively who shall vote in state and national elections, the 15th and 19th amendments forbid discrimination because of race, colour, previous condition of servitude or sex, and the United States supreme court held that the 14th amendment forbids state legislation with respect to like discriminations in party primaries. Of all the states, Maine alone still adheres to a date for state elections different from that for national elections As soon as national and state elections came generally to be held upon the same day, there was a full establishment of the dominance of national politics

Powers of the States and Nation.—In powers within their own borders and in senatorial representation the states are equal.

The states under the federal system are units in the formation of a nation, not governments independent of a nation Before the Civil War a number of conflicts arose between national and state power, in which first one group of states and then another asserted its authority to proceed independently of the nation. Pennsylvania, Massachusetts, Virginia, South Carolina and other states in turn opposed the supremacy of national power under the constitution. The Civil War settled finally and conclusively that the states are merely units, although indispensable units, in the formation of a single national organization

The limitations imposed upon the states by the constitution of the United States clearly indicate the purpose to establish a single national organization with the states as units in that organization States are forbidden, without the consent of congress, "to keep troops, or Ships of War in time of Peace, enter into any Agreement or Compact with another State, or with a foreign power, or engage in war, unless actually invaded, or in such imminent Danger as will not admit of delay." They are forbidden to enter into treaties, alliances or confederations. These types of limitations upon the states indicate a definite purpose to deprive the states of any independent existence as organizations in themselves, and this purpose is supported by the language making the "Constitution, and the Laws of the United States which shall be made in Pursuance thereof; and all Treaties made, or which shall be made, under the Authority of the United States" the supreme law of the land.

The power of congress to consent to an agreement or compact by one state with another state is important, particularly where states are close to each other. Such consent has authorized cooperation between states in the construction and use of bridges and tunnels, the apportionment of waters, harbour development, improvement of navigation, flood control, sanitation or abatement of pollution, conservation of fisheries, recreation, crime prevention and the regulation of oil production Political compacts, however, have not been undertaken between states.

The powers of the national government are such as are granted to it by the constitution of the United States. They must be found within the terms of that document It has no others. This basic principle was implied but not expressed in the constitution as first adopted. So important was its expression in the constitutional text regarded that the 10th amendment, adopted in 1791, provides that "powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." Yet, as late as 1941, the United States supreme court said that this amendment was but a truism. The states gave up certain powers in establishing the national government. They set out these powers in a written document and expressly reserved all other powers to themselves or to the people. The powers of the nation, found within the terms of this written document, are superior to the powers of the states.

Who is to determine, in case of doubt or conflict, whether such a superior power, asserted by the government of the United States, is within the terms of the constitution? Before the Civil War, states often asserted the authority to determine for themselves what powers belonged to the national government, but such assertions were unsuccessful. Since 1816 the legal principle has

been established that the line between national and state powers is to be drawn by the United States supreme court, an organ of the national government.

What are the powers granted to the nation? Express powers, couched in most cases in broad language, are conferred on congress, by a series of 18 paragraphs in article I, section 8, of the constitution. In even more general terms powers are conferred on the executive and judicial departments of the United States. In only one case is the power granted to the national government expressed as an exclusive power. Certain powers are of such a character that they must be exercised exclusively by the national government, as, for example, the levying of federal taxes, borrowing money on the credit of the United States, constituting federal tribunals inferior to the supreme court and the establishment of a uniform rule of naturalization. Others are made exclusively national by constitutional prohibitions upon the states The federal power to coin money is supplemented by forbidding states to coin money. The federal war powers are made exclusive by prohibitions upon the states. The federal treaty-making power is supplemented by forbidding state treaties and by inhibiting state compacts without the consent of congress. Other powers are of such a character that they may be exercised by either of two governments, but not by both The grant of such a power to the national government makes it exclusive.

Of necessity, many of the powers granted to congress are not exclusive In such matters, states may exercise power also, provided state action does not conflict with the superior powers of the national government in the same field Congress has complete power to regulate bankruptcies, but during a good part of the time since 1789 there has not been a federal bankruptcy law, and the matter has been left to the states. Congress has only in small part exercised its power to fix the standard of weights and measures, and there is valid state legislation upon this subject in all the states.

The constitution itself expressly provides for concurrent authority over the militia.

Under a general grant of power to regulate interstate commerce, congress has full power, but the states may legislate in regard to local needs and circumstances, unless congress otherwise directs.

Although all powers of the national government must be found within the terms of a written document, this by no means implies that all powers must be expressly granted by that document. The constitution of the United States grants a number of important powers in broad terms to congress and to the other departments of the national government. It further empowers congress "to make all Laws which shall be necessary and proper for carrying into Execution the foregoing Powers, and all other Powers vested by this Constitution in the Government of the United States, or in any Department or Officer thereof."

Throughout the earlier decades of government under this constitution, political and legal contests centred about the meaning of the words "necessary and proper," one party emphasizing the word "necessary" as narrowing the powers conferred and the other the word "proper" as broadening them. The rule of broad and liberal construction announced by Chief Justice John Marshall in 1819 has prevailed:

"Let the end be legitimate, let it be within the scope of the Constitution, and all means which are appropriate, which are plainly adapted to that end, and which are not prohibited, but consistent with the letter and spirit of the Constitution, are constitutional."

Substantially all powers not national belong to the states, and such powers must be determined in large part by a process of subtraction Naturally no precise result can be obtained when the powers to be subtracted are based on broad implications and are not definitely determined The important national powers with respect to interstate commerce, taxation, treaties, post offices and post roads and maritime jurisdiction have been construed broadly, almost without exception.

The United States supreme court has long been engaged in determining the line between national and state power. This is a continuing duty. It is impossible to draw any definite or permanent line between national and state functions The steamboat and the railroad, the telephone and the telegraph, the aeroplane, the radio and television were potent factors in the development of national power. Railroad regulation began with the states but has tended to come almost completely under national control. Rapid progress in this direction has been made since the creation of the Interstate Commerce commission in 1887. The so-called antitrust movement began with the states, but restrictive commercial practices have largely come under national supervision with the Sherman Anti-Trust act of 1890 and the creation of the Federal Trade commission in 1914. Where a problem is national in character, its solution will by some means fall to the national government. The broad and flexible powers of that government are capable of further expansion as new needs develop with economic, social and engineering changes.

Along with the increase in national powers and in the activities of the national government has come also a similar increase in the functions performed by the state government. State governments today do more than ever before and cost more in proportion.

Powers of state governments are broad and comprehensive. Subject only to the condition that the government shall be republican in form, the states organize their own central and local governments and provide revenues for the support of these governments The state courts administer the great body of law affecting the rights of individuals and for the suppression of crime. Education, though aided by the national government, is under the control of the states and of the local governments created by them. The same statement applies to the construction and maintenance of highways and to the great mass of governmental details with which the citizen comes in daily contact. Indeed, except for the fact that the national government reoccupied the field of bankruptcy in 1898, the American is still in much the position described by James Bryce in the 19th century·

"The State, or local authority constituted by State statutes, registers his birth, appoints his guardian, pays for his schooling, gives him a share in the estate of his father deceased, licenses him when he enters a trade (if it be one needing a license), marries him, divorces him, entertains civil actions against him, declares him a bankrupt, hangs him for murder. The police that guard his house, the local boards which look after the poor, control highways, impose water rates, manage schools—all these derive their legal powers from his State alone."

But attention should be called to the fact that developments after 1933 greatly increased the importance of the national government, not only in the functions which it performs but also in its dominance over state governments. Unemployment compensation and old-age pensions are theoretically under state control, but in fact, federal control over state action is maintained through conditional federal subsidies and through a federal tax subject to 90% credit upon state compliance with federal requirements. Through a broad construction of federal power to regulate "commerce . . among the several States" there came a federal control over labour disputes and over hours and wages of labour where a substantial part of the articles dealt with has passed from one state to another or is to be marketed across state lines, or where the transaction is associated with the means of interstate traffic. Through the same power the national government came to determine the planting acreage of crops and the conditions and prices in the marketing of milk Through the enormous funds spent on relief the national government also established a substantially complete dominance over the states. The states remain, and will remain, as instruments of government; but the dominating control of the national government will also remain. The functions enumerated by James Bryce will remain state functions, but the states will be largely dominated in the performance of these functions The maintenance of state functions must, however, depend (1) upon the more efficient conduct of state governments and (2) upon the more effective co-operation with each other by the states as to problems which extend beyond the boundaries of a single state. Insurance was in 1944 held subject to control by congress as interstate commerce; but congress left control to the states, and the continuance of such state control is likely to

depend upon the efficiency and uniformity of state regulation.

Crime also came to be regarded as interstate, and thus more largely under federal control

Separate Administrative and Judicial Systems of Nation and States.—Throughout the territory of each state two governments operate—the nation with its administrative and judicial organizations for the enforcement of national law, and the state with its administrative and judicial organizations for the enforcement of state law. Federal revenues are collected through officers controlled from Washington; state revenues are collected by independent state and local officers Taxes levied by the two are in some cases similar in character. The nation and a number of states impose income taxes, but their administration is independent Violations of state law are tried and punished in state courts, violations of national law, in separate federal courts. However, a decision by the United States supreme court in 1945 makes violation of state law by a state officer punishable in federal courts where the disobedience of state law by the state officer is violative of due process of law under the 14th amendment. In some cases the laws of the two are directed to the same purpose, and are substantially identical. The constitutions of both forbid that a person be twice put in jeopardy for the same offense, but in legal theory the two governments are so distinct that one act, forbidden by substantially identical laws of each, may be punished by each as a separate offense

The reasons for this sharp distinction between the two governments are historical. The Articles of Confederation (1781–89) sought to act through the governments of the several states and not directly upon the citizens of the states. Government under these articles failed because each state finally determined for itself whether it would enforce the policies of congress. The national government, organized under the constitution of 1787, had it thought proper, might have sought to use the states as agencies for the enforcement of national law, as is largely done under the federal system of Switzerland But under the circumstances it was natural to build up an independent administrative and judicial system This system has steadily grown with the expansion of national activities

Taxation of Employees and Securities of One Government by the Other.—For many years it was the established principle in the United States that the exercise of independent powers by the nation and the state forbade either government to tax the employees or securities of the other. This principle, which was based on the theory that "the power to tax is the power to destroy," was later in large part replaced by the principle that each government may without discrimination tax the income of employees of the other; and the same principle may be applied to the taxation of securities issued by the national, state and local governments. However, the U.S. supreme court expressed the view that the national government may enter upon an enterprise personal in nature and forbid state taxation thereon, but that a similar state enterprise may be taxed by the national government.

2. WRITTEN CONSTITUTIONS

Under the federal system it is substantially necessary to have a written document defining the organization of the central government and determining the respective powers of the states and the central government. It was natural that articles of confederation should be framed for the creation of the first union of the American states, and that, when improvement was needed, these articles should be replaced by the national constitution of 1787.

There was no similar legal necessity that written constitutions be framed for the government of the American states. Yet the Colonies were accustomed to written instruments of government. Certain of them operated under royal charters. Massachusetts largely remained under its charter government until 1780, Connecticut until 1818 and Rhode Island until 1842. In other colonies the royal commissions to governors gave some written basis for government. Moreover, the leaders in the Colonies were familiar with and largely adherents of the theory that government is a result of social compact, and theories of natural rights were strong

It was therefore natural that, upon separation from England the several Colonies should embody in written form a declaration of their rights and the general organization of their governments. Before the framing of the national constitution in 1787, constitutions had been framed and adopted by all the original 13 states except Connecticut and Rhode Island. The framers of the national constitution therefore had before them the texts of state constitutions and were familiar with the experience under these constitutions. Each state is now governed by a written constitution.

3. JUDICIAL CONSTRUCTION OF WRITTEN CONSTITUTIONS

The constitution was regarded from an early date as law of a superior order and of a more permanent character than legislative acts Under the first state constitutions legislatures were the dominant organs of government. They abused their wide powers and helped develop a feeling that legislative authority should in some measure be curbed. In New Jersey in 1780 a statute was declared invalid as violative of the state constitution. Other decisions of this character gradually accumulated Apparently the framers of the federal constitution were in 1787 of the opinion that it would be the function of the federal courts to preserve the powers of state and nation under the federal constitution Such a power in the federal courts carries with it authority, in a case involving the issue, to declare either a federal or a state law invalid as violative of the constitution of the United States. Since Chief Justice Marshall's opinion in 1803, in *Marbury* v. *Madison*, the principle of judicial power to declare laws unconstitutional has been established in the federal system The authority of state courts to declare state laws invalid as violative of state constitutions is equally well established Except for a few provisions which are regarded as committed to the political organs of government, it may therefore be said that placing language in a written constitution makes such language judicially enforceable as against the legislative bodies. Whereas parliament is the supreme lawmaker under the English system of government, in the United States the written constitution as finally construed by the courts is supreme. Where constitutional provisions are clear and precise, this supremacy of the constitution as judicially construed makes little difficulty. But where language is used that is not capable of precise definition, as that of the 14th amendment that no state shall "deprive any person of life, liberty, or property without due process of law," the court may in fact determine not only the constitutionality but also the wisdom of legislative action.

The exercise of broad judicial power in such a manner as to control legislative policy has, however, largely ceased; the "due process of law" clause, the principle of the separation of powers and the broad language of the constitution with respect to federal powers are now construed not only in such a manner as to enlarge national authority but also in such a manner as to leave larger powers in the hands of the political departments of government—the president and the congress in the national system.

4. SEPARATION OF POWERS

National and state governments in the United States are each organized into three departments. The theory of separation of powers is formally announced in 40 state constitutions In the remaining eight state constitutions and in the constitution of the United States the same constitutional result arises from the fact that these nine documents create three departments of government and vest the legislative power in one, the executive power in another and the judicial power in a third.

There are no clear lines separating one governmental function from another, and the courts have therefore been unable to develop any logical lines of division Legislative power having been delegated to congress and the state legislatures, the courts frequently say that legislative power may not be delegated, but the very necessities of modern life have forced in the United States, as in England and on the continent, the vesting of a large amount of subordinate legislative authority in permanent administrative bodies within the executive department. In order to avoid terming this a delegation, the courts have come to designate such powers as "quasi-legislative," rather than "legislative." In the same manner, administrative bodies within the executive department have come

to exercise powers that are sustained on the ground that they are "quasi-judicial" rather than "judicial." The result is therefore not dissimilar from that in countries that have not attempted to set up three separate departments through judicially enforceable constitutions. But such flexibility as develops under the U S plan comes more slowly and can be achieved only with judicial approval. A study of U.S political institutions must, therefore, always take into account the greater rigidity in governmental structure resulting from the constitutional principle of separation of powers, although that rigidity has been to a large extent abandoned through less strict judicial construction.

5. PRESIDENTIAL SYSTEM OF EXECUTIVE ORGANIZATION

The federal government and the states of the United States have adopted the presidential system of executive organization, as distinguished from the cabinet or ministerial system found in England and most other countries. Under the presidential system there is an independent executive (president or governor) elected for a fixed term and holding office during that term irrespective of whether he is or is not in political harmony with both legislative bodies or either of them. The members of the legislative bodies are elected at fixed times and for fixed terms, and no power is vested in the executive to dissolve them or to force elections at any other times than those fixed. The principle of separation of powers as applied in the United States precludes any member of the executive department from having a seat in a legislative body Under this system the president or governor has real executive authority, and in all states but North Carolina has and exercises large power to control legislation by an executive veto. The presidential system presupposes that the executive and the legislature may at times not be in political harmony. And in fact this is the case in many of the states and in the national system. In the states of New York and New Jersey, for example, the governors have often been members of the Democratic party, while both houses of the state legislature have been controlled by the Republican party. The power ordinarily vested in the legislative bodies to impeach and remove the executive is judicial in character, and efforts have only occasionally been made to employ the power of impeachment to remove an executive politically hostile to the two houses of the legislature Such an effort was made, unsuccessfully, to remove Andrew Johnson from the presidency of the United States

The presidential system is more rigid than the ministerial plan of government, but it accords with the U.S doctrine of separation of powers When the country faces a crisis, as during the Civil War and the World Wars, popular sentiment maintains political harmony between the president and congress; and the executive tends to become the dominant factor in government The presidential system of the United States in fact met the serious problems of World Wars I and II with less difficulty than did the ministerial systems of England and France.

6. NATIONAL GOVERNMENT

National Constitution.—The constitution of the United States, framed in 1787 and adopted in 1789, is a brief and well-drafted document. Its influence has been felt, not only in the United States, but in the federal systems of Switzerland, Argentina, Brazil, Canada and Australia. The constitution outlines the organization of the three departments of the national government, defines the powers of that government and the relationship between the nation and the states. It provides a method of amendment and up to mid-20th century had been amended 22 times since its adoption. The first ten amendments, adopted in 1791, were the direct results of criticisms of the constitution at the time of its adoption and may almost be regarded as parts of the original document. Of the other amendments, the 11th, adopted in 1798, overcame a decision of the United States supreme court to the effect that a state might be sued by a citizen of another state. The 12th amendment, adopted in 1804, corrected a defect in the original constitution as to the method of choosing the president and vice-president. The 13th, 14th and 15th amendments were the immediate outcome of the Civil War. The 13th abolished slavery, the 15th forbade denial of the right to vote "on account of race, color, or previous condition of servitude." The 14th amendment, regarded for a while by the courts as limiting itself to the protection of the freed slaves, has become, by expansion of the terms "due process of law" and "equal protection of the laws," the means through which the United States supreme court determines the policy of state enactments in the field of social legislation The 16th amendment in 1913 gave congress an effective power to levy a federal income tax Popular election of United States senators under the 17th amendment, adopted in 1913, has somewhat reduced the importance of the state, as did the 18th (1919) transferring the liquor problem to the national government The 19th amendment (1920) nationalized women's suffrage The 20th amendment altered the time of beginning of terms of president, vice-president, senators and representatives; changed the time for sessions of congress, and provided for certain contingencies which may arise as the result of the death or failure to qualify of a president-elect. The 21st amendment repealed the 18th amendment and restored the control of intoxicating liquors to the states. The 22nd limited the presidential tenure of office to two elective terms. On the whole, the process of amendment, while to some extent enlarging federal powers, has been less influential in this direction than the decisions of the U S. supreme court.

Congress.—Legislative power in the national system is exercised by a congress composed of two houses The two houses have grown—the senate from 26 to 96 members, and the house of representatives from 65 to 435 members.

With respect to the house of representatives, article I, section 2 of the constitution provides that: "when vacancies happen in the Representation from any State, the Executive Authority thereof shall issue Writs of Election to fill such Vacancies." With respect to the senate, the 17th amendment provides that: "when vacancies happen in the representation of any State in the Senate, the executive authority of such State shall issue writs of election to fill such vacancies: Provided, That the Legislature of any State may empower the Executive thereof to make temporary appointment until the people fill the vacancies by election as the Legislature may direct." Temporary appointments to the senate are infrequent.

United States senators are elected for six-year terms, and terms are so arranged that one-third of its members retire each two years. Since 1913 the elections in each state are by popular vote of the whole state, except that temporary appointments to fill vacancies are permitted. Members of the house of representatives are elected for two years, and the whole membership changes each two years. Each state is required to be divided into districts equal to the number of members it has in the house of representatives; but if the number of representatives apportioned to a state is increased, and the state legislature makes no reapportionment of districts within the state, then the additional representative or representatives are elected by the state at large; if the number of representatives apportioned to a state is decreased, and the state legislature makes no reapportionment of districts within the state, then all representatives are elected by the state at large. Each member of the house of representatives is required to be a resident of the state from which he is chosen; political and sectional interests make it practically impossible for a person to be elected for a district within the state in which he does not reside The result is that an able and experienced person ceases to be a member of congress if he fails of re-election by his district. In addition to the elected members, territorial delegates sit without vote in the house of representatives—one each from Alaska and Hawaii. One resident commissioner from Puerto Rico also has a seat in the house.

Beginning in Jan. 1947, the compensation of senators, representatives in congress, delegates from the territories and the resident commissioner from Puerto Rico is at the rate of $12,500 per annum each; from 1949 the compensation of the speaker of the house of representatives and the vice-president of the United States is at the rate of $30,000 per annum each, Whenever there is no vice-president, the president of the senate for the time being is entitled to the compensation provided by law for the vice-

president Starting also in Jan. 1947, each member of either house receives an additional $2,500 per annum as an expense allowance for which no accounting is made. Beginning at the same time the government contributes to an annuity which a retiring member of congress may receive after six years of service and attainment of the age of 62 years, or upon retirement for disability after five years of service

Prior to the adoption of the 20th amendment, on Feb 6, 1933, the president, vice-president, senators and members of the house of representatives assumed office on March 4 following their election; and the congress met annually on the first Monday of December. Under this plan newly elected members of the senate and house, elected in November of an even-numbered year, did not take office until March 4 of the succeeding year; and, unless the president called a special session of congress, the newly elected members did not actually begin to function until the regular session in the succeeding December, more than a year after their election. It was possible that the session meeting from Dec. 3 of the even-numbered year until March 4 of the odd-numbered year be controlled by members who had already failed of re-election, and who might therefore be regarded as no longer representing their constituents. In order to avoid control of a session of congress by defeated members, who were termed "lame ducks," the 20th amendment was adopted, under which the terms of the president and vice-president begin on Jan. 20 following their election; the terms of senators and representatives begin on Jan 3 following their election and congress assembles each year on Jan. 3. The regular sessions of congress usually adjourn in the early summer. The president may on extraordinary occasions convene the two houses in special session

The organization and procedure of the two houses of congress are to a limited extent determined by congress and to a larger extent by the size and traditions of the two houses. The rules of the senate permit great freedom of debate; those of the house of representatives restrict debate and expedite business. Under the senate rules obstructive tactics may be and are often resorted to, though such tactics relate in fact to relatively few measures. The house of representatives, with its larger membership, would be helpless with complete freedom of debate, yet both houses accomplish a large amount of legislative business.

The house of representatives elects from its own members a speaker as presiding officer. The vice-president of the United States is the presiding officer of the senate The work of both houses is largely done in committee The committee systems of both houses developed largely by accident; and many committees in each house, once created for important tasks, remained long after their usefulness had ceased The senate, in 1921, and the house of representatives, in 1927, reorganized their committees and materially reduced their number. But further increases immediately began, and multiplicity of committees, with conflicts of their jurisdiction in each house, led to confusion and interfered with joint action by committees of the two houses. With legislation enacted in 1946, 15 standing committees replaced 32 in the senate and 19 replaced 48 in the house. The act also specifically defined the authority of each committee, and encouraged co-operation between the two houses.

Committees in each house are controlled by the political party having a majority of the members of that house. Appointment to important committees is based largely on seniority in term of service, and a member serving continuously over a long period is likely to become chairman of an important committee, if his political party is in control. Seniority as such naturally plays a larger part in the house of representatives than in the senate with its smaller number of members, though the business of the senate is in good part controlled by a small group of experienced members. Leadership in the two houses is always exercised by a few members of the politically dominant party. In the house of representatives for many years before 1911, the real leadership was largely vested in the speaker, who made the appointments to standing committees. After 1911 the speaker was relegated more distinctly to the position of presiding officer, and committees were elected by the house itself on the basis of selections first made by the party organizations The majority and minority floor leaders have large influence. In the senate there is less individual leadership than in the house of representatives

Federal Executive.—In discussing the presidential system, the relation between the president and congress has been generally described. There were no constitutional limitations upon a president's succeeding himself, but a tradition long existed that a president should not serve for more than two terms, a tradition based on the example set by George Washington and other early presidents This tradition was broken by Franklin Delano Roosevelt, who was elected successively in 1932, 1936, 1940 and 1944, and who served from 1933 until his death on April 12, 1945. The 22nd constitutional amendment, proposed in 1947 and ratified by three-fourths of the states in 1951, provides that: "No person shall be elected to the office of the President more than twice, and no person who has held the office of President, or acted as President, for more than two years of a term to which some other person was elected President shall be elected to the office of the President more than once." This amendment was made specifically inapplicable to the person holding the office of president during the time of proposal and adoption of this amendment.

The constitution expressly authorizes the president to make certain appointments to office and the expansion of the national administration has greatly increased the number of officers owing their appointments to him. The more important appointments are subject to confirmation by the senate. The United States supreme court has determined that where power to appoint to an executive office is vested in the president, this carries with it a complete power to remove from office. Efforts upon the part of congress to impose restrictions upon the president's power to remove even his more direct advisers in 1868 led to the impeachment of Pres. Andrew Johnson, who escaped conviction by one vote. However, the president's power of removal may be limited by act of congress with respect to quasi-legislative or quasi-judicial officers, who are required to discharge their duties independently of executive control; and the use of such officers (particularly as members of independent commissions) has greatly increased with the extension of federal control with respect to commercial transactions of various types, including labour disputes and hours and wages of labour.

The president's control over the national executive administration is primarily exercised through the heads of ten executive departments, appointed by the president. These departments are department of state; department of the treasury; department of defense; department of justice, post office department; department of the interior; department of agriculture; department of commerce; department of labour, department of health, education and welfare. Department heads (the cabinet) are responsible to the president, and the extent to which he meets with them and seeks their advice rests entirely on his discretion In addition to these ten departments there are numerous boards and offices. The federal executive organization under the president is not systematically organized, and plans for its reorganization came under consideration early in the 20th century. During World War I and World War II the creation of new governmental agencies was necessary, and wide powers were conferred upon the president to redistribute the functions of governmental agencies. The need for reorganization in time of peace had become increasingly apparent with the expansion of activities of the national government Definite steps toward such reorganization were taken by an act of congress in 1933 which vested some power in the president for a two-year period and by an act approved April 3, 1939, which vested authority in the president to submit reorganization plans to congress before Jan. 21, 1941, the organization submitted by the president to take effect within 60 days after submission unless the two houses should disapprove by concurrent resolution. Substantial improvements were obtained under this act. Some readjustments were obtained under a similar act of 1945, which, however, did not give sufficient power to the president. A reorganization act of 1949 was based upon investigation by a commission headed by former Pres. Herbert Hoover. Under this act the presi-

dent might submit reorganization plans to take effect upon the expiration of the first period of 60 calendar days of continuous session of congress, unless rejected by one of the two houses of congress. Twenty-seven such plans were submitted to congress by May 31, 1950.

The great mass of the lesser employees are selected under a merit system, for whose conduct a civil service commission was first created in 1883 (*See* CIVIL SERVICE: *United States*) The finances of the national government were to a large extent systematized through the creation of a bureau of the budget in 1921 and through an improved committee organization effected in the house of representatives in 1927 for the consideration of national appropriations and expenditures.

The president's influence in the national government rests upon (1) powers granted him by the constitution and by federal statute; (2) political factors not found in constitutions or statutes; (3) the personality of the president

The president's position as head of a large executive organization, with wide powers of appointment and removal, in itself makes the position important. The authority to veto legislation, subject to being overridden by two-thirds of the two houses, gives him a power that may be employed with effect The authority to recommend measures to congress is only of such value as may be given to it by the position and influence of the president making the recommendation He is charged with the conduct of foreign relations, though here his authority is materially crippled by the requirement that two-thirds of the senators concur in treaties.

But the president's political position is equally as important as his constitutional power. He is in effect the chieftain of his party. He is also the outstanding figure in U.S. politics.

The possibilities of exercising power are great. The extent to which power is actually exercised depends upon the personality of the president and his capacity for political leadership The influence of the presidency varies with the man who occupies the office and with the circumstances that surround him, as in time of war.

Little need be said about the vice-president. His chief official duty is to preside over the senate, though he has substantially no influence in the deliberations of that body The machinery for nominating party candidates ordinarily chooses a vice-presidential candidate almost purely on the basis of political expediency and with little consideration of the fact that the vice-president may succeed to the presidency.

Yet within the first half of the 20th century three vice-presidents—Theodore Roosevelt, Calvin Coolidge and Harry S. Truman—succeeded to the presidency as a result of death, and thereafter were elected to the office In the case of death or disqualification of both president and vice-president, it was provided by the Presidential Succession act of 1947 that succession to the presidency be first to the speaker of the house of representatives; next to the president pro tempore of the senate; and successively to members of the cabinet who are heads of the departments listed several paragraphs above.

The president receives for his services the sum of $100,000 per year. The salary of the vice-president is $30,000 per year

Federal Judiciary.—The constitution of the United States provides for a supreme court and "such inferior courts as the Congress may from time to time ordain and establish." For the enforcement of federal law, congress has provided a complete judicial system paralleling that of the states. The judges of these courts are appointed by the president of the United States and hold their offices during good behaviour. They are removable only by the cumbersome machinery of impeachment.

At the head of the judicial system is the supreme court of nine judges, which sits at Washington. There are 11 judicial circuits of the United States, each with at least 3 judges, one being the District of Columbia with 9 judges, the 11 together having 65 circuit judges. To each circuit is assigned a justice of the United States supreme court, one of the justices being assigned to two circuits and the chief justice being assigned to both the District of Columbia and an additional circuit. The pressure of business in the United States supreme court, however, made it impossible for the judges of the supreme court to go on circuit. The district court is the court of original jurisdiction. In erecting districts for the organization of this court, state lines are regarded The smaller states constitute single districts, the larger are divided For the districts in which federal judicial business is especially heavy, more than one district judge is provided. For example, four districts with 26 judges exist in New York There are 93 districts with more than 200 judges, and the number of judges constantly increases. In addition to the general system of courts here outlined, there are a court of claims, court of customs and patent appeals, the tax court of the United States and federal courts for the District of Columbia and the territories.

With the two systems of courts—federal and state—exercising jurisdiction over the same territory, it is necessary that there be certain principles as to their relationship Such principles may be chiefly summarized as follows.

1. Upon questions of federal constitutional law, the United States supreme court is the final court of review. If the highest court of a state holds a federal statute or treaty to be invalid, or a state statute valid that is alleged to violate the federal constitution or federal statutes, the losing party has a right to a final decision by the highest federal court Where federal constitutional issues are otherwise involved in state courts, the United States supreme court may, in its discretion, review the state decision

2. Substantially all cases involving enforcement of criminal law of the federal government are tried in federal courts

3. With few exceptions, cases of admiralty and maritime jurisdiction and bankruptcy proceedings are tried in the federal courts

4. Under federal statutes, the federal courts alone have jurisdiction of suits against the United States, and of suits for the enforcement of federal revenue, immigration and other similar laws directly affecting the administration of the federal government.

5. In civil cases involving as much as $3,000, and (*a*) arising between citizens of different states or (*b*) arising under the constitution, laws or treaties of the United States, the parties have the choice of suing either in state or federal courts; but if the plaintiff sues in the state court, the defendant may transfer the case to the federal court

6. By statute it is provided "that the laws of the several States, except where the constitution, treaties or statutes of the United States otherwise require or provide, shall be regarded as rules of decision in trials at common law, in the courts of the United States, in cases where they apply." By recent decisions of the United States supreme court, the federal courts must apply not only state statutes but also the law as found in the decisions of the state courts. Until the adoption of uniform rules of civil procedure for United States district courts in 1937, the procedure in such courts in cases at common law was required to conform, as near as may be, with the procedure "in like causes in the courts of record of the State within which such district courts are held."

Through legislation of 1925 an effort has been made to reduce the number of cases that must be decided by the United States supreme court. That court has a limited original jurisdiction, the most important cases of such jurisdiction being cases to which a state is a party. Cases not infrequently arise in which one state sues another state. Aside from its original jurisdiction, cases come to the United States supreme court either from the highest state courts or from the lower federal courts. The decisions of the United States supreme court are of primary importance in the fields of constitutional and public law.

7. STATE GOVERNMENTS

The 48 state governments of the United States have certain common characteristics. Each state is legally the equal of every other state in the federal system. Each controls the organization of its own state and local governments. Each has a written constitution providing for three departments of government, with a legislature of two houses (with one exception) elected by popular

vote and a popularly elected governor as head of its executive department. Each state has a judicial system not essentially dissimilar in external organization from that of the other states Each state has created local governing areas for the performance of certain functions. The government of each state and of its important local areas is controlled through political parties organized on a national basis

Superficially, all the 48 state governments appear to be more or less alike and appear to be doing the same things The constant shifting of population has prevented the development of sharp differences in governmental organization Not only this, but from one state to another there has been a great deal of copying of political and legal institutions. However, each state is distinguished from its fellow states, not only in size and population, but also in location, climatic conditions and resources; and these differences reflect themselves in the political and governmental organization of the states

State Constitutions.—The constitutions in force in the 48 states vary a great deal in length and in content. Some were adopted in an earlier period, and some bear recent dates The constitution of Connecticut, adopted in 1818, together with subsequent amendments, requires only about 16 printed pages; the Louisiana constitution of 1921 requires 90 pages. The constitutions of Oklahoma, California and a number of other states are highly detailed Massachusetts still boasts that it is governed by the constitution of 1780; but this constitution has been altered in form by so many amendments that it would hardly be recognized by its original framers. By amendment or by the adoption of new constitutions, the states have steadily readjusted their institutions to meet changing needs The national constitution has proved a model for much of the development in the field of state constitutional history, particularly with reference to the establishment of three co-ordinate departments of government.

In most of the states the state constitutions organize three departments of government in some detail They contain elaborate declarations or bills of rights, and most of them contain provisions regarding the organization of local government Limitations upon the power of state legislatures have multiplied. Moreover, the framers of constitutions are inclined to include in these documents regulations of any matters of great public interest at the time. The state constitution has in this way come to contain many matters of temporary detail, and such detail requires frequent amendment.

The state constitutions provide for methods of change. The methods employed are three: (1) constitutional conventions; (2) legislative proposal of amendments; (3) proposal by popular initiative petition. All but 12 of the state constitutions expressly provide for constitutional conventions; in all of these 12 it is recognized as proper to employ conventions for constitutional change Ordinarily conventions assemble as a result of popular vote and submit their recommendations for popular approval

Proposals of constitutional amendment may be made by the legislatures in 47 states. In New Hampshire changes may be made only by constitutional convention Methods of amendment through legislative proposal vary in the 47 states, but in all except Delaware, a legislative proposal of amendment must be submitted to and approved by popular vote before it becomes effective Details of the amending process vary. In some states, as California, Louisiana, New York, the adoption of amendments through legislative proposal is easy; in others, as Illinois and Minnesota, the constitution is substantially impossible to amend, although an effort at greater ease was made by Illinois.

The proposal of constitutional amendments through popular initiative petition, followed by popular vote, is a fairly recent development; but this plan has now been adopted by 13 states. In these states also, there is a varying ease or difficulty in employing the plan of amendment. In Oregon and four other states it is as easy to amend the constitution through initiative petition and popular vote as it is to enact a statute through the same devices In each state that had adopted the plan of popular initiative, this plan has merely been added to the two already existing devices of constitutional conventions and proposal by legislative action. By the three methods of change more than 1,500 amendments were proposed in the 48 states between 1900–20, of which about three out of five were adopted.

State Legislature.—In all of the states except Nebraska, legislative power is exercised by a body composed of two houses. Constitutional amendments for the organization of a legislative body composed of but one house were proposed in Oregon in 1912 and 1914, in Oklahoma in 1914 and in Arizona in 1916. All of these proposed amendments failed, but the plan of a unicameral legislature was adopted by Nebraska in 1934. Since Vermont abandoned the unicameral system in 1836, the Nebraska legislature of 1937 was the first to be so organized. It is composed of a single chamber of 43 members elected on a nonpartisan basis In all other states, the smaller of the two houses is called the senate. All but eight of the states call their larger house a house of representatives; but the eight have such varying titles as assembly, general assembly and house of delegates Nearly half of the states use the term legislature to designate the two houses together; but so use the term general assembly and 3 use the term legislative assembly. Massachusetts still uses the term general court, which was first employed in the colonial charter, and New Hampshire uses the same term In view of the fact that the legislative bodies have somewhat varying names in the several states, it has been customary to refer to the larger of the two houses as the lower house and to the smaller as the upper house.

To a large extent the exact number of members of the two houses, or of one of the two houses, is left to legislative determination, subject to constitutional restrictions The size of the two houses varies a good deal from one state to another. The Minnesota senate is the largest, with 67 members, and that of Delaware the smallest, with 17. The size of the lower house ranges from 35 in Delaware to 443 in New Hampshire. The membership of the lower houses is especially large in several of the New England states because of the system of town representation, but in these states the senate is relatively small

In a majority of states, senators are elected for four years and representatives for two years. In some states, one-half of the members of the senate are elected every two years, so that the senate has continuous membership, as contrasted with the house, whose membership is chosen as a whole at each election. In Alabama, Louisiana, Maryland and Mississippi, however, four-year terms have been provided for members of both houses; and a number of states have a two-year term for members of both houses

In some states financial measures must originate in the lower house; and in most of the states the senate has certain powers with respect to confirmation of executive appointments. The provisions for impeachment of public officers also ordinarily prescribe that charges shall be brought by the lower house and tried by the senate. But on the whole it may be said that, from the standpoint of legislation, the two houses of state legislature have equal powers and do not represent different points of view in the community. Distinct differences that existed in many states in earlier times have substantially ceased to exist, although in a number of states differences in territorial representation have grown up.

In the earlier state governments the substantially equal representation of local areas was not grossly unfair, because of the absence of great inequalities in their population. To a large extent, the idea of geographical representation survives in a number of states The lower houses of Connecticut, New Hampshire and Vermont, and both houses of Rhode Island, are based upon town representation, and with the growth of large urban communities this basis has become highly unequal. In 1920 New Haven, with 162,000 inhabitants, had two representatives in the lower house of the Connecticut legislature, but so also did the town of Union, with 257 inhabitants. Such inequality is not confined to New England

The present representative system is the result of two conflicting forces In most of the states some attention is paid to local governmental areas. It is common for constitutional provisions to forbid the crossing of county boundaries in the establishment of

representative areas. On the other hand, the principle of equal representation upon the basis of population has steadily developed. The more common plan today is to provide for the periodical reapportionment of membership in the two houses upon the basis of population. Delaware, however, permits a reapportionment only by constitutional change, and other states, while providing for periodical reapportionment, limit the basis of representation in such a manner as to preserve an inequality. In California, New York and some other states representation in one house is based on population and in the other in large part upon the counties as units, in an effort to balance urban and rural interests and to prevent domination of the legislature by a single large community.

Members of the state legislature are chosen from local districts by popular vote. Proportional representation has been proposed, but has not been adopted for the choice of members of state legislatures, although in municipal elections it has come to some use. All states adopt the plan under which a candidate is elected who receives a plurality of the votes in his district; though Illinois since 1870 has provided for three members of the lower house in each electoral district, and that each voter may vote for three or cumulate his votes for one or two candidates

Under the first state constitutions provision was generally made for the annual election of members of legislative bodies and for annual legislative sessions. Frequent elections of the legislature were deemed essential safeguards of popular rights and were at this time thought sufficient safeguards. Most state legislative bodies now meet in January of odd years, and constitutions ordinarily prescribe the number of days for which the session may continue. Biennial sessions are held in even years in Kentucky, Louisiana, Mississippi and Virginia. Annual sessions are held in Massachusetts, New Jersey, New York, Rhode Island and South Carolina. Massachusetts adopted the plan of biennial sessions in 1918 and returned to annual sessions in 1944. Alabama and Mississippi experimented for a time with quadrennial sessions.

As is the case with congress, the work of state legislatures is largely done through committees. There is little of an effective legislative program or of organized leadership in the two houses A number of states have in recent years sought to devise a more definite legislative policy through the creation of legislative councils, composed of representatives of the two houses, each council to remain continuously in existence and to consider important matters of legislation with the aid of a permanent body of experts An efficient and influential governor occasionally exercises a distinct leadership in important matters of constructive legislation, but over legislative enactments in general his influence is negative rather than affirmative.

He now has a veto power over legislation in all of the states except North Carolina; and the veto can, in most of the states, be overcome only by a two-thirds vote, although only a three-fifths vote is required in some states, and a bare majority in others. There has also been a definite increase of the governor's control over appropriations, through the vesting in him of a power to veto items in appropriation bills Such a power now exists in all but 10 of the states There has been a tendency in some states to extend the governor's veto power still further. The Washington and South Carolina constitutions confer upon the governor the power to veto any item or section of a bill presented to him, and a similar power exists in Alabama. In addition, several states have recently given the governor wide powers with respect to the state budget

The veto power is not an idle weapon in the governor's hands Its use and effectiveness depend upon several factors—the extent of the governor's constitutional power, the personality of the governor and the political agreement or disagreement at the time between the governor and the two houses. Of about 1,600 measures passed in 1923, for example, by the legislatures of 44 states, more than 1,100 were disapproved in their entirety, and more than 1,000 parts of bills were disapproved. Of the bills disapproved, 104 were repassed by legislatures; and of the parts vetoed, only 40 were repassed.

State Executive.—In the first state constitutions the executive department was subordinate to the legislature In most states, the governor and certain other state officers were chosen by the legislature; and an executive council, also chosen by the legislature, was substantially placed on guard to prevent executive usurpation. Such an attitude toward the governor was natural in 1776; but the governor's power almost immediately began to grow. New York in 1777 made its governor popularly elective, though it at the same time created a council—the council of revision and the council of appointments—to share with the governor the powers of veto and of appointment to office. Massachusetts (1780) and New Hampshire (1784) followed with the plan of popular election Executive councils now remain in Massachusetts, Maine and New Hampshire.

In all states the governor became a popularly elected officer and hence independent of legislative dominance. Other state officers became popularly elective, though some such officers are still chosen by state legislatures Until late in the 19th century the functions of state government were few and were chiefly conducted by a small group of popularly elected officers As new needs have developed, the constitution itself has provided for new offices, which have usually been filled by popular election Illinois has six such officers in addition to the governor; Idaho and Nebraska, seven each. Chief among the state executive offices, independent of the governor in most states, are lieutenant governor; secretary of state; superintendent of public instruction, attorney general, treasurer; and auditor, or comptroller

By creating a group of state officers, all popularly elected in the same manner, state constitutions in fact create a plural executive, although the theory of state government presupposes a single head of the executive department But only to a slight extent are constitutional powers directly conferred upon the lieutenant governor, secretary of state and other popularly elected state officers The governor has thus had the opportunity to become the chief state executive in fact as well as in constitutional theory The increase in the governor's executive power has come about primarily through the creation of new offices by statute and the vesting in the governor of power to appoint to such offices. In this manner, as new state functions were assumed, numerous offices were created, without reference to any efficient supervision by the governor Some states had as many as 200 independent officers, most if not all of whom were appointed by the governor, but over whom it was physically impossible for the governor to exercise an effective supervision. A recent movement in the states has sought to organize executive functions into a small group of departments, each under a director appointed by and responsible to the governor. One of the chief difficulties in building up an effective state executive system is that the governors of half the states are elected for terms of only two years. In the other states the term is four years. There has, however, been an increase in state executive powers and leadership, but any possibility of leadership is greatly handicapped by the fact that the majorities of one or both of the two houses of the state legislature may often be politically opposed to the governor This lack of political harmony is more common in the states than in the national government

Unfortunately, most state governments are operated for the political advantage of the party or persons in control. In order to avoid such political conditions, the state of Georgia, under the leadership of its governor, adopted a new constitution in 1945, placing control of education and of other important state functions in the hands of boards appointed by the governor for terms of such length that no one governor would control the membership of the board.

State Judiciary.—Generally the states have courts of three types:

1. Justices of the peace, having a limited and inferior jurisdiction in both civil and criminal cases. Justices of the peace are ordinarily elected from towns or townships or from districts created for the purpose within the county The jurisdiction of justices of the peace is strictly limited by statute, and their courts are not courts of record Appeals are allowed from their action to the court of general trial jurisdiction and ordinarily the trial in the higher court is a trial *de novo* The system of justices of the peace paid on a fee basis has not proved satisfactory and has been replaced in the larger communities. Virginia and Missouri have taken steps which may lead altogether to the abandonment of the system To some extent a major defect in the system has been met by placing the justice of the peace on a salaried basis

2. In all states there are courts of general trial jurisdiction, known as superior courts, district courts, circuit courts and in some states by still a different name. The court of general trial jurisdiction has ordinarily a general authority to try all cases in law and equity. Five states still retain the old English plan of separate courts for the trial of cases at law and in equity, but most of the states have abolished the distinction between law and equity. In some states, as in Arizona, California and Ohio, the court of general trial jurisdiction is organized upon a county basis, and there is a separate court for each county The more common plan, however, is to have the court of general trial jurisdiction go on circuit from one county to another, at least in the smaller counties of the state

3. Each state has a court of review, the function of which is chiefly that of hearing appeals from the courts of general trial jurisdiction This court is ordinarily termed the supreme court But in Kentucky, Maryland and New York it is called the court of appeals; and slightly different names are used in several other states. The highest court is usually given some original jurisdiction, but ordinarily this original jurisdiction is small, and its use is strictly limited by the court itself, in order that time may be available to hear appeals from other courts.

As these three features are outlined, state judicial organization becomes to a large extent a matter of diversities In many larger communities a municipal court has been organized, which not only replaces justices of the peace, but is granted a much more extended jurisdiction than that ever been conferred upon justices of the peace. In a number of states there is also a so-called county court, with some jurisdiction, both civil and criminal, and also usually a fairly large authority with respect to rather distinctly administrative matters, such as those relating to county affairs, elections and charities. Where county courts exist independently of the court of general trial jurisdiction, they are often vested with authority in probate matters as well.

There are also other types of trial courts with special jurisdiction. Every large community now has a juvenile court, and separate probate courts are not uncommon Other specialized courts, such as domestic relations courts, morals courts, boys' courts, speeders' courts and small

claims court have been established in many larger communities, often as branches of a municipal court In some cases there are separately organized criminal courts, although ordinarily criminal jurisdiction is exercised by the courts of general trial jurisdiction. In all of the states the prosecution of *criminal offenses* is by and in the name of the state and is conducted by prosecuting attorneys, who are usually elected by the voters of the county

The state judicial organization has placed great emphasis upon appeals from lower to higher courts No case of any importance is regarded as settled until it has been taken to the highest court Increased complexity of appellate court organization has been forced by the growing number of appeals to be heard The increased mass of appellate work has been handled in three ways: (1) by increasing the number of judges of state supreme courts; (2) by authorizing these courts to sit in sections; and (3) by creating intermediate appellate courts, standing midway between the trial courts of general jurisdiction and the highest court

There are now three methods of selecting judges in the United States. (1) In 38 states, with the exceptions hereafter noted in California and Missouri, judges of the highest court are elected by the people; in all of these states except one the trial judges are chosen in the same manner, (2) in four states the judges are elected by the legislature, and in one they are appointed by the legislature upon the nomination of the governor; (3) in five states the highest judges are appointed by the governor, subject to confirmation by the governor's council in Maine, Massachusetts and New Hampshire, and to confirmation by the *senate* in Delaware and New Jersey. Certain inferior judges in other states are also appointed by the governor

A new plan adopted by California in 1934 removes that state from any one of the classes indicated above The California plan, which applies to justices of the supreme court and of the district courts of appeal, provides that upon the expiration of the term of office of any such judge, such judge may file a declaration of candidacy to succeed himself If he does not do so, the governor nominates a suitable person, subject to confirmation by a commission composed of the chief justice of the supreme court, the attorney general of the state and a justice of one of the district courts of appeal The name of the candidate to succeed himself, or of the candidate nominated by the governor and confirmed by the commission, is then placed upon the ballot at the next general election and the electors vote upon the question as to whether he shall be elected. If a majority vote "yes" he is elected to or continued in office Under this plan a candidate has no opposing candidate, but an election determines whether he shall become or remain a judge By popular vote in any county the same plan may be adopted for the superior court judges of that county.

In 1940 Missouri adopted a plan similar in certain respects to that of California with respect to judges of the supreme court, the courts of appeal and the circuit and probate courts in the city of St. Louis and Jackson county.

8. LOCAL GOVERNMENT IN THE STATES

What is ordinarily referred to as the "state government" is the central organization located at the state capital But this central organization does much the smaller part of the work of the state Unlike the national government, which establishes its central organization for

[illegible]

ration of small communities as villages, with a simpler form of government than that provided or permitted for cities

[illegible]

(1) small boards of commissioners elected at large by the county; (2) large boards elected by townships and cities within the counties. But in a number of states, counties are divided into districts for the election of a small county board In each county will be found a clerk (or *clerks*) of court and a sheriff. Each county provides a courthouse and a jail Locally elected county judges and county treasurers will ordinarily be found and a prosecuting officer elected by the voters of the county. In many states the county is a unit of school administration, and there is a county superintendent of schools, usually elected by the voters of the county A movement is now actively under way toward a more centralized executive organization in the county

The terms town and township are usually employed to designate areas of local government into which the county is divided, though in New England the town is the most important unit of local government New England towns have areas of from 20 to 30 sq.mi, and usually include both rural territory and more compact village settlements. About three-fourths of them have less than 2,500 inhabitants each, and hence may properly be classed as rural communities. The large communities usually become incorporated as cities, and generally the creation of city government terminates the existence of town government within the city's limits The town meeting is the chief organ of government in the New England towns.

So-called town or township systems of government are found in the great central group of states extending from New York to Nebraska. The forms of township government in these states may be classified as follows (1) those which, as in New York, have the town meeting and township representation on the county board; (2) those, as in Minnesota, which have the town meeting but no township representation on the county board, and (3) those, as in Pennsylvania, which have merely a local township organization, but no representation on the county board and no town meeting.

Efforts have been made to introduce the township system in the states of the south and of the west, but in these states the counties are ordinarily divided into subordinate districts, largely for administrative purposes; and such districts, though sometimes called townships, usually have little, if anything, of independent authority in the field of local government.

The growth of urban population has naturally led to the development of cities as the chief agencies to meet local needs occasioned by more compact population. The chief forms of city government in the United States are primarily three. (1) the mayor-council, or federal, plan, (2) the commission plan; and (3) the manager plan.

The mayor-council, or federal, plan is still the most general. It is to a large extent organized upon the analogy of the national government. There is a popularly elected mayor with large powers, which have tended steadily to develop The mayor normally has a veto power and a fairly large power of appointment, although several of the more important officers, such as clerk and treasurer, are usually elected by the voters of the city, just as is the mayor. There are ordinarily under the mayor a group of departments whose heads are appointed either by the mayor alone or by the mayor with the approval of the council. Usually there is a council composed of a single house, whose members are elected from wards into which the city is divided, although occasionally some or all of the members are elected from the city at large.

The fundamental characteristic of the commission plan of city government is an elective commission, usually of three or five members, having large municipal powers, both legislative and executive. Each of the commissioners is the head of a department, and there are as many main city departments as there are commissioners. Along with this system have come ordinarily the initiative and the referendum in municipal ordinances and a power to recall the members of the commission by petition and popular vote

The so-called manager type of city government had its origin about 1908, though it first received serious consideration upon its adoption by the city of Dayton, O., in 1913 Nearly 1,000 cities in the U.S. are now governed under the manager plan Under this plan there is a commission or council, whose members are usually elected from the city at large, oftentimes by the use of proportional representation This body determines the policy of city government and selects a manager to administer the affairs of the city. Through the commission plan, which originated in 1901 and which for perhaps 15 years had great sway in U.S. city development, and through the manager plan, which originated in 1912 and has tended to replace the commission plan, much has been done since 1901 toward the reconstruction of city government in the U S

9. ELECTIONS AND POLITICAL PARTIES

The state government has the primary responsibility for the conduct of elections, national, state and local State constitutions and state laws set up machinery for the conduct of elections, and determine the qualifications for voting, subject to the federal restrictions against discriminations because of race, colour, previous condition of servitude or sex.

Through a succession of changes, the states have now come to have substantially universal suffrage for males and females above the age of 21 years. Georgia in 1944 reduced the voting age to 18. Suffrage for women became national in 1920 through the adoption of the 19th amendment to the constitution of the United States. Educational

qualifications for voting have been imposed in some states, as in New York; and qualifications as to education or tax-paying have been imposed in a number of southern states, which discourage voting by Negroes. State laws require registration of voters in the larger communities to identify those qualified to vote

Few officers are chosen by popular vote in the federal system—the president, vice-president, members of the two houses of congress and presidential electors are so chosen. A much larger group of state officers are chosen by popular vote and an even larger number of county, city and other local officers When all of these types of offices are united on one ballot in one election, the voter is at times faced with the problem of choosing 100 or more officials from among several times that number of candidates Moreover the so-called initiative and referendum have been adopted in 18 states; constitutional amendments are proposed for popular approval by state legislatures and under many state laws, proposals of municipal bond issues and other local questions must be submitted for popular approval The voter is somewhat at a loss when forced to express himself upon perhaps 30 technical proposals and upon a large number of candidates for public office. His choice upon the measures submitted to him is largely haphazard, except upon the occasional measure of real importance. His choice among candidates for national, state and local offices is primarily guided by political parties.

Practically throughout its history, the United States has been a country of two parties A third party has occasionally been important, as was the case with the Progressive party under the leadership of Theodore Roosevelt in 1912 In the early years of the nation, the Federalist party represented the interests of a stronger nationalism; the Republican party under Thomas Jefferson, the interests of the states In the period of Andrew Jackson, the name of the then dominant party changed from Republican to Democratic; and, the Federalists having disappeared, the Whigs became the other great party The Whigs were replaced by the Republicans, who elected Abraham Lincoln to the presidency in 1860. During all of this period lesser parties have existed and have occasionally cast a vote sufficient to determine which of the two major parties should control

Political parties originated as voluntary organizations But they soon came to control the election to their state and national offices; for in the election no one except a candidate of one of the two leading parties had or has the possibility of being elected. The methods of the political party thus became of importance to the government itself Today political parties are in reality no longer voluntary organizations but are rather organs of the government itself, controlled in great detail by state legislation. One of the first respects in which political parties came under official control was the printing of the ballot Before 1888 parties printed their own ballots and naturally determined also the conditions under which the names of their party candidates should appear upon such ballots. Serious abuses arose under this arrangement, particularly with respect to the secrecy of the ballot Beginning in 1888, the states adopted the official, or so-called Australian, ballot Under the official ballot plan, ballots are printed at governmental expense This expense is usually borne not directly by state government but by the local bodies charged by the state with the conduct of elections In practice the printing of ballots, state laws at the same time necessarily determine the conditions under which party organizations shall be entitled to have the names of their candidates appear upon such ballots

But with the adoption of the so-called Australian ballot political parties still had, and have, sufficient power to determine the form of that ballot. Massachusetts and a few other states have adopted a plan under which the names of the candidates are grouped under the titles of the offices; though under the Massachusetts plan the party to which each candidate belongs follows the name of the candidate This arrangement of the ballot makes it necessary for the voter to mark separately on his ballot the name of each candidate for whom he desires to vote Most of the states, however, have adopted the so-called "party-column" ballot. The party-column ballot varies in different states, but its fundamental idea is that all of the candidates for one party shall appear in a single column so that a voter may vote for all of them by placing one mark upon the ballot. If the voter does not wish to vote the party ticket, he is put to the burden of marking each of the candidates for whom he wishes to vote, or at least each candidate not belonging to his own party.

The methods of party nomination next came under state control Serious abuses in the party convention system for the nomination of candidates and the framing of party platforms led to legislation regulating the convention; but such regulation did not appear sufficient. The primary election system (see PRIMARIES) has now been established in some form in all but two of the states, although recently there has been a strong political movement against primary elections and some gain for the older convention system Where the primary system has been adopted, conventions normally remain, with more limited functions.

Control by law over the official ballot and over the methods of party nomination has naturally been followed by a detailed regulation of the machinery of party organization. Through primary elections, the party voters in most of the states choose their party committeemen. State laws determine the power of such party committeemen and also determine the manner in which they shall form the various party governing bodies State laws also determine how party organizations shall frame platforms Governmental regulation of political parties has largely been occasioned by a feeling that party organizations themselves control the government and that they should, rather, be controlled by the government But governmental regulation has not weakened political parties

When it is first created, a party usually stands for some political principle as opposed to other parties Ordinarily, however, parties are merely convenient devices for the operation of government and for presenting political issues to the voters when such issues arise Political issues are not created merely by the existence of two opposing parties, and during much of the time no real issues exist upon the basis of which parties may oppose each other At such times parties proclaim principles, but have no sharp differences When issues are altogether absent, parties still perform the functions of narrowing the choice of the voter and of uniting candidates into groups for final elections

The political expert (who is termed "boss" if sufficiently successful) has the tasks of keeping the party organization together, getting party members to the polls and rewarding political service He can perhaps be more successful if he holds no office, because by holding office he divides his energies and subjects himself to personal criticism for possible errors of political conduct Each political group has its precinct and ward committeemen, who are normally on the public pay roll (local, state or national); if their group is in power, and whose continuance on that pay roll depends upon their efficiency, not as public employees, but in controlling the vote of the precinct or ward The spoils of office and the grosser forms of political corruption are the bases of political organization; corruption secures contracts upon those who practice it. But these are contracts to be let, without too great an insistence on standards, and other similar opportunities for enormous profit Furthermore, important business and professional interests in a community usually co-operate with the organization in return for special favours

With party organization a vast and complex mechanism, nomination and election to office almost of necessity come, in most cases, as a reward for service in the party organization No man of ambition who lacks the support of a party organization has much opportunity either to be nominated or elected, though an independent candidate may occasionally win, in case of great popular upheaval Even under such conditions, the independent candidate who wins must almost necessarily have financial resources sufficient to set up a rival organization of his own. Many states have enacted statutes limiting expenditures of candidates in party primaries and in elections, but such laws have not been effectively enforced While they operate in favour of the candidate sponsored by the political organization Those who come to office usually do so only after a long apprenticeship in party service

The recognition that national parties should not control in the election of local and judicial officers has led to a movement for nonpartisan elections In a number of states judicial officers are nominated and elected through ballots required to contain no party designations. But a candidate must actually be sponsored by a political organization if he is to fare well in any election The nonpartisan election has accomplished more in municipal than in state elections

Parties are organized on the basis of national issues. Few such issues are important in state government and fewer still in local government But the party organization, though national in scope, supports itself largely through the offices and other profits derivable from state and local government In spite of the movement for nonpartisan elections, it is still possible to apply to the U S party system the statement made by James Bryce in the 11th edition of the *Encyclopædia Britannica*:

"The national parties have been so pervasive in their influence, and the working of their machinery has formed so important a part of the political history of the United States, that it is necessary here to call attention to the high significance of this element in the system of the Republic. The party system has made nearly all elections, including those for state offices and city offices, the functions of which have, as a rule, nothing whatever to do with national party issues, matters of party strife fought upon party lines It has disposed voters in state and city elections to support party candidates, of whom they might otherwise have disapproved, for the sake of maintaining in full strength for national purposes the local party organization, and it has thereby become a fruitful source of municipal misgovernment. It has thrown great power into the hands of party managers, because where the strife between the two great parties is keen and the result of a contest doubtful, discipline and obedience are deemed needful for success. It has tended to efface state lines, and to diminish the interest in state issues, and has thus helped to make the nation overshadow the states."

The democratic movement in the United States places upon the voter the duty of electing numerous officers of whose qualifications he cannot have knowledge and of expressing an opinion upon numerous measures of whose merit he cannot be informed The most intelligent citizen, devoting all of his time to public affairs, would in a large number of cases, of necessity, cast an unintelligent ballot. But the functions so imposed upon the voter must be exercised, and the political party has been devised for their exercise. So long as the voter is asked to vote too much, party organization rather than political principles will dominate U S. policies, except in the occasional case where the issue as to a candidate or a principle becomes sufficiently

important to foice the party organization into the background.

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X. HISTORY

BEGINNINGS OF SELF-GOVERNMENT, 1578-1783

The American nation owes its origin to colonizing activities in which the British, Dutch, Swedes, French and Spaniards bore a share, and which were continued during a period of more than two centuries at the beginning of the modern era. The settlements of the Dutch and Swedes (New Netherland and New Sweden) were soon merged in those of the British, and of the territory colonized by Frenchmen and Spaniards the United States, as it was in 1783, included only certain outlying regions. All the European nations which were interested in colonization shared in the enterprise, and the population of the region was therefore cosmopolitan from the outset; but the British, especially after 1660, secured a controlling influence.

Permanent settlements on the Atlantic seaboard were first made in the early years of the 17th century, and they continued steadily to increase until after 1680 Relatively speaking, that was the period of settlement, but population continued slowly to advance westward In the 18th century occurred a large immigration of Germans and Scottish-Irish, who settled in Pennsylvania and New York and thence overflowed into the western parts of Virginia and the Carolinas. The only Colony founded in the 18th century was Georgia (1732), by means of which British outposts on the Florida frontier were strengthened.

General Aspects of Colonization.—British colonization originated chiefly in private initiative, though it acted in half-conscious obedience to certain general principles. To this fact is due the trend toward self-government, which was fundamental and controlling in the history of the British on the American continent. But to an extent the tendencies which favoured self-government were counteracted by the influence of the British Crown and parliament. The influence of the Crown was continuous, except during the period of the Civil War and Commonwealth (1642–60), while that of parliament was not felt until the middle of the 17th century, and its colonial legislation subsequent to that time was chiefly confined to matters of trade The activities of Crown and parliament were directed toward the securing of imperial interests and of that degree of subordination and conformity which, in States that have developed from Roman and feudal origins, attaches to the condition of colonies or dependencies. The term "imperial control" therefore suggests the second tendency in colonial affairs, to the discussion of which the historian must address himself.

Among the colonists the trend toward local independence and self-government was in harmony with the spirit of the English. Neither was it lacking among the other nationalities represented in the Colonies But in the case of the British it was greatly strengthened by the fact that the Colonies were founded by private initiative, the government legalizing the efforts of the "adventurers" and planters, but leaving them in many cases almost wholly to themselves. Hence many small Colonies and settlements were founded. A variety of motives—economic, religious and political—contributed to the founding of these Colonies, and naturally people correspondingly different in type came to inhabit them The remoteness of the Colonies from Europe and the difficulties under which communication with them was maintained confirmed and perpetuated the tendency toward independence Somewhat similar conditions controlled intercolonial relations, kept the colonists apart from one another and checked co-operation Thus it was that the causes which confirmed the colonists in the spirit of independence toward the mother country also made them jealous of external authority

Chartered Colonies.—The term "chartered Colonies" is the one which best describes the forms under which the British-American settlements were founded and under which they all continued for varying periods. They were the direct and characteristic results of private initiative. The discoverers and would-be colonizers, acting individually or in groups, collected the ships, men and resources necessary for their enterprises, and procured from the Crown a charter By this document the King conveyed to them a claim to the soil which would be valid in English law, gave them the right to transfer Englishmen thither, to trade with them and with the natives, and to govern the Colony, subject to the conditions of allegiance and of British sovereignty in general. The rights and liberties of the colonists as British subjects, without attempt to define what they were, were guaranteed by the charters, and the grantee was prohibited from passing laws or issuing orders which were repugnant to those of England In only a part of the charters—those chiefly which were issued subsequent to 1660—was express reference made to the calling of assemblies. So general were the provisions of the charters that they only remotely determined the forms which government should assume and what the rights of the colonists should be A considerable variety of institutions and social types existed under them. But their very indefiniteness made them valuable as objects of appeal to those who in time of controversy were upholding local rights and liberties

London and Plymouth Colonies.—Of the chartered Colonies there were two varieties—proprietary provinces and corporate Colonies. Though alike in the fact that the patentees who founded them were mesne tenants of the Crown, they were quite unlike in their internal organization and to a considerable extent also in the character of the people who inhabited them The proprietary province was a development from the principle of the fief, though with many variations. The early charters of discovery, those for example which were granted to John and Sebastian Cabot and to Sir Humphrey Gilbert, contemplated the founding of feudal principalities in the New World The grant to Sir Walter Raleigh, which resulted in the abortive colonial experiment at Roanoke, was of the same character. At the period of transition from the rule of the Tudors to that of the Stuarts, trading companies and companies for colonization were increasing in number and importance. The joint companies which were chartered by James I in 1606, one to have its residence at London and the other at Plymouth, were of this character They were granted the right to colonize, the one in northern and the other in southern "Virginia"; the intervening territory, three degrees in breadth, being left common to the two. The rights of the companies were confined to settlement and trade The Plymouth patentees achieved no permanent result; but those of London founded Jamestown (1607) and other settlements along the James river, which later became the province of Virginia.

But before this result had been reached the London patentees had secured in succession two new charters, one in 1609 and another in 1612. By means of these grants they had practically separated from the Plymouth company, had secured a concession of territory 400 mi. broad and extending through the con-

tinent, and had been able to perfect the organization of their company. By the grant of 1606 the right to govern the Colonies had been reserved to councils of royal appointees, but by their later charters the London patentees were fully incorporated, and in connection therewith received not only the power to grant land but rights of government as well This made the Virginia Company of London the proprietor of the province which it was founding. It now appointed resident governors, councillors and other officials and instructed and controlled them in all ways, subject of course to the general supervision of the King in council. Under the charter of 1606, in order to facilitate colonization on a strange continent, joint management of land and trade was temporarily instituted But under the fully organized company this system was abandoned, and private property in land and the control of trade through private "magazines" were established A number of distinct plantations and settlements were founded. From these localities, in 1619, under authority from the company, representatives were elected who met with the governor and council at Jamestown and formed the first colonial assembly held on American soil. Its acts were duly submitted to the company in London for its approval or disapproval Other assemblies were called, the tobacco industry was established and the principles upon which traffic in that staple was to be conducted with Europe were announced. Thus Virginia assumed the form of a proprietary province, with an English trading company as its proprietor

New England Council.—Meantime west of England men had been making fishing voyages and voyages of discovery to northern "Virginia," which now was coming to be known as New England. In 1620 a new charter was procured, the reorganized company being known, in brief, as the New England Council Like the London patentees, this body was now fully incorporated and received a grant of the vast territory between 40° and 48° N. lat. and extending through to the South Sea (Pacific) Full rights of government, as well as of trade and settlement, were also bestowed. The moving spirit in this revived enterprise was Sir Ferdinando Gorges (*q.v.*), an Anglican and royalist from the west of England. For a time John Mason (*q.v.*) was his most active coadjutor. Such backing as the company received came from nobles and courtiers, and it had the sympathy of the court. But lack of resources and of active interest on the part of most of the patentees, together with the development of a Puritan interest in New England, led to the failure of this enterprise. No Colony was established directly by the council itself, but that part of its vast territory which lay adjacent to the coast was parcelled out among the patentees and by them a few weak and struggling settlements were founded They were all proprietary in character. But, as events proved, Plymouth Colony (founded in 1620), which was Puritan and Separatist to the core, became a patentee of the New England council; and the Colony of Massachusetts Bay (founded 1628–30), which was to become the citadel of Puritanism in America, procured the original title to its soil from the same source. At the outset both Massachusetts and Plymouth must be classed as proprietary settlements, though far different from such in spirit and destiny. Massachusetts soon (in 1629) secured a royal charter for its territory between the Merrimac and Charles rivers, and thus took a long step towards independence of the council. At the same time the Plymouth settlers were throwing aside the system of joint management of land which, as in the case of Virginia, had been imposed upon them by adventurers who had lent money for the enterprise; were paying their debts to these same adventurers; and were establishing a system of self-government similar to that of Massachusetts Thus a strong Puritan interest grew up in the midst of the domain granted to the New England council, and in connection therewith the type of colony to which we have given the name corporate came into existence.

Corporate Colonies.—In order to understand the nature of the corporate colony, it is necessary to explain the internal organization of that type of company which, like the Virginia Company of London, was founded for purposes of trade and colonization. It was composed of stockholders, who became members as the result of the purchase of shares or of migration to the Colony as planters, or of both acts combined. In the Virginia company they were known as the "generality," in the Massachusetts and other companies as the "freemen" In them, when met as a democratically organized body under the name of "quarter court" or "general court," was vested the governing power of the company It elected the officers, chief among whom were a treasurer or governor, and a council or board of assistants These, as well as the subordinate officers, held annual terms only. Membership in such companies might be indefinitely increased through the issue and sale of shares They were, in other words, open companies, whereas the New England council was a closed body, its membership being limited to 40.

Massachusetts.—In 1629 the prospects of Protestantism at large, and of Puritanism in England, were so dark that the founders of the Massachusetts company, who were decidedly Puritan in spirit and inclined to nonconformity in practice, resolved to remove with their charter and the governing body of their company into New England. Preparatory to this, John Winthrop was elected governor and a settlement was made of their business relations in England After the removal had been made, the assistants and general court met in New England and business was carried on there exclusively by planters. An order was soon passed that none should vote or hold office who were not members of some one of the churches within the Colony. As all these churches were Independent or Congregationalist in form and doctrine, this order gave a wholly new definiton to the term "freemen." It made of this colony something approximating to a biblical commonwealth, and subordinated trade, landholding and settlement to the interests of the Puritan faith As local settlements about Massachusetts Bay were founded, the general court, which before had been a primary assembly—simply the freemen of the company—came to consist partly of representatives elected by the freemen of the towns. In this way a second chamber—that of the deputies—was added to the assistants to form the general court of the Colony. Taxes were levied by this body, and laws and orders proceeded from it which related to all functions of government. It elected or appointed the governor and other chief officials.

Of primary importance in the affairs of the Colony was everything which concerned religious belief and church government. The churches and their relation to the civil power presented the great questions upon which hinged its policy. This was true not only in its internal affairs, but in its relations with other Colonies and with the mother country. An ecclesiastical system was developed in which Independent and Presbyterian elements were combined. By a rigid system of tests this was upheld against Antinomians, Baptists, Quakers and dissenters of all sorts.

Connecticut and Rhode Island.—As a consequence of the Puritan migration from England and of the expulsion of dissenters from Massachusetts, Plymouth and Connecticut, the New Haven Colony, and the towns about Narragansett Bay which became the Colony of Rhode Island were settled. These all were corporate Colonies, organized upon fundamentally the same plan as Massachusetts. Their settlers at the outset had no charters, but by means of plantation or town covenants assumed powers of government, which ultimately were vested in general courts similar to that of Massachusetts. Rhode Island was formed by a union of towns, but elsewhere the Colony was coeval with or antedated the town. Connecticut and Rhode Island, in 1662 and in 1663 respectively, secured royal charters by which they were incorporated within New England itself and the governments which they had established there were legalized. New Haven was absorbed by Connecticut in 1664 under the charter of 1662 and Plymouth remained without a charter from the King until, toward the close of the 17th century, it became a part of the enlarged province of Massachusetts.

The most prominent feature of the New England land system was the "town grant," which in every case became the territorial basis of a group settlement. Throughout New England, and in the outlying districts which were colonized by New Englanders, settlement was effected by groups. The process began in Ply-

mouth and was extended through the entire section. The Puritan migration from Europe was of the same general character. Groups of people, animated by a common religious or political ideal, broke away from their original or temporary abiding-places and pushed farther into the wilderness, where tracts of land were granted to them by the general court.

Over the founding of towns the general courts, as a rule, exercised a watchful supervision. Not only did the courts fix and maintain their bounds, but they issued regulations for the granting of lands, for common fields, fences, herds, the punishment of trespass, the admission of inhabitants and freeholders, and the like But subject to these general regulations, the allotment and management of its land was left to each town. The Colonies had no land system apart from the town. It was partly in order to manage their lands that the towns were made centres of local government and town meetings or boards of town proprietors were established. By means of town action, taken in town meetings and by local officials, the land of each settlement was laid off as house lots, common and common fields, meadow and pasture. Detailed regulations were made for the management of common fields and for their ultimate division and allotment among their proprietors. The same was true of fences and herds. The result was an organization similar to the English manor, but with the lord of the manor left out. To this peculiarity in the form of New England settlement is due the prominence of the town, as compared with the county. The town was the unit for purposes of taxation and militia service as well as of elections It was also an important ecclesiastical centre.

As a result of the process thus sketched, southern New England was settled by a population of English origin, with similar instincts and a form of political organization which was common to them all. Gorges, meantime, had secured (1639) a royal charter for his province of Maine, but Mason had died before he obtained such a guaranty for his settlements on the Piscataqua river. The small communities along that entire coast remained weak and divided. In 1635 the New England council surrendered its charter. The helplessness of the Gorges family was insured by its adherence to the royalist cause in the English Civil War. Massachusetts availed itself of a forced interpretation of the language of its charter respecting its northern boundary to extend its control over all the settlements as far N.E. as the Kennebec river This was accomplished soon after 1650, and for the time Anglican and royalist interests throughout New England seemed hopelessly wrecked. New England had thus developed into a clearly defined section under Puritan domination. This fact was also clearly indicated by the organization, in 1643, of the New England Confederacy, or the United Colonies of New England (*see* NEW ENGLAND).

Middle and Southern Colonies.—The Colonies of the middle and southern sections of the territory which later became the United States were wholly proprietary in form. This was true of New Netherland (founded by the Dutch West India Company in 1621) and of New Sweden (settled under the authority of the Swedish Royal Company in 1638), as well as of the English Colonies. In the case of Virginia and of the Dutch and Swedish settlements, trading companies were the proprietors. But the later English Colonies, beginning with Maryland in 1632, and continuing with the Carolinas (1663), New York (1664), New Jersey (1665), Pennsylvania and the Lower Counties, afterwards Delaware (1681), were founded by individual proprietors or proprietary boards. Georgia (1732), the only English Colony settled after 1681 on the continent, existed for 20 years under a proprietary board of trustees. By the efforts of adventurers of this class, put forth chiefly during the period of the Restoration, the entire coast-line from Florida to Acadia was permanently occupied by the English. But, unlike New England, the population was of a mixed character, as were the economic and religious systems, and to an extent also the political institutions.

As has already been stated, in their internal structure and in the course of their history the proprietary provinces differed very materially from the corporate Colonies. Those of later English origin also differed in some important respects from Virginia under the company and from New Netherland and New Sweden. The system of joint management of land and trade, which was so characteristic of early Virginia, was outgrown before the other proprietary provinces were founded. Neither did it prevail in the Dutch and Swedish provinces.

In the proprietary province the proprietor, or board of proprietors, was the grantee of powers, while in the corporate Colony it was the body of the freemen organized as an assembly or general court. He might exercise his powers in person, or, as was usually the case, delegate them to one or more appointees In any case, the form of government of the proprietary province was essentially monarchical in character. The powers that were bestowed were fundamentally the same as those which were enjoyed during the middle ages by the counts palatine of Chester and Durham. The normally developed provinces which resulted were miniature kingdoms, and their proprietors petty kings. This character arose from the fact that the grantee of power was the executive of the province. This branch of government was thereby brought into the forefront At the beginning and for a long time thereafter it continued to bear the leading part in affairs. It was not so in the corporate Colony, for there the freemen and the general court stood at the centre of the system In most of the corporate Colonies the executive was strong, but that was due to the political and social influence which its officials had gained, and not to their tenure of office.

Proprietary Colonies.—In every case, apart from the ordinary rights of trade and the guarantees of the liberties of the colonists, the powers which were bestowed on the proprietors were territorial and governmental. The territory of the provinces was granted under the conditions which by English law controlled private estates of land. An entire province, or any part of it, could be leased, sold or otherwise disposed of like a private estate It was an estate of inheritance, descending to heirs. The attitude of proprietors toward it was that of landlords, investors or speculators in land. They advertised for settlers, and, in doing so, an ever present motive with them was the desire to secure more private income from land In 1664 the duke of York sold New Jersey to Berkeley and Carteret, and the sale was effected by deeds of lease and release. In 1708 William Penn mortgaged Pennsylvania, and under his will devising the province legal complications arose which necessitated a suit in chancery.

In all the later proprietary charters, except that of New York, the operation of the statute *Quia emptores* was suspended, so far as relations between the proprietor and his immediate grantees were concerned By virtue of this provision each proprietor, or board, became the centre from which originated an indefinite number of grants. These were held directly of the proprietor and through him of the Crown. In practice the same was true also of New York. The proprietors were thus left free to make grants on such conditions as they chose. Preparatory to the exercise of this power, the proprietors issued so-called "concessions" or "conditions of plantation," stating the terms on which they would grant lands to colonists. Under a system of head rights, analogous to that which existed in Virginia, land was thus bestowed on settlers upon easy terms. Proportional amounts of land were granted upon the importation of servants, and in this way a traffic in servants and their head rights to land was encouraged among planters and masters of merchant vessels. In all the provinces, except New Netherland, a quit-rent was imposed on all grants. In the Dutch province rents were sometimes imposed, but they varied in character and differed from the English quit-rent. In Maryland fines were levied on alienations. In Maryland and Pennsylvania the demand for land became so great that it was sold.

In all the provinces territorial affairs were administered directly by the provincial authorities, and not by towns as in New England. In Maryland a land office was fully organized, towns developed only to a very limited extent, and when they did originate they were in no sense village communities Lots in them were granted by provincial authorities and they were subject to a quit-rent. They were simply more densely populated parts of the counties, and, unless incorporated as boroughs, had no distinct

institutional life In almost all cases land, in the provinces, was granted to individuals, and individual ownership, with direct relations between the owners or tenants and the proprietary authorities, was the rule.

Had governmental powers not accompanied the territorial grants, these grants would have been estates of land, unusually large, no doubt, but nothing more In cases where the governmental rights of proprietors were suspended or resigned into the hands of the Crown, they remained thereafter only private landlords. But the rights of government bestowed with the land made the territory a province and the proprietor its political head

The provincial charters made the proprietors of the proprietary provinces the executives of their provinces and for the most part left it to them to determine how and under what forms the governmental powers which they had received should be exercised. The powers which were definitely bestowed were executive and judicial in character, giving to the proprietor an importance, especially at the outset, which was comparable with that enjoyed by the general courts in the corporate Colonies It made him in a derived and inferior sense the source of office and honour, the fountain of justice, the commander of the militia, the recipient of the provincial revenue, the constituent part of the legislature. But in most cases the proprietors did not attempt to exercise these powers in person By means of commissioners they appointed a group of leading officials for their provinces, as a governor, councillors, a secretary, surveyor general, receiver general or treasurer, and somewhat later an attorney general These all held office at the pleasure of the proprietor.

The Governor.—The governor was *par excellence* the agent for the proprietor for all purposes of administration. In making appointments the proprietor was usually guided by the governor's recommendations. In some cases he was a relative of the proprietor; family influence in Maryland after the Restoration came to dominate the government of the province In all his important acts the governor was required to take the advice of his council, and that body was expected to co-operate closely with him, but the governor was not bound to follow their advice. The relations between the two were the same as that between the King and his privy council in England. As settlements multiplied and counties and other local subdivisions were formed, other and inferior offices were created, the right of appointment to which rested with the governor By means of an executive, thus organized, land was granted and the revenue from it collected, counties and other local divisions were established, early preparations were made for defence, courts were opened and the administration of justice begun.

In the later proprietary charters generally, with the exception of that issued to the duke of York, provision was made for assemblies. It was made, however, in very general terms, and it was left to the option of the proprietors to determine when, where and how they would call them. These legislatures did not originate in the natural or pre-existent rights of Englishmen, nor did the existence of a parliament in England make them necessary, though it greatly increased the difficulties of governing the Colonies without them. These legislatures were immediately proven to be indispensable and their activity in the provinces gradually opened the way for the growth of modern democratic institutions

The Legislature.—When met in regular form, the provincial legislature consisted of the governor, the council or upper house, and the assembly or deputies. These deputies, who were elected by the localities, constituted the only representative part of the legislature. In tenure and functions the governor and council were largely independent both of the deputies and of the electors. They were a part of the executive and were naturally swayed by a regard for the interests of the proprietor and by administrative traditions. In many cases the importance of the councils was increased by the fact that, with the governor, in early times they formed the highest judicial tribunal in the province. As the governor had the sole power of calling, proroguing and dissolving the general assembly, the council might advise him in such a way as to destroy the body itself or thwart its plans. The joint work of the council and assembly was subject to the veto of the proprietor, or of both the proprietor and his governor. The legislature of the province, therefore, differed materially from the general court, though in practice this was somewhat offset by the fact that in the New England Colonies the magistrates were usually re-elected for a long series of terms.

In the province, as in the kingdom, the legislature was in a sense an expansion of the executive, developed out of it, and was to an extent controlled by it Out of this relation arose the possibility of conflict between the two parts of the legislature—that which represented the people and that which represented the proprietor In the history of the provinces this formed the central line of cleavage. From the first the assemblies largely controlled taxation Using this as a lever, they endeavoured to limit and define the powers of the executive and to extend the sphere of legislation more widely. Fees, from which officials derived most of their support, were a favourite object of their regulation Occasionally offices which had originally been appointive were made elective. Protests of various kinds were made against official cliques Now and again the lower house came to a deadlock with council or governor. Threatened or actual revolt was sometimes necessary to bring the executive to terms. By such tactics as these the popular elements in the constitutions of the provinces asserted themselves The sphere of ordinance was gradually limited and that of statute extended.

Constitutions.—In a number of provinces—the Carolinas, New Jersey and Pennsylvania—the proprietors at various times initiated elaborate constitutions, in which not only a land system, but forms and functions of government were prescribed on a large scale. These were variously known as fundamental constitutions, concessions and agreements, and frames of government, and in every case were submitted to the general assembly for its acceptance or rejection Long struggles often ensued over the question of acceptance, which usually ended in the modification or rejection of the schemes.

Course of Development.—The history of these provinces was not uniform In New Netherland and New York occurred a struggle for the establishment of a legislature, which continued at intervals for 40 years and was not permanently successful until after New York had become a royal province. The proprietors of New Jersey never secured a royal charter, and therefore were not able to establish satisfactorily their claim to rights of government. Within the vast reaches of the Carolina grant developed two provinces. One of these—North Carolina—was almost entirely neglected by the proprietors, and the weakened executive repeatedly succumbed to popular violence. In South Carolina many violent controversies occurred, especially over the efforts of the proprietors to compel the acceptance of the Fundamental Constitutions, which originated with Locke and Shaftesbury. But in the end this failed, and a simple form of government, such as was adapted to the needs of the province, was developed. In Pennsylvania the liberal policy of the proprietor led at the beginning to unusual concessions in favour of the colonists, one of the most characteristic of these being the grant of an elective council The total neglect of provision for defence by the Quaker province led to the suspension of Penn's powers of government for about two years after the English Revolution and the outbreak of the war with France This did away with the elective council for the time, and an appointive council was soon substituted. Finally, in 1701, the council was deprived of its powers of legislation and thereafter the legislature of Pennsylvania consisted of only one house—the assembly

Imperial Control, 1606–1760.—Imperial control over the Colonies, it is to be noted, proceeded chiefly from the English Crown. It was exercised through the secretary of State, the privy council and a succession of boards subordinate to it which were known as commissioners of plantations or the board of trade; by the Treasury and Admiralty boards and their subordinate bureaux; by the attorney general and the solicitor general and by the bishop of London. The more continuous and intimate supervision proceeded from the privy council and the commissioners subordinate to it, and from the Treasury board,

which caused the auditing of such revenue as came from the Colonies, supervised expenditures for them and had an oversight over appointments in the colonial service. The privy council received letters and petitions on almost every kind of colonial business, caused hearings and inquiries to be held, and issued letters, instructions and orders in council on an equally great variety of matters It also acted as the regular court of appeal for the plantations. As time advanced, more of the administrative business passed directly into the office of one of the secretaries of State and the privy council became less active. The Admiralty was concerned with the equipment of the navy for service in the Colonies, and the high court of admiralty with the trial of prize cases and of cases arising from violations of the acts o trade. The bishop of London had supervision over the appointment and conduct of clergymen of the English Church in the colonies and over parish schools there.

Parliamentary Control.—The parliament by mentioning the dominions in its statutes could extend their provisions to the colonies The early acts of supremacy and uniformity contained such reference, but it was dropped after the Restoration and no serious attempt was ever made to enforce uniformity in the Colonies. Parliament did not begin to legislate seriously for the colonies until after the Restoration Then the acts of trade and navigation were passed, to which additions were made in the reign of William III. and from time to time during the 18th century This body of legislation comprised the most important acts relating to the Colonies which were passed by Parliament. A few statutes relating to military affairs were passed about the middle of the 18th century About 100 statutes in all were passed prior to 1760. The colonists themselves imitated in a general way the organization and procedure of the English courts. The main features of the common law came spontaneously into force in the Colonies. The legislatures of several of the Colonies adopted large parts of the statute law of England. The colonists were always accustomed to avail themselves, as far as possible, of the great English statutes which guaranteed liberty. After about 1690 the obligation was very generally enforced upon the Colonies of sending the acts of their assemblies to England for acceptance or rejection by the King in council.

But this, though far-reaching, was only one of the objects which were sought through the exercise of imperial control. Its chief object was to maintain the rights of Great Britain over the Colonies and her interests in them in all respects. The diplomacy of Great Britain concerned itself to an increasing extent, as the 18th century advanced, with the acquisition or losses of colonial territory, with the fixing of boundaries and with the securing of commercial interests. The interests of trade, more than any other subject, determined the colonial policy of England The church and her interests also demanded attention. In all these matters the English executive—the Crown—continuously, and for the most part exclusively, managed colonial affairs. During the Commonwealth in the 17th century, parliament was the source of all activity, whether legislative or executive, but at other times its legislation was confined chiefly to the subject of trade.

Isolation of the Colonies.—A natural condition which affected colonial administration as a whole and to a large extent determined its limits and character was the remoteness of the Colonies from England. At best three months were required for sending a dispatch from London to America and procuring a return. This explains the large degree of self-government which the Colonies possessed and the indifference with which their affairs were usually viewed, even by British officials. Only a relatively small part of colonial business came before English officials or received their serious attention. Only at long intervals and in summary fashion was it brought to the attention of Parliament. It is believed that the affairs of the continental Colonies were never seriously debated in Parliament until after the beginning of the controversy which led to the American War of Independence. Social and political intercourse with the colonists and governmental control over them were therefore very imperfectly developed. In fact, the control over them was almost wholly executive, and during most of the period it was to a degree unintelligent and weak; in fact it was something more resembling a federation.

Chartered Colonies.—The central fact in colonial history during the 17th century was the development of the chartered Colonies At their founding, as we have seen, the Crown delegated rights of settlement and subordinate rights of government to proprietors, who used them in a variety of ways The effect of this was to introduce a number of mesne lords between the king and his colonial subjects, a phenomenon which centuries before had vanished from England itself The patentees governed the colonists, and the Crown interfered only at intervals to adjust matters. Under the first two Stuarts some rather desultory efforts were made to check the development of such a system in the early stages After a controversy over a contract for the sole importation of tobacco, which became involved with the political struggles of the time in England, the charter of the Virginia Company of London was revoked (1624). A royal commission was appointed to readjust the affairs of Virginia and to inaugurate its government as a royal province. In 1634 a board of commissioners of plantations was created and it received very large powers over the Colonies. The year following the New England council resigned its charter, a writ of *quo warranto* was issued against the Massachusetts charter, and a plan was nearly perfected for sending out Sir Ferdinando Gorges as royal governor, or rather governor general, to New England. But means were lacking, the suit against the Massachusetts patent failed to accomplish its purpose, and troubles at home soon absorbed the attention of the Government.

During the Great Rebellion in England New England was left practically to itself. Strife broke out in Maryland, over which the home Government was scarcely able to exercise even a moderating influence. The Dutch from New Netherland and Europe were able to monopolize a large part of the carrying trade in tobacco and European goods. Virginia assumed an attitude of distrust or hostility toward the new Government in England. In 1651 and 1652 Parliament sent out a commission, with an armed force, which adjusted affairs in Virginia by suspending Government under Sir William Berkeley, the royalist governor, and leaving control in the hands of the assembly By a stretch of power the commissioners also took control of affairs in Maryland, but there they intensified rather than allayed the strife. Baltimore, however, managed to save his interests from total wreck, and at the Restoration was able to re-establish his authority.

Navigation Acts.—During this time of unstable government in England the seeds were planted of a colonial policy which was henceforth to dominate imperial relations. It was then that England entered upon the period of commercial rivalries and wars. The Cromwellian Government determined to wrest the control of the carrying trade from the Dutch, and the Navigation Act of 1651 and the first Dutch War were the result. Gen. Robert Sedgwick was sent against New Netherland, but ended in attacking Acadia. At this time also the national hatred of Spain, which had so characterized the age of Elizabeth, reasserted itself and the Spanish seas were invaded. In connection with these events plans were formed for a more systematic colonial administration, which Cromwell did not live to execute, but which were taken up by Clarendon, the duke of York, the earl of Shaftesbury and a large group of officials, lawyers and merchants who surrounded them. They took definite shape after the Restoration in the creation of a council for trade and a council for foreign plantations, in the passage of the acts of trade, in the conquest of New Netherland, in the settlement of the Carolinas, and in a resolute attempt to adjust disputes in New England. These events and their consequences give greater importance to the next three or four decades than to any later period until the colonial revolt.

The council for foreign plantations was continued, sometimes under a patent and sometimes as a committee of the privy council, until in 1696 it was commissioned as the board of trade. As a board of inquiry and report, subordinate to the privy council, the most important business relating to the Colonies was transacted before it. The acts of trade, in which the principles of the system were laid down, were passed in 1660, 1663, 1673 and 1696. They expanded and systematized the principles of mercantilism as they had long been accepted. The import and export trade of the

Colonies was required to be carried on in English and colonial built ships, manned and commanded by Englishmen. The policy of the staple was applied to the trade of the Colonies by the enumeration of their chief products which could not be raised in England and the requirement that such of these as were exported should be brought to England and pay duties there, and that the supplies not needed for the English market should be sent thence to foreign countries. The same policy was applied to all colonial imports by the requirement that they should pass through English ports. In order to prevent intercolonial traffic in enumerated commodities, which might lead to smuggling, the act of 1673 provided for the levy of an export duty on them in the Colonies in cases where a bond was not given to land them in the realm.

In the 18th century severe restrictive measures were passed to prevent the growth of manufactures in the Colonies; but these acts proved mostly a dead letter, because the Colonies had not reached the stage where such industries could be developed on any scale. Certain compensations favourable to the Colonies also appear in the system, *e.g.*, the measures to suppress the raising of tobacco in England and Ireland, in order that the colonists might have the monopoly; the payment of bounties on the importation of naval stores and on the production of indigo by the colonists; the allowance, on the re-exportation of colonial products, of drawbacks of part or all of the duties paid on importation; the admission of colonial imports at lower rates of duty than were charged on the same products from foreign countries In order to ensure the enforcement of these acts elaborate provisions became necessary for the issue of bonds, and this, with the collection of a duty in the Colonies, led to the appointment of colonial customs officers who were immediately responsible to the commissioners of the customs and the Treasury Board in England. With them the governors were ordered to co-operate Courts of vice admiralty, with authority to try cases without a jury, were established in the Colonies; and just before the close of the 17th century they were given jurisdiction over violations of the acts of trade, a power which they did not have in England. It thus appears that the resolve to enforce the policy set forth in the acts of trade resulted in a noteworthy extension of imperial control. How far it was successful in the immediate objects sought it is impossible to say. In some of the Colonies and at some times the acts were practically nullified. Illegal trading was always carried on, especially in time of war. But in the large it is probable that the acts were effective, and their existence always furnished a standard to which officials were required to conform.

By the Act of Union of 1707 Scotland was admitted to the advantages of the English trade system. In 1733, in order to check the development of the French colonies and prevent the importation of their products into English possessions, the Molasses Act was passed. This provided for high specific duties on rum, molasses and sugar, when imported from foreign colonies into those of Great Britain. So high were these rates that they could not be collected, and little attempt was made to enforce the act.

Returning to the 17th century, the conquest of New Netherland by the British in 1664 was an event of great importance. Taken in connection with the settlement of the Carolinas, it completed the hold which the English had upon the North American coast and gave them for the first time an extent of territory which could be profitably developed. The occupation of New Netherland was effected by a royal commission, which was also empowered to hear complaints and report a plan for the settlement of disputes in New England. A little more than ten years later a similar body, accompanied by a military force, was sent to Virginia to adjust matters at the close of Bacon's rebellion. But the commission of 1664 was the most noteworthy example of its kind. Yet, though it succeeded at New Amsterdam and in the southern Colonies of New England, it failed at Boston. Massachusetts would not admit its right to hear appeals. It did not succeed in wresting from Massachusetts the territory of New Hampshire and Maine, which the heirs of Gorges and Mason claimed

Dominion of New England.—In 1676 Edward Randolph was sent as a special agent to Massachusetts, to require it to send agents to England. He returned to England the sworn enemy of that Colony and continued to be its tireless prosecutor. A series of negotiations ensued which lasted for almost a decade, and ended in the revocation of the Massachusetts charter by a decree in chancery, 1684 New Hampshire had already been organized as a royal province. Government under the charters of Rhode Island and Connecticut was soon after suspended. All New England was then organized as a dominion or viceroyalty under Sir Edmund Andros Assemblies were everywhere abolished and government was left wholly in the hands of the executive. New York—also without an assembly—and New Jersey were soon after incorporated with the Dominion of New England, its boundary being extended to the Delaware river After Bacon's rebellion in 1676 the lines of executive control were strengthened in Virginia, but the assembly continued active These rapid changes involved the downfall of the former system of chartered colonies and the substitution of royal provinces in their place The effect of this was to introduce into the Colonies a large number of officials of royal appointment The entire executive and judiciary in a royal province was appointed directly or indirectly by the king. Its members held under commissions subject to the king's pleasure and were controlled by his instructions

Colonial Reorganization.—By the abolition of assemblies and the union of Colonies on a large scale James II did violence to the strongest feelings and traditions of the colonists The New Englanders not only viewed the levy of taxes by prerogative with the utmost aversion, but they feared a general unsettlement of land titles, the destruction of much that was valuable in their system of town government, and the introduction of Anglican worship They shared also in the fear, which was widespread among the colonists, that the Crown intended by an alliance with the French and Indians to force Roman Catholicism upon them. Therefore the fall of the Stuart Government in England was the signal for an uprising at Boston (April 1689) followed by a less successful one at New York. The Dominion of New England at once collapsed and the old Colony Governments were generally restored. A revolt against the Catholic proprietor in Maryland resulted in the suspension of his powers of government and the organization of Maryland as a royal province. William III granted a new charter to Massachusetts (1691) in which full provision was made for an assembly, but also for a governor and secretary of royal appointment. Rhode Island and Connecticut were allowed to remain under their corporate charters. New York and New Hampshire were organized as royal provinces with assemblies. Proprietary government struggled back into existence in New Jersey. In Pennsylvania the governmental powers of the proprietor were suspended from 1692–94, because of his neglect of provision for defence; then they were restored and Pennsylvania continued under proprietary government until the War of Independence.

The transition from the system of chartered colonies to that of royal provinces was thus well advanced towards completion. But it was a gradual process, and the later stages of it were not reached until the second decade of the 18th century South Carolina became provisionally a royal province in 1719, and a parallel change was completed in North Carolina a decade later. Georgia received a royal government in 1752. But in 1715 Maryland was permitted to resume its proprietary form. After the Revolution of 1689 the change to royal governments did not involve in any case the abolition of colonial assemblies. Henceforward the Crown had a fully equipped executive in every royal province The governors exercised the royal rights of calling, proroguing and dissolving the assemblies; they assisted in initiating legislation and exercised the right of veto. All bills passed by the assemblies were required to be submitted to the King in council for acceptance or disallowance. The upper houses of the legislature were the councils of the provinces. These were small bodies and consisted, in every case except Massachusetts, of royal appointees. Their support was in most cases given to the governors, and by that means they were greatly assisted in resisting the encroachments of the lower houses of assembly which were elected by the freeholders But, as a rule, the Crown made no provision for the salaries of its governors and other officials, and left them largely dependent for support on appropriations by the assem-

plies. Under this system of balanced forces, analogous in general to that which was reached after the Revolution in England, the Colonies entered upon the long period of the French wars.

Struggle with the French, 1690–1760.—Early French discoveries and colonization in North America were confined chiefly to the valley and gulf of the St. Lawrence. These led in the early seventeenth century to the establishment of the province of Canada. By 1670 the French had possessed themselves of the valley of the lower St Lawrence, and the relations with the Indian tribes were being determined During the next 50 years Canada grew slowly into an autocratically governed province, in which the Roman Catholic church was so strong as to contest supremacy at times with the civil power. The fur trade became from the first a most important industry The Jesuits and other priestly orders undertook missionary work on a large scale among the natives. The fur trader and the missionary soon extended French influence through the region of the Great Lakes. Between the Iroquois and the French, wars were almost continuous, but with the other Indian tribes the French were in general on friendly terms. The Iroquois maintained friendly relations with the Dutch and afterwards with the English This deeply affected relations between the English and the French, as well as the entire development of the province of New York.

French Expansion.—Exploration was a most important incident of both the fur trade and the missionary enterprises of the French. Between 1670 and 1690 their work culminated in the great exploring activity of Marquette, Joliet and La Salle. The Ohio and Mississippi rivers were discovered and their courses were mainly or wholly traced. Explorers also penetrated far into the regions beyond the Mississippi. Posts were established at various points along the Great Lakes. During the first two decades of the 18th century the French also established themselves on the Gulf of Mexico, Mobile being founded in 1702 and New Orleans in 1718 Quebec and the Gulf ports were then connected by a series of forts which, though few and weak, sufficed for communication and for the establishment of a claim to the Mississippi valley. They were Niagara and Detroit, commanding the approaches to lakes Erie and Huron; Fort Miami, on the Maumee river; Fort St. Joseph, at the southern end of Lake Michigan; Vincennes and French Fort, on the Wabash; Fort Chartres, on the Mississippi opposite St. Louis; Michillimackinac and Ste. Marie, which guarded the upper lakes French zeal and enterprise had thus seized upon the heart of the continent. It seemed possible that English settlements might be confined to the coast, for they expanded slowly and no genius for exploration or sympathy with Indian life was shown The tendency of British commercial policy was likewise to confine them there. The Indian alliances of the English were also far less extensive than those of the French. The provinces of South Carolina and Georgia had conflicts with the Spanish on the Florida frontier, and in these the Indian tribes of the south were also involved But these rivalries were slight and local in character when compared with the struggle for supremacy which was preparing between the French and English.

The conflict with the French was precipitated by events in Europe. It was the English Revolution of 1689 that opened the great conflict between France and England. The question of Protestantism versus Catholicism was involved, but at bottom the struggle was one for the balance of power among European States. Rival claims, too, existed between the two powers in America, Africa and Asia. Questions of commercial and naval supremacy world-wide in extent were involved, and the colonial possessions of the two States were necessarily drawn into the struggle. In America it involved four intercolonial wars (Dutch War with France, War of Queen Anne or Spanish Succession, War of Austrian Succession and Seven Years War), which were closed respectively by the treaties of Ryswick (1697), Utrecht (1713), Aix-la-Chapelle (1748), and Paris (1763). On the American continent during the first two wars the struggle was confined to the northern frontier, and consisted of devastating raids by the French and Indians, which in turn provoked retaliatory efforts on the part of the English. These took the form in part of attacks on Acadia and of unsuccessful efforts to conquer Canada by means of joint expeditions by sea and land. The favourite land route was that from New York by way of Lake Champlain to Montreal, while the expeditions by sea were forced to make the long and perilous voyage round Nova Scotia and through the Gulf and River St. Lawrence to Quebec In 1690 and again in 1711 an enterprise of this kind was actually undertaken. Acadia, "with its ancient limits," and the claim of France to Newfoundland and the Hudson Bay territory were, however, ceded to England by the Treaty of Utrecht

Wars Between French and British in America.—As the great world conflict progressed the relative importance of the colonial and maritime issues which were involved increased The first two wars had their origin primarily in European questions The third war had its beginning in the Spanish West Indies, and clearly revealed the existence of the Bourbon Family Compact, which bound France and Spain together On the American continent the most striking event was the capture, in 1745, of Louisburg, a stronghold which the French had recently fortified on Cape Breton. This victory was secured largely by the efforts of the New England colonists. In the following year another plan for the conquest of Canada was thwarted by the necessities of war in Europe. At the close of the war Louisburg, too, was restored to the French. After this fashion did the world struggle react upon the special interests of the English in North America, and perplex and irritate the colonists.

In the fourth intercolonial war (1754–63) the struggle between the two nationalities in North America was decided. Events which immediately preceded this war—the occupation of the Ohio valley and the building of Fort Duquesne—clearly revealed an intention on the part of the French to exclude the English from the Mississippi valley. A persistent effort was also made to recover Acadia. The western, as well as the northern, frontier was now threatened, and the war which followed affected all the Colonies. Great Britain sent over a succession of commanders-in-chief. Great improvement was made upon the crude efforts at joint colonial action which had characterized the earlier wars: the Albany congress of 1754 greatly surpassed in importance the meetings of governors and military officers which had occasionally been held in previous times, though its plan of colonial union failed. The campaigns of this war were all upon a comparatively large scale. Campaigns were carried on not merely along the line of Lake Champlain and in Acadia, but against Fort Duquesne, Oswego and Fort Frontenac, Louisburg and Quebec itself. The weak Spanish power was overthrown in Florida and expeditions were sent against the southern Indians In all quarters, and especially after Pitt became secretary of State, the British assumed the offensive The Navy of Great Britain, as well as its Army, was called into action on a much larger scale in America than ever before. The result was the conquest by the British of Canada, and all North America east of the Mississippi river; the French claim to territory west of this river was ceded to Spain in 1762

The wars with the French brought the problem of colonial defence among the English into greater prominence than ever and added it to the other questions at issue. Against the Indians the colonists in the 17th century had provided for their own defence. Chiefly with this object in view, each Colony had developed a militia system. But such a force was not fitted for long campaigns or large operations: it was comparatively undisciplined; the commissariat was poor or totally lacking, and the men were able to remain away from their homes for only brief periods. The colonists possessed no navy. So poor were means of communication and so isolated were the Colonies from one another, that co-operation was very difficult. Equally difficult was it to secure proportional contributions of money from the Colonies. Early in the French wars the British Government prescribed quotas both of men and money to be raised by the Colonies, but little attention was paid to these except by the Colonies in immediate peril. Because of the limited amount of available money and the modest resources of the colonists heavy taxation was impossible. The assemblies resorted to the issue of bills of credit, to which they gave legal tender quality, and for the redemption of which in nearly all cases they made inadequate provision. The

paper depreciated and in some Colonies became worthless Great confusion resulted, involving loss to all, and among the sufferers were British merchants Strained relations were produced between the assemblies and the colonial executive, who, acting under royal instructions, persisted in vetoing bills for additional issues of currency For this reason, in addition to others, the assemblies withheld the salaries of governors and other officials, and in this way sought to coerce the executives. In some Colonies the assembly secured the right of electing the treasurer, and in most of them appropriations were made specific. Thus by skilfully utilizing their control over the purse, and that during a long period of war, the colonial assemblies were able materially to limit the authority of the executives It was in such ways as these that the Constitutions of the provinces became developed and liberalized during the French wars.

The Canadian Government.—The quality of the rank and file of the Canadian militia was not essentially different from that of the British Colonies. But the Canadian Government was autocratic. The power of the French was also concentrated in a single large province. These conditions greatly promoted military efficiency. When taken in connection with their Indian alliances, they enabled the French to take the offensive in the earlier wars much oftener than did the English, and with much greater effect. The English frontier was more accessible and more exposed than was the lower part of the valley of the St. Lawrence. Quebec was in every sense a citadel to which additional security was given during a large part of every year by the intense cold of the Canadian winter. But so superior were the training and enterprise of the French *coureur de bois* that, with his Indian allies, he was far better able than the English farmer or artisan to penetrate the wilderness, whether in winter or in summer, and massacre the exposed dwellers on the frontier. It was this class which gave the French the superiority in the long succession of raids by which the English frontier was laid waste.

Though the French by their skill and boldness achieved a remarkable success, their defects and weaknesses were equally evident. The flow of population from France to America was never great, and was diminished by the exclusion of Huguenots. The natural growth of population within New France was not rapid and the French colonists did not become sufficiently numerous to maintain the interests to which their vast claims and possessions gave rise. At the opening of the last intercolonial war the proportion of English to French colonists was approximately 15 to one. The resources of the British exceeded those of the French colonists to a corresponding degree. Had the decision of the questions at issue depended upon population and wealth alone, the issue could not long have remained doubtful But they were so offset by other circumstances, already alluded to, that the result of the struggle was for a long time uncertain. The motherlands were to be the decisive factors in the problem, which thus depended to an extent on complications which existed in Europe or even on remoter seas and continents. When the climax of the struggle was reached the result might have been different if France at the time had not been so deeply involved in the politics of central Europe.

Of the first importance in reaching a decision were the fleets and armies of Great Britain and France, or those parts of them which were available for use on the continent of North America. During the larger part of the period under review the French neglected their fleet, while the English steadily advanced toward naval and commercial supremacy. But the first conspicuous service on the northern coasts was that which was rendered by Commodore Peter Warren and his squadron at the capture of Louisburg in 1745. In the next year a large French fleet was despatched to North America, but it accomplished nothing. In the last intercolonial war the operations before Louisburg in 1758 and at Quebec in 1759 decisively proved the superiority of the British Navy. The Colonies also, in the later stages of the struggle, contributed loyally toward the result. France failed to make her natural military superiority effective in North America, and her power on that continent had to yield before the combined attacks of Great Britain and her Colonies by land and sea.

Colonial Revolt, 1763–76.—The Treaty of Paris (1763), by which the period of colonial wars was concluded, added vast stretches of territory to the dominions of Great Britain in North America. The Floridas, Canada and Louisiana as far west as the Mississippi river now came into the possession of the English. Of the islands which were occupied, the two most important—Guadaloupe and Martinique—were restored to the French The retention of Canada in preference to these involved an important change in the nature and objects of British colonization. Hitherto tropical colonies had been preferred to those in northern climes But it was now bent upon continental expansion. Canada and the West were retained and the most important French islands were given back The development of modern industry—the so-called industrial revolution had already begun in Great Britain Its effect was vastly to increase the population of the British Isles and to necessitate an overflow into the unoccupied regions of the globe. Henceforth, as time progressed, colonies were to be valued as homes for a surplus population quite as much as sources of raw materials and food supplies. The retention of Canada and the West also coincided exactly with the desires of the continental Colonies. The chief gains of the war went therefore to them and not to the island colonies. They now possessed a continental domain which was adequate to their need for expansion, and their long-cherished desire to be rid of the French was gratified. The conquest of the French removed the sense of dependence on Great Britain for military aid previously felt by the northern Colonies in particular.

Increase of Imperial Control.—In consequence of the policy thus adopted, largely increased burdens were devolved on the Imperial Government, while the conquest and the events which led to it strengthened imperialist sentiment. The course of action which was at first favoured by leading officials, both in England and the Colonies, was a more systematic administration of Indian affairs, the employment of sufficient regular troops under the commander-in-chief to defend the newly acquired territory, the maintenance of posts with English settlers in the interior on a scale sufficient to prevent the French or Spanish from securing the trade of the region. Improved methods of administration were urged; French methods were praised and the shortcomings of the surviving chartered Colonies were again emphasized This all required additional revenue, as well as administrative vigour, and that at a time when Great Britain was especially burdened with debt and when several of the Colonies had recently incurred heavy expenditures. The large acquisitions of territory also necessitated some changes in the acts of trade. The necessity for their more vigorous enforcement was revealed by the existence of a large contraband trade between the colonists and the enemy during the later years of the war and also of a considerable illegal trade with Europe. These conditions, together with the conviction that, as the continental Colonies had reaped the chief advantages of the war, some favour should be extended to the islands, led to the passage of the Sugar Act by the Grenville ministry in 1764. It also caused a resort to writs of assistance in two of the Colonies, and finally the legalization of them in all the Colonies by Act of Parliament (1767) The aid of the Navy was directly invoked in the enforcement of the trade laws, and the activity of the customs officials and of the admiralty courts in the Colonies was increased. Garrisons of regular troops—numbering several thousand —with a commander-in-chief were now present in the Colonies in time of peace, and their aid might possibly be invoked by the civil power to suppress disorder. The Sugar Act itself was a trade and revenue act combined, and the fact was expressed in the preamble of the measure. It was intended directly to affect the traffic between the northern Colonies and the foreign West Indies in lumber and food-stuffs, molasses and rum. The duty on foreign molasses, for which provision had been made in the Molasses Act of 1733, was halved; but now it was proposed really to collect this duty. A cry was immediately raised in New England that, if the duty was collected, the manufacture of rum—of which molasses was the staple material—would be lessened or wholly prevented and a most important industry sacrificed. The fisheries would incidentally suffer. In spite, however, of the opposition which it provoked in the northern Colonies, it is probable that the Sugar Act could have

been permanently enforced The Act of Trade of 1673 and the Molasses Act—though it was not fully executed—were two early instances of the exercise by Parliament of the right to tax the colonies Had the Sugar Act been enforced, a clear and decisive precedent in favour of this right would have been established. In view of the general situation, that was probably as far as the British Government should have gone at that time But it immediately committed itself to another and still more significant measure, and the two acts combined caused an outburst of protest and resistance from the colonists

The Stamp Act.—Repeatedly in earlier years the imposition of a stamp duty upon the Colonies had been suggested. The cost of the regular troops which must be stationed in America was estimated at about £300,000 annually The Sugar Act was expected to yield about £45,000 a year It was thought that the colonies should raise about £100,000 more as their reasonable share of the cost. George Grenville resolved to secure this by means of a stamp duty. This would fall upon the island colonies equally with those of the continent, though it would be expended chiefly for the enlarged military force on the mainland. Though its simplicity and ease of collection recommended it, the Stamp Act was a purely fiscal measure, and its character was not concealed by any features which allied it to the earlier acts for the regulation of trade. It was passed by Parliament in 1765, almost without debate and with scarcely a thought that it would be resisted It provided for the appointment of officials to distribute the stamped papers in the colonies and further extended the power of the admiralty courts by giving them jurisdiction over violations of this act. The legal theory upon which the act was based was that of the unqualified sovereignty of Parliament as the representative body for the whole empire, and that its authority, if it chose to use it, was as effective for purposes of taxation as for the regulation of trade or other objects of legislation. But never before, during the century and a half of colonial history, had the taxing power been so unqualifiedly exercised It followed close on the heels of the Sugar Act, which itself had aroused much hostile criticism. The two measures also came at a time when the consciousness of strength among the Colonists had been increased by the defeat and expulsion of the French. Moreover, at the time when the policy was initiated, George III. had undertaken to crush the Whig party and to revive the latent prerogatives of his office. This resulted in the formation of a series of coalition ministries. Vacillation and uncertainty were thus introduced into the colonial policy of the Government The royal policy also brought into the public service in England and kept there an unusually large group of inferior men who persistently blundered in the treatment of colonial questions. It was only with the accession of the North ministry, in 1770, that permanence and a certain consistency were secured. But, in the view of the colonists, the prestige of the Government had by that time been seriously lowered

Resistance to the Stamp Act.—Determined opposition to the Stamp Act was shown in all the Colonies, by or before the time (Nov. 1) when it was to go into effect. The forms assumed by this opposition were such as characterized the entire controversy with Great Britain until the opening of hostilities in 1775 It consisted in the passage of resolutions of protest by the lower houses of some of the colonial legislatures; in the calling of a congress at New York which was attended by delegates from nine of the Colonies; in the activity of mobs organized under the name of the "Sons of Liberty"; and, finally, in a somewhat widely extended movement against the importation of British, or even foreign, goods and in favour of frugality and the encouragement of home manufactures. The newspaper press also sprang into much greater activity than ever before, and many notable pamphlets were published. The most important resolutions at the outset were those adopted by the Virginia House of Burgesses and by the House of Representatives of Massachusetts. Through the first-named body the dramatic eloquence of Patrick Henry forced five resolutions. Two others, which threatened resistance and the coercion of any who should venture to uphold the home Government, failed to pass, but the whole seven were published broadcast through the Colonies. The calling of a general congress was proposed by the House of Representatives of Massachusetts. Prominent among its members was James Otis, who had already distinguished himself by radical opposition to measures of the Government, especially in the case against writs of assistance which was argued before the superior court in 1761. Samuel Adams, already a prominent man, was now elected a member of the House from Boston. He almost immediately became its leader, drafting its most important resolutions and papers, and to a large extent directing its policy. With the aid of others he was able greatly to increase the activity of the town-meeting in Boston, and in the course of a few years to develop it on occasion into a great popular convention Throughout New England the town and its institutions served well the purposes of opposition and facilitated its extension over large areas. The intense Puritan spirit, with its century and a half of pronounced independence, both in polity and temper, was lacking outside New England, though on the frontiers of the provinces from Pennsylvania southward was a Scottish-Irish population which exhibited many of the New England characteristics But the tenant farmers of New York, the German pietist sects of Pennsylvania, the Quakers wherever they had settled, and in general the adherents of the English Church were inclined toward indifference or, as the controversy progressed, toward positive loyalism Hence the mixture of nationalities in the middle colonies greatly increased the difficulty of rousing that section to concerted action In Pennsylvania the issues were obscured by a struggle on the part of the western counties to secure equal representation with those of the east. This helped to make loyalists of the Quakers Special grievances also produced among the frontier settlements of North and South Carolina quite as much dislike of the officials and social leaders of the tide-water region as they could possibly feel toward Crown and Parliament. Throughout the struggle New England and Virginia exhibited a unity and decision in action which were not equalled elsewhere

Increased Opposition.—But to return to the Stamp Act. Before the meeting of the congress at New York outbreaks of mob violence in Boston had forced the stamp distributor there to resign, and had wrecked the house of Thomas Hutchinson, the chief justice. Owing largely to the indecision of the elective council, the Government had proved powerless to check the disorder. The resolutions passed by the Congress, as well as its petitions to the home Government, gave authoritative form to the claims of the colonial opposition in general, though the body which issued them, like all the congresses which followed until 1776, was extra-legal. In these utterances, as later, the colonists sought to draw their arguments from British precedents and their own history. The two British rights which, it was claimed, were violated by the Stamp Act were the right to trial by jury and the right to be taxed only by an assembly in which they were represented. The first grievance was simply an incident of the second, and was occasioned by the extension of the jurisdiction of the admiralty courts. The tax was a direct grievance. For purposes of legislation like this these bodies denied that Parliament was representative of the whole empire. For purposes of taxation, their assemblies, they affirmed, were the only representative bodies they had known. Therefore, ignoring the earlier and tentative measures by which Parliament had actually taxed the Colonies, and falling back upon the sweeping declarations of their assemblies, they denied the right of Parliament to tax them. They declared that the recent policy of Parliament was wholly an innovation and insisted upon a return to the constitution as it was before 1763. The doctrine of natural right and compact was also resorted to with increasing emphasis in New England utterances.

Repeal of the Stamp Act.—The decisive blows, however, were struck by the mobs in the Colonies and by the Government itself in England. As the time for the execution of the Stamp Act approached, more or less violent demonstrations occurred in New York and in many other localities. The stamp distributors were forced to resign. Everywhere in the original continental Colonies the use of stamped papers was prevented, except to a slight extent in Georgia. Business requiring the use of stamps was in part suspended, but far more generally it was carried on

without their use. Without the aid of the militia, which in no case was invoked, the colonial executives proved indisposed or powerless to enforce the act and it was effectively nullified. In England the petitions of the colonists produced little effect. There the decisive events were the accession of the Rockingham ministry to power and the clamours of the merchants which were caused by the decline in American trade. The serious lack of adjustment between British politics and colonial government is illustrated by the fact that, more than three months before the Stamp Act was to go into effect, the ministry whose measure it was resigned, and a cabinet which was indifferent, if not hostile, to it was installed in office. Preparations were soon made for its repeal. The slight extent to which relations with the Colonies had been defined is indicated by the fact that the debates over the repeal contain the first serious discussion in parliament of the constitution of the British empire. While the Colonies were practically united in their views a great variety of opinions was expressed in parliament. On the question of right Lord Mansfield affirmed the absolute supremacy of parliament in dominions, while Camden and Pitt drew the same sharp line of distinction between taxation and legislation upon which the colonists insisted, and denied the right of parliament to tax the Colonies. Motives of expediency, arising both from conditions in the colonies and in England, proved decisive, and in the spring of 1766 the Stamp Act was repealed, while its repeal was accompanied with the passage of a statute (The Declaratory Act) affirming the principle that Great Britain had the right to bind the Colonies in all cases whatsoever. This measure was received with joy in the Colonies, but the prestige of the home Government had received a severe blow, and the colonists were quick to resent further alleged encroachments.

Townshend Acts.—These soon came in the form of a colonial Mutiny Act and of the so-called Townshend Acts (1767). The Mutiny Act was intended largely to meet the needs of the troops stationed in the west and in the new Colonies, but it also affected the older Colonies where garrisons of regular soldiers existed. The act provided for a parliamentary requisition for barrack supplies, and partly because it included certain articles which were not required for the soldiers in Europe, the New York legislature at first refused to make the necessary appropriation. Partly through the influence of the governor it later came to think better of it and in a non-committal way appropriated the supplies required. But meantime in England the Pitt-Grafton ministry had come into office, in which the brilliant but reckless Charles Townshend was chancellor of the exchequer. Pitt himself was disabled by illness, and the ministry, lacking his control, steadily disintegrated. Townshend availed himself of this situation to spring upon his colleagues and upon Parliament a new measure for colonial taxation, and with it a bill legalizing writs of assistance and establishing a board of commissioners of the customs in America, and a third bill suspending the functions of the assembly of New York until it should comply with the terms of the Mutiny Act. These bills all became law. Before the last-mentioned one reached the colonies, the New York Assembly had complied, and therefore the necessity for executing this Act of Parliament was avoided. The establishment of a customs board at Boston did not, of itself, provoke much criticism. But the Act of Trade and Revenue, which provided for the collection in the Colonies of duties on glass, lead, painters' colours, paper and tea, and that out of the revenue raised therefrom salaries should be paid to the governors and judges in America, opened anew the controversy over taxation.

John Dickinson, in his *Letters of a Former* (1767–68), denied *in toto* the authority of Parliament to tax the Colonies, and his argument was widely accepted. Massachusetts petitioned the home Government, and in a circular letter conveyed its views to the other colonies and asked an expression of theirs in return. The activity of the customs officials at Boston in seizing John Hancock's sloop, "Liberty," occasioned rioting, which in turn was followed by the transfer of two regiments to Boston. Several vessels of war were also stationed in its harbour (autumn of 1768). Deprived of their assembly, the towns of Massachusetts chose deputies, who met in convention, but without important result. Favourable replies to its circular letter were, however, received from a majority of the Colonies. Resolutions against the new act were passed by many colonial assemblies, and in several cases petitions were sent to England. The King and ministers expressed the view that the Americans were opposed to all restrictions, and that in Massachusetts treason or misprision of treason had already been committed. In this they had the support of large majorities in Parliament. The statute of 35 Henry



BY COURTESY OF THE N.Y. HISTORICAL SOCIETY

THE BOSTON "MASSACRE," MARCH 5, 1770. AFTER AN ENGRAVING ATTRIBUTED TO PAUL REVERE (1735–1818), REVOLUTIONARY PATRIOT

VIII., for the punishment in England of such offences when committed outside the realm, was now revived, and the royal officials in Massachusetts were instructed to collect evidence against suspected popular leaders with a view to their deportation across sea for trial. Though sufficient evidence was not found, nothing could have been better calculated to increase the exasperation of the colonists than a threat of this kind. It drew from the Virginia burgesses strong addresses and resolutions of protest. Fear lest the English Church would induce the Government to establish a colonial episcopate caused much discussion at this time, especially in New England, and led to plans for joint action on the part of Dissenters, in self-defence. In the course of 1769 the policy of commercial non-intercourse was again revived, and resolutions in favour of its enforcement were passed by many local bodies. But it was found difficult to enforce these, and, as the Colonies were prosperous, trade, open and illicit, with Europe continued to be large. The British merchants did not clamour for relief, as they had done at the time of the Stamp Act, but gave loyal support to the policy of the Government. The King was also steadily gaining an ascendancy, which in 1770 was permanently established by the accession of Lord North to the premiership. Thus, on both sides of the ocean, parties were bracing themselves for a struggle, the one for and the other against the principle of the Declaratory Act. The question of revenue was now largely obscured by that of right and power.

The Tea Tax.—It cannot be said that the Townshend Revenue Act was nullified, for to a certain limited extent it was executed. But in 1770, on the specious plea that the duties were uncommercial because they were levied on British manufactures, all except the duty on tea—3d. per lb.—were repealed, and a drawback of one-fourth and later of three-fifths of this duty was granted on the re-exportation of tea to the Colonies. But the preamble of the act was retained, and with it the principle of taxation. For this reason opposition continued and non-importation agreements, especially against tea, were maintained. But after the collision which occurred between the troops and the people in Boston, in

March 1770, the soldiers were removed from that town and affairs became more quiet. For more than a year it seemed as if the controversy was wearing itself out and that the old relations would be restored. But the conduct of certain naval officers and small vessels of war which had been trying to suppress illegal trade in Narragansett bay led, in June 1772, to the destruction of the schooner "Gaspee." The inquiry which necessarily followed this, together with legislation for the protection of the royal dockyards, ships and supplies, again revealed the possibility that colonists might be removed to England for trial. About the same time provision was made for the payment by the home Government of the salaries of the governors and of the judges of the superior court of Massachusetts while those officials continued to hold at the pleasure of the Crown. These events occasioned a movement in Massachusetts and Virginia which led at once to the organization of committees of correspondence, and these ultimately extended far and wide throughout the Colonies. At the same time in England the East India Company appealed to Parliament for relief from the losses caused by the transfer of the American trade so largely to the Dutch, and in response the Tea Act was passed authorizing the company to import its teas into the Colonies and providing that the English duties should be wholly drawn back on exportation, and that no compensation need be made to the Government for consequent loss of revenue This, it was expected, would enable the company to out-compete the Dutch But popular uprisings prevented the reception or sale of the tea at any of the ports and culminated in the destruction (Dec 16, 1773) of 340 chests at Boston. As the King and the North ministry were now fully entrenched in power, coercion was at once resorted to and affairs were thus brought to a crisis.

The Quebec Act.—Those among the colonists who were intelligent enough to watch the course of events had long felt that they were being enveloped in a network of relations over which they had no control. This was a result of the development of the empire, with its world-wide interests. The Quebec Act, which was passed by Parliament near the close of the session of 1774, furnished a case in point. Owing to the failure of the Imperial Government to secure the revenue which it had hoped to collect under the Stamp Act and the later statutes, it had been forced to abandon its plans for the vigorous administration of Indian affairs and of the West. In view of these facts, it was thought wisest and cheapest to commit the immediate charge of the west to the province of Quebec, and therefore to extend its bounds southward to the Ohio. The Roman Catholic religion was recognised as legal within Quebec, and no provision was made for an assembly. Its extension also indicated a purpose to prevent the westward movement of population across the mountains, which was already beginning from the middle and southern Colonies

First Continental Congress.—But the acts of the session of 1774 which were of most immediate importance were those which directly affected Massachusetts, where lay the centre of disturbance. One of these closed the port of Boston, another substituted an appointed for an elected council in Massachusetts and took the selection of jurors out of the hands of the people, and a third made possible the removal from Massachusetts of the trials of persons indicted for capital offences committed in support of the Government into neighbouring Colonies or to Great Britain, where a fair hearing was considered possible. Gen. Thomas Gage, who had been commander-in-chief in America, was now appointed governor of Massachusetts, with authority to uphold the new acts with military force. As soon as knowledge of the fate impending over Boston reached the other Colonies, conventions, local and provincial, were held, and the plan of a general congress, as proposed by Massachusetts and Virginia, was adopted. Delegates were chosen from all the Colonies except Georgia, though that province fell into line when the second Congress met. The members were instructed to the general effect that they should consult together and adopt such measures as were best calculated to secure the just rights of the colonists Voting by Colonies, but occasionally listening to utterances which implied that Americans were now thrown into a single mass, this body sent addresses to the King, to the people of the Colonies, of Quebec and of Great Britain, and prepared a declaration of rights. It is a significant fact that no address was sent to either of the Houses of Parliament. In its statement of rights the Congress (known as the First Continental Congress) limited itself to those which it believed had been infringed since 1763. These acts they described as innovations, and claimed themselves to be the true conservatives who only desired peace on the basis of the former constitution. The opposition which Massachusetts was making to the recent Acts of Parliament was approved, and the view was expressed that, if an attempt were made to execute them by force, all America should support Massachusetts Though the work of this Congress was deliberative, it performed one positive act which contained the germ out of which new governments were to develop. That was the issue of the Association, or non-importation and non-exportation agreement, accompanied with resolutions for the encouragement of agriculture and home manufactures and for the organization of committees to carry these measures into effect. Coercion, according to the principle of the boycott, was to be applied by the Colonies and other local bodies to all who declined to accept and obey the terms of the Association. This policy had been followed at intervals since the time of the Stamp Act. It had been revived by many local and provincial bodies for the past few months. The Association became the touchstone by which loyalty to the Colonies, or to the King, was determined. Those whose loyalty to the King forbade their submission to the new regulations now felt the power of committees, even to the extent of virtual trial, imprisonment or banishment. From this action the First Continental Congress derived its chief significance.

Increase of Friction.—The Association, with its threats and dependence upon extra-legal bodies for enforcement, was a direct blow at the commercial system of the empire and could scarcely help provoking retaliation When the Congress adjourned, some of its members predicted war. In New England the impression that war was inevitable was widespread. In Massachusetts a provincial congress was at once organized, which assumed the reins of government and began to prepare for defence A committee of safety was chosen to carry on the work during recesses of the Congress. Thomas Gage, the governor, began fortifying Boston, while he looked about for opportunities to seize military stores which the colonists were accumulating. The raising of voluntary militia companies was soon begun in Virginia. In South Carolina, as earlier in Boston and New York, a quantity of tea was now actually destroyed, and a general committee assumed practical control of the province. From New York city and Philadelphia, as centres, the process of revolutionizing the two most conservative provinces was carried on. When Parliament met, at the close of 1774, the King and ministers declared that a most daring spirit of resistance existed in Massachusetts, which was countenanced by the other Colonies, where unlawful combinations against the trade of Great Britain were already widely extended. In these opinions the Government had the support of the majority in the two Houses, and in a joint address the rebellion in Massachusetts was declared to be a fact. As a conciliatory measure Chatham proposed that Parliament agree by resolution not to levy any tax upon the Colonies, but that the Continental Congress be required to make a free grant of a perpetual revenue which should be fully at the disposition of Parliament, the Congress fixing the quota which should be paid by each province. But the imperialist and mercantilist ideas of Chatham were expressed in the further provisions that the system of trade and navigation should not be changed and that the Army might be lawfully kept in any part of the dominions, though it should never be used to violate the just rights of the people. Edmund Burke, in his great speech on conciliation, advocated a return to the system of requisitions and did not consider a representation of the colonists in Parliament as a possibility. But these motions were rejected, and a resolution introduced by Lord North was passed. This contained no recognition of extra-legal bodies, but provided that when the assembly of any Colony should engage to support civil government within the Colony and contribute according to its ability to the common defence, the King and Parliament would then forbear to levy any more taxes on that province except what

were necessary for the regulation of trade The Colonies, with the exception of New York, North Carolina and Georgia, were excluded from the fisheries, as a counterstroke to the Association North's resolution proved futile, and the two parties drifted steadily toward war, though the British Government in its military estimates made no adequate provision for meeting the crisis

Lexington and Concord.—On April 19, 1775, hostilities began in Massachusetts. A force was sent overland to Concord, 20m from Boston, to seize or destroy the military stores which the colonists had brought together at that village The minutemen were warned to oppose the approaching force, and at Lexington, a village situated on the road to Concord, occurred a skirmish in which the first blood of the American War of Independence was shed. The troops marched on to Concord and destroyed such of the stores as had not been removed or concealed. On their return march they were pursued by a galling fire from behind fences and buildings, and had it not been for the arrival of a relieving force the command would have been destroyed before it reached the protection of the British vessels of war at Boston. The "Lexington alarm" brought in throngs of militiamen from all parts of New England Officers were appointed by the provincial congress of Massachusetts and by similar bodies in the other Colonies, and immediately the so-called siege of Boston began. Cannon, as well as every other form of military equipment, were now in great demand. In order to secure supplies and at the same time strike a telling blow at British authority in the north, Ticonderoga was surprised and taken on May 10. Men from Connecticut, Massachusetts, and the New Hampshire Grants (later Vermont) co-operated in this enterprise. It was soon followed by a dash into Canada, by steps which involved New York in the affair, and by the organization of a military force under Gen Philip Schuyler for permanent service on the northern frontier. Meantime reinforcements reached Boston, led by Howe, Clinton and Burgoyne, and it was resolved to extend the British lines by occupying the heights of Dorchester on the south and those of Charlestown on the north.

Bunker Hill.—The Americans, hearing of this, seized Breed's Hill, overlooking Charlestown, where they hastily threw up a redoubt on the night of June 16. The British might easily have entrapped them, but instead on the next day the American position was assaulted on the left and carried, though with much difficulty and after a loss to the assailants of more than 1,000 men. Such was the battle of Bunker Hill, one of the most dramatic encounters in the war. In connection with all these events the Americans claimed to be acting on the defensive. But it was not difficult to perceive that, especially in New England, this claim only imperfectly concealed an intensely aggressive spirit.

Second Continental Congress.—The news of the outbreak of hostilities aroused strong feeling throughout the Colonies. The Second Continental Congress met under its influence. Its members, however, had been chosen and instructed before the clash of arms, and for that reason the course which had been worked out for them differed only slightly, if at all, from that which had been followed by their predecessors. To a certain extent the new body adhered to the former course of action. But a state of war now existed in New England and on the Canadian border. Troops were expected soon to arrive at New York Reports of these events were thrust upon the attention of Congress at once, and the provinces involved asked for advice as to what course they should pursue As a result of these events in the Colonies generally, the Association was being changed from a system of co-operation against British trade into a union for purposes of defence This new situation the Congress was forced to meet. This it did largely by resolutions of advice to the Colonies, but also by positive orders. Of the former class were the resolutions about the procuring of military supplies, the assumption of powers of government by the various Colonies, and concerning defence at New York city, on the northern frontier and, later, in the highlands of the Hudson. Of a more decisive character was the appointment of officers for the army, George Washington being made commander-in-chief, the prescribing of their pay, the issue of continental bills of credit, the issue of articles of war, the regulation of trade and of Indian affairs, and the establishment of postal communication As the revolutionary movement progressed through 1775 and the early months of 1776, executive authority in the royal and proprietary provinces collapsed The assemblies were either dissolved or ceased to meet. The governors, their authority gone, retired on board British vessels of war, returned to England or, perchance, found themselves prisoners. This gradual fall of the old governments, imperial and colonial, was the revolution on its negative side. The rise of the system of congresses, conventions and committees, deriving their authority from the people, was the revolution on its positive side, and foreshadowed the new federal system which was rising on the ruins of the half-federated empire.

Collapse of the Royal Governments.—In Connecticut and Rhode Island the corporate system of government, which they had inherited from the 17th century, necessitated no change. The general assemblies always had been the centres of power, and the leading officials were elective for short terms and were subject to the control of the electorate So far as the internal organization of the Colonies was concerned that was all which the revolution demanded In the two proprietary provinces—Pennsylvania and Maryland—the executives were not so directly interested and pledged to support the Imperial Government as were those of the royal provinces. But Governor Robert Eden of Maryland was so tactful that, though the last assembly met in 1774, he was able, with the courts, to keep up some form of government there in the name of the Crown and proprietor until the early summer of 1776. In Pennsylvania the proprietors, though in sympathy with the British Government, never sought actively to influence events in their province. In the royal provinces the prorogation of the legislatures for indefinite or prolonged periods caused them early to disappear—that of Massachusetts in October, 1774 The burgesses of Virginia last met for business in May, 1774 They were prorogued to several later dates, but the governor was never again able to meet them The long and important session of January–March, 1775, was the last ever held by the New York assembly. In April, 1775, Governor John Martin of North Carolina met the assembly for the last time, and even then the provincial convention was in session at the same time and place and the membership of the two bodies was the same In May, 1775, disappeared the assembly of Georgia; in June those of New Hampshire and South Carolina met for the last time. Governor William Franklin was able to meet the assembly of New Jersey as late as November, but months before that date the provincial convention had practically assumed the control of affairs.

Washington in Command.—After Bunker Hill the command at Boston had been transferred from Gage to Sir William Howe. In July, Washington took command of the colonists and gradually established some degree of order and discipline among them. Though the American levies were raw and ever fluctuating in numbers, the British never seriously attempted to break through their lines. Indeed, it was not the plan of the British to make New England the chief seat of war. As early as Aug. 2, 1775, Lord Dartmouth wrote to General Gage on "the obvious advantages that would attend the taking Possession of New York and the hazard of the Army's continuing at Boston." Rhode Island was considered as a convenient naval station, and steps were soon taken to secure possession of it and its surrounding waters The British wished to so plan the war as to secure the maximum of advantage from their fleet. This would give them an easy command of the entire coast, and enable them to secure a foothold at strategic centres. Hence it was that, though the arrival of a fresh supply of cannon enabled Washington to fortify Dorchester Heights, this simply enabled him to hasten a process for which Howe had long been preparing. The evacuation occurred on March 17, 1776, and the British force withdrew temporarily to Halifax. Meantime the bold expeditions of Arnold and Montgomery against Canada had met with only a partial success. Montreal had been occupied, but the assault upon Quebec had failed.

The view, as it was now repeatedly expressed by King and Parliament, was that the colonists were in open rebellion. North's offer of conciliation was peremptorily rejected by Congress. The acts of Parliament were being openly resisted, and Congress in its

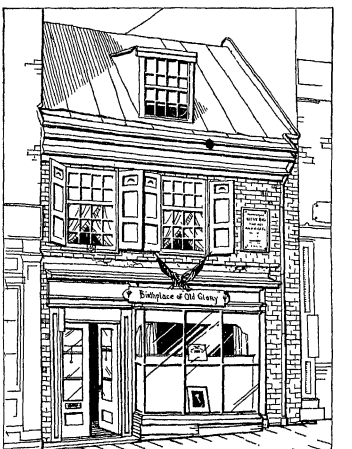
manifestos had ignored the two houses. Therefore the British Government stood committed to coercion. That was the meaning of the legislation of the winter of 1776—the prohibition of trade with the rebellious Colonies, the increase of the estimates for the Army and Navy, the employment of German auxiliaries for service in America. Preparations were made to send a large military and naval force the following season, which should operate in part against the insurgents in New York and the southern Colonies and in part through Canada. New England was no longer to be the direct object of attack. The Howes, as commanders of the royal Army and Navy, were appointed commissioners to grant assurance of peace and pardon and the repeal of the obnoxious acts, provided submission was made and some way could be found by Parliament in which an imperial revenue for purposes of defence could be secured from the Colonies. Military operations, meanwhile, should be directed against points of least resistance, and in that way, if possible, the union of the Colonies should be broken. The trend of British policy indicated that an invasion from Canada might be attempted and an effort made to hold Charleston, Philadelphia, and especially New York as strategic points on the coast.

The course of events in the Colonies by which this situation was met was the erection of a system of feeble defences about New York and the removal thither of the Army of about 9,000 men in the spring of 1776; the fitting out of privateers to prey on British commerce; the disarming of loyalists; the opening of American ports to the trade of all peoples who were not subject to the British Crown; and the tentative opening of relations with France. As the result of a combination of ill luck, bad management and American energy the British suffered a repulse at Charleston, South Carolina, in June, which was analogous to the affair of the year before at Bunker Hill, and which necessitated a postponement of their plans in the south.

The Congress and the various revolutionary bodies in the Colonies were forced to carry on war upon a constantly increasing scale. They had to assume powers of government and gradually to perfect their organization for the purpose. Committees in Congress became more permanent. Conditions approximating to those which existed the year before in New England extended through the Colonies generally.

The Declaration of Independence.—On May 15, 1776, as the result of various earlier applications and especially of one from certain Whigs in New York, the Congress recommended to the assemblies and conventions of the Colonies where no Government sufficient to the exigencies of their affairs had been established, "to adopt such government as shall, in the opinion of the representatives of the people, best conduce to the happiness of their constituents in particular and of America in general." The preamble to this resolution set forth as facts the statements that the Colonies had been excluded from the protection of the Crown, that no answer had been given to their petitions for redress, and that the whole force of the kingdom was to be used for their destruction, and therefore that it was no longer reasonable or honest for the colonists to take the oaths or affirmations necessary for the support of Government under the Crown. Though the preamble was warmly debated, it was adopted. And this act marked a turning-point, for the progress of events from that time to the Declaration of Independence was rapid and decisive. The Colonies—now becoming States—one after another, in response to letters from Philadelphia, empowered their delegates to concur in declaring independence. On June 7, R. H. Lee of Virginia introduced in Congress a resolution "that these United Colonies are and of right ought to be free and independent states," that it was expedient forthwith to take effectual measures for securing foreign allies, and that a plan of confederation should be formed. The debate showed that the delegates from the middle colonies and South Carolina could not act, and the decision was postponed for three weeks. In the interval steps were taken to draft a plan of treaties and articles of confederation. A board of war and ordnance, the earliest germ of an executive department, was also created by Congress.

At the end of the three weeks the delegates from all the Colonies except Georgia, South Carolina and New York had received instructions favourable to independence. The two former left their delegates free, and under the influence of the British attack on Charlestown they voted for independence. News had just come that Howe had landed with a large force at Sandy Hook. Under the impression of these stirring events the Declaration, substantially in the form given to it by Thomas Jefferson, was agreed to (July 4, 1776), only three adverse votes being cast. The delegates from New York took no part, but a few days later the act was approved by the convention of that State. The signing of the document by



HOME OF BETSY ROSS, LEGENDARY MAKER OF FIRST AMERICAN FLAG
The little house on Arch Street, Philadelphia, where Mrs. Ross lived at the time she is said to have made the first American flag (1777), was converted into public property by the Betsy Ross Memorial Association in 1905 and has since been known as the American Flag House

the members took place at a later time. Thus triumphed the tendencies toward self-government which had been predominant in the continental Colonies from the first, and which the system of imperial control had only superficially modified and restrained. But the most significant part of the document for the future was the preamble, in which the democratic aspirations of the new nation were set forth, the spirit to which Thomas Paine had just made so powerful an appeal in his *Common Sense*. Governments, it was said, derive their just powers from the consent of the governed, and when any system becomes destructive of these ends it is the right of the people to abolish it and to institute a new Government, establishing it upon such principles and under such forms as seem most likely to effect their safety and happiness. (*See* DECLARATION OF INDEPENDENCE.)

Weakness of the General Government.—Viewed from one standpoint, the Declaration of Independence was apparently an act of the utmost recklessness. The people were by no means a unit in its support, and in several of the States widespread indifference to it, or active sympathy with the British, prevailed. The United States, as yet, had no international status, and it would seem that that must be secured, if at all, by a series of victories which would ensure independence. But how could these be won against the greatest naval power on the globe, supported

by veteran armies of continental and British troops? The Colonies had no money; the few vessels which, as a collective body, they did send out, were more like privateers than anything else Their Army was an undisciplined throng of militiamen, serving on short enlistments, without organized commissariat, and for the most part under inexperienced officers. Its numbers, too, were far inferior to those of the British Taxation by the Continental Congress for the support of the war was not among the possibilities of the case. A strong tendency toward the provision for immediate needs by the issue of bills of credit had been inherited from the period of the French wars, and that device was again resorted to. The battle of Bunker Hill had been immediately followed by an order of Congress for the issue of $2,000,000 in that form of currency. Issues followed in rapidly increasing amounts, until by the close of 1779 $241,000,000 had been authorized. The States put out nearly as much ($209,000,000) The continental paper money depreciated until it became worthless, as to a large extent did that of the States also The States decreed it to be legal tender, and dire threats were uttered against those who refused to receive the bills; but all to no purpose. The Congress also tried to induce the States to tax themselves for the general cause and was forced to rely on requisitions for the purpose. These measures proved as complete a failure as when resorted to by the Crown. The revolution was therefore never financed. It early became necessary to resort to loans and that chiefly from foreign sources It was therefore an absolute necessity that the Colonies should secure international recognition and status Then loans were obtained from the Government of France and Spain and from private bankers in Holland to the amount of about $7,830,000

The collapse of royal Government left the Colonies in a chaotic state. The old institutions had disappeared and new ones could not be immediately developed to take their place. But the institutions of local Government, the town and county systems, were left intact, and upon these as a basis the new fabrics were erected. It was therefore easier to construct the Governments of the States than to define and develop the general Government. At first little else was intended than that the Congress should be the mouthpiece of the patriot party. It proceeded mainly by way of recommendation, and looked to the States, rather than to itself, as the ultimate sources of authority. Upon them it depended for the execution of its measures. As the war proceeded the States grew jealous of the central body and tried to prevent appeals to it from the State courts in prize cases. Under the pressure of war, moreover, the enthusiasm, which had been strong at the outset, declined, and it became increasingly difficult to secure co-operation or sacrifice toward any general enterprise.

Difficulty of Congress.—At the same time, war devolved upon Congress an enormous burden of work. It was forced to devise general policies and provide for their execution, and also to attend to an infinite number of administrative details. Most of the able members were drawn off into the Army, into diplomatic service or official service in the States. Sectional and State jealousies also developed and became intense. As the Congress voted by States the smaller commonwealths were often moved by jealousy of their larger rivals to thwart important measures. But, above all, the conduct of the war and foreign relations occasioned infinite jealousies and cabals, while many of the most important measures seemed to meet with downright indifference. Washington's correspondence abounds in evidence of these facts, while it is well known that he was the object against whom one of the cabals of the time was directed. Benjamin Franklin was the object of somewhat similar jealousies. But, as time passed, rudimentary executive departments, beginning with the board of war and the postmaster general, were developed, and some advance was made toward a working and permanent system. In 1781 the offices of foreign secretary, superintendent of finance, secretary of war and secretary of marine were created.

Military Disasters.—Until almost its very close the campaign of 1776 was a disheartening failure The battle of Long Island was lost by the Americans and, as at Bunker Hill, it would have been quite possible for the British to have captured the entire force which opposed them on Long Island. Howe compelled Washington to evacuate New York city. On Nov. 16 the practical abandonment of the State of New York by the main army was necessitated by the capture of Ft Washington. Earlier in the year the Americans had been compelled to retire from Canada, while the Tories in northern New York were contributing valuable aid to the British

The Tide Turns.—But there was another side to the picture, and already certain faint outlines of it were being discerned The British commander was, at practically every step failing to seize the advantages that were within his reach, while Washington was learning to play a losing game with consummate patience and tact. After Washington had crossed the Delaware, Howe, instead of seizing Philadelphia and driving Congress and the American Army to some remote places of refuge, as he might have done, prepared for winter quarters. Washington seized the opportunity to return across the Delaware and surprise the British outposts at Trenton (Dec. 26, 1776) and Princeton (Jan 3, 1777), and thus secured a safe post of observation for the winter at Morristown Confidence was to an extent restored, the larger part of New Jersey was regained, and many loyalists were compelled to take the oath of allegiance. Howe's plan for the next campaign involved the strengthening of his army by large reinforcements. With this force he proposed to capture Philadelphia and thereby to bring the War of Independence to an end in Pennsylvania, New Jersey and New York New England and the states farther south could then be dealt with in detail. But Howe was overruled by Lord George Germain, the colonial secretary, whose plan included an invasion from Canada, in which Tories and Indians should share, while Howe should advance up the Hudson and meet the northern forces at Albany. If this ambitious scheme should succeed, the British would occupy the valley of the Hudson and New England would be cut off from the rest of the colonies. Gen. Burgoyne was appointed to command the northern expedition. But the failure of the plan was almost ensured from the outset by the neglect on the part of British officials to instruct Gen Howe as to his part in its execution. Burgoyne was forced to surrender near Saratoga on Oct. 17. Meanwhile, Howe, who had long waited for instructions respecting the northern expedition, was finally informed that he might undertake the Pennsylvania campaign, but with the hope that at its close he would still be able to march up the Hudson. Thereupon, embarking his army, Howe sailed for Chesapeake Bay, at the head of which he landed and advanced towards Philadelphia. Washington's army opposed his march at the Brandywine (Chad's Ford), but was defeated (Sept. 11, 1777) and forced to retire beyond Philadelphia. The British then entered the city (Sept. 26) and the Congress withdrew to Lancaster, and later to York, in the interior of Pennsylvania. The British fleet had in the meantime arrived in Delaware Bay, and, after a prolonged and brave defence, had captured Forts Mercer and Mifflin. When winter began the Delaware, as well as lower New York and Rhode Island, was in the possession of the British. With the fragments of an army Washington retired to Valley Forge.

French Alliance.—But the influence of Burgoyne's surrender in Europe was to prove a turning-point in the war. Since 1763 a strong sentiment at the French court had been favourable to a resumption of war with Great Britain. An opportunity was now presented by the colonial revolt. In February 1776 Silas Deane was sent to Paris, ostensibly as a business agent, and with the connivance of the French Government supplies were sent to America and American vessels were received into French ports. Soon American privateers were bringing their prizes into French harbours, and British commerce began to suffer from these attacks. On the French side Beaumarchais and others actively co-operated in this. In the autumn of 1776 Congress appointed three commissioners to France, and resolved that Spain, Prussia, Austria and other European States should be approached with a view to securing recognition and aid. In December 1776 Franklin, who, with Deane and Arthur Lee, had been appointed commissioner to France, arrived at Paris, bringing with him proposals for treaties of commerce and alliance. But, though the attitude of the French court toward the Americans was friendly,

and though it continued to send secret aid, and to exert a favourable influence upon Spain, yet it could not be induced to abandon its outward appearance of neutrality until after the news of Burgoyne's surrender arrived Then the real purpose of the French Government was revealed. On Feb. 6, 1778, the treaties were signed, and in the following summer war between France and England began. The influence of France under the Family Compact, brought Spain into the alliance in April 1779. In October 1779 Henry Laurens was elected minister to the Netherlands, and sailed for Europe, taking with him a plan of a commercial treaty But Laurens and his papers were captured by the British at sea, and partly by that event the Netherlands were forced into war with England. With the other States of northern Europe they undertook to defend the interests of neutrals against the arrogant enforcement by Great Britain of the rights of search at sea. Thus the conflict expanded into a commercial and naval war, Great Britain being confronted by the larger part of Europe

Philadelphia Recaptured.—The conclusion of the treaty of alliance by France was immediately followed by the equipment of a fleet under the comte d'Estaing, which sailed from Toulon in April 1778. Sir Henry Clinton had now succeeded Howe in command of the British army. The certainty that a French fleet would soon appear in American waters made it necessary for the British to evacuate Philadelphia and return to a point on the coast where the army could be in easy communication with the fleet. This fact shows how the French alliance had changed the nature of the war. It now became to a large extent a contest between the two navies, the principal evolutions of which occurred in West Indian and European seas. In the north the British now relatively neglected the land war, and refrained from sending such forces to the eastern coast as had supported Howe in 1776. The Americans, on the other hand, had a naval force upon which they relied, in the hope that the blockade of their coasts might be raised and trade routes opened more freely. On the evacuation of Philadelphia in June Washington's army pursued the British as they retired toward New York, and the indecisive battle of Monmouth was fought on June 28. It did not prevent Clinton from reaching New York, and that city continued to be the centre of British power and operations in the north until the close of the war The Congress returned to Philadelphia. Washington's army came gradually to occupy a line of forts, of which West Point in the highlands of the Hudson was the citadel From there as a centre it was possible to communicate with Newport on the east and with the Delaware region on the south, and at the same time to prevent the British from gaining access to the interior of the country. Though the fleet of D'Estaing carried a heavier equipment of cannon than did that of Admiral Howe, the French commander did not choose to risk an attack on New York, but passed eastward to Newport. Howe followed him, while Washington and his generals planned active co-operation with the new allies by land. But a sudden storm so dispersed and injured the fleets that the French admiral retired to Boston for repairs and later sailed for the West Indies.

State Constitutions.—While the war and foreign relations were thus developing, the States were organising their governments and Congress was beginning to consider articles of confederation between the States. In this way an effort was made to gather up and make permanent the positive results of the revolution. As under the chartered and royal governments of the colonial period the source of political authority had been the Crown, now by a necessary reaction this was sought in the people. This principle had been stated in the Declaration of Independence, and had been implied throughout the earlier controversy. The Colonies had insisted on a more precise definition of the powers of government; they had opposed Parliament because its powers were undefined and therefore dangerous Following these ideas, the States now described their institutions of government and defined their powers by means of written constitutions. These were formulated by the provincial congresses—which had now become the legislatures—or, as they came to insist upon a more specific expression of the popular will, by conventions chosen for the purpose by the electors. Connecticut and Rhode Island retained their colonial charters In the earlier days of hasty and temporary devices, the constitutions, like statutes, had been promulgated by the legislatures which formed them and had been put into force by their authority alone But as time passed and more permanent arrangements became necessary an express popular approval of the instruments was obtained before they were put into force The establishment of State governments in this way began before the issue of the Declaration of Independence It was actively continued during 1776 and the early months of the following year, by which time all of the States had secured at least a temporary constitution. Of the constitutions of the revolutionary period the two most striking features were the bills of rights and the provisions which were made concerning the executives and their relations to the legislatures. The men of that generation were jealous of government. They insisted upon individual rights, not as acquired and guaranteed by the State, but as original, natural and inhering in time prior to all governments. Governments were instituted for the common benefit, protection and security. Officials were trustees and were accountable to the people. There should be no hereditary title to office or power. There should be no titles of nobility, and in Virginia the system of entails was swept away. Monopolies were declared to be inconsistent with the spirit of a free State Freedom of the press and of conscience was asserted, and no obstacles to fair and speedy jury trials were to be tolerated. Elections should be free and frequent, and a preference was expressed for short terms of office. The legislature was universally regarded as the most important department of government. Although the principle of the separation of powers was recognized, in eight States provision was made that the executives should be elected by the legislatures, 11 withheld from them the veto, and the States generally provided for a council to advise them So manifold and important, however, were the restrictions on suffrage that the States were as yet far from being democracies.

The Articles of Confederation.—The first draft of the Articles of Confederation between the States was prepared by John Dickinson in the early summer of 1776 and was reported. Owing to the pressure of war it was then laid aside until the autumn of 1777. By that time the feeling in favour of State sovereignty had so increased that the impossibility of securing assent to the articles in any form had begun to be feared. But the document was completed and submitted to the States in November 1777, when all were encouraged by the news of Burgoyne's surrender. The system for which provision was made in this document was a "confederacy," or "firm league of friendship" between the States The Congress was to be continued, and was to consist of delegates annually appointed by the legislature of each State and paid by their States. No attempt was made to create an executive for the confederacy, though authority was given to Congress to appoint a council of State which should manage general affairs, especially during recesses of Congress. To Congress various general powers were entrusted, as deciding on peace and war and superintending the conduct of the same, building a navy, controlling diplomatic relations, coining money and emitting bills of credit, establishing post offices, regulating Indian trade, adjusting boundary disputes between the States. The financial powers entrusted to Congress included those of borrowing money and determining necessary expenditures, but not the power to tax. For supplies the general government had to depend on requisitions from the States. The same system also had to suffice for the raising and equipment of troops. Congress could not make its laws or orders effective in any matter of importance. This was simply a continuation of the policy under which the revolution was being conducted The control of trade was practically left with the States, the Americans in this matter failing to live up to the requirements of the British system The predominance of the States was further ensured by the provision that no votes, except those for daily adjournment, could be carried without the assent of a majority of all the States, and no important measure without the consent of nine States. But a common citizenship was declared to exist, and Congress received authority to establish a court of appeal which might pass finally

on all disputes between States. Taken as a whole, the Articles of Confederation would bear favourable comparison with other schemes of their kind, and they fairly represented the stage of development to which the American States had then attained.

The West.—We have seen that, on the whole, the attitude of Great Britain, after the peace of 1763, was not favourable to the colonization of the Mississippi valley. To the colonists the Quebec Act gained in offensiveness by seeming to imply that it was intended to exclude them from the West. But all such plans were swept away by the outbreak of the War of Independence. Already, before the beginning of hostilities, emigrants had begun to flock across the mountains. Plans were on foot for the establishment of a number of commonwealths, or proprietary provinces, as the case might be. Daniel Boone and his associates pushed farther west into the Kentucky region, and there it was proposed to establish the commonwealth of Transylvania. Other similar projects were started, all repeating in one form or another the political methods which were used when the seaboard colonies were first settled. The backwoodsmen who managed these enterprises were extreme individualists, believed in the propriety of resistance to governments, and were in full sympathy with the War of Independence. The States which had claims in the West opposed the founding of independent settlements there and, if possible, induced the settlers to be content with the status of counties within some one of the eastern States. After the beginning of the War of Independence, the British from Detroit incited Indian raids for the purpose of destroying or driving out the settlers, especially in Kentucky. These provoked the important expeditions of George Rogers Clark in 1778 and 1779. With a force of Virginians he seized Kaskaskia and later, after a long march, captured Vincennes and compelled General Henry Hamilton, who had come with a relief force from Detroit, to surrender. This secured to the Americans a permanent hold upon the north-west. But Spain, after she entered upon the war, was determined, if possible, to wrest the valley of the Mississippi from the British and to keep all, or the larger part of it, for herself. To that end, operating from New Orleans, her troops took possession of Natchez, and other posts on the lower Mississippi, and occupied Mobile and Pensacola.

Articles of Confederation Ratified.—Within the Confederacy a fundamental line of cleavage was that between the large and small States. It was jealousy on the part of the small ones, their fear lest they might be absorbed by their larger neighbours, which had necessitated the adoption of the plan that in the Congress the delegates should vote by States. When the articles were referred to the States for ratification, the difficulty reappeared. Massachusetts, Connecticut and New York, with Virginia and the three States to the south of it, had large claims to territory between the Appalachians and the Mississippi. New Hampshire, Rhode Island, New Jersey, Delaware and Maryland, which were without hope of westward extension, hesitated to enter the Confederacy, if the large States were to be still further increased by additions to their areas of vast stretches of western country. They insisted that before ratification the States which had claims to western lands should surrender these for the common benefit of the United States. Maryland insisted upon this until, in the end, the cause of State equality and of nationality triumphed. Congress declared that the ceded lands should be formed into States, which should become members of the union with the same rights as other States. When in 1781 the course of action had become possible, Maryland ratified the articles and they came into effect.

War in the South.—So far as the north American continent was concerned, the character of the last stage of the struggle with Great Britain was determined by the fact that the British resolved to transfer the main seat of war to the southern States, in the hope that Georgia and South Carolina might be detached from the union. At the close of 1778 Savannah was captured. In September 1779 D'Estaing returned and assaulted Savannah, but, failing to capture it, sailed for France. In 1780 Clinton sailed from New York, besieged Charleston with a force much superior to that of Lincoln, and captured it (May 12). State government in South Carolina ceased. But the chance of detaching those States from the union and of bringing the war in that region to an end was finally lost by the British. This was chiefly due to an order which recalled the paroles of many of those who had surrendered at Charleston and required that they should perform military service under the British. The attempt to enforce this order, with the barbarities of Colonel Banastre Tarleton and certain Tory bands, provoked a bloody partisan conflict in the upper districts, especially of South Carolina, which contributed more than any other cause to run the scale against the British in the remote south. By the winter of 1781 they were forced back to Charleston and Savannah.

Yorktown.—During the summer of 1780, Washington was prevented from accomplishing anything in the north by the demoralized condition of the finances and by the decline of public spirit. It was very difficult to secure recruits or supplies. The pay of the troops had fallen so into arrears that some of them had already begun to mutiny. A second French squadron and military force, under De Ternay and Rochambeau, landed at Newport, but they were at once shut up there by the British. Clinton and Cornwallis were now planning that Cornwallis, having put down resistance in the remote south, should march through North Carolina and Virginia to Baltimore and Philadelphia and that a junction of the two British forces should be effected which, it was believed, would complete the ruin of the American cause. But the turn of the tide in favour of the Americans began with the partisan warfare in South Carolina, which delayed the northward march of Cornwallis, who retired to Wilmington and thence marched north with a small force into Virginia, and in July retired to Yorktown, in the peninsula of Virginia. Washington and Rochambeau had meantime been planning a joint move against the British at New York, or possibly in Virginia, and a letter was sent to De Grasse, the French admiral in the West Indies, suggesting his co-operation. De Grasse replied that he would sail for the Chesapeake. This confirmed Washington and Rochambeau in the opinion that they should march at once for Virginia and, after junction with the force of Lafayette, co-operate with De Grasse against Cornwallis. By well-timed movements the forces were brought together before Yorktown and Cornwallis was forced to surrender on Oct. 19, 1781.

Treaty of Peace.—This proved to be the last important operation of the war in America. The King was compelled to give way. Rockingham was called into office at the head of a cabinet which considered the recognition of American independence to be indispensable. The negotiations fell into the hands of Shelburne, the friend of Franklin and disciple of Adam Smith. Richard Oswald was the leading British agent, while Franklin, Jay, John Adams and Henry Laurens were the American negotiators. From the first the acknowledgment of independence, the settlement of the boundaries and the freedom of fishing were insisted on as necessary terms by the Americans. The three points were early conceded by the British. They also agreed to restrict Canada to its ancient limits. But discussions later arose over the right to dry fish on the British coasts, over the payment of debts due to British subjects prior to the war and over the compensation of the loyalists. Adams vigorously insisted upon the right to dry and cure fish on British coasts, and finally this concession was secured. Franklin was opposed to the demands of the loyalists, and they had to be content with a futile recommendation by Congress to the States that their claims *should be adjusted*. It was also agreed that creditors on either side should meet with no lawful impediment to the collection of their debts. Both France and Spain considered the claims of the Americans to be excessive, and were not inclined to yield to them. But the Americans negotiated directly with the British and the articles were signed without consultation with the French government. Peace was formally ratified on Sept. 3, 1783.

The American army was now disbanded. Since the close of active military operations both officers and men had been striving to secure their pay, which was hopelessly in arrears. Congress had voted half-pay to the officers for life, and many had agreed to accept a commutation of this in the form of full pay for a certain number of years. Certificates for these amounts were issued. But

in this, as in other cases it was found impossible to procure the money for the purpose from the States Parts of the army repeatedly mutinied, and it was only the influence of Washington which prevented a general outbreak. When the disbandment was finally effected the officers found their certificates depreciated and the states indisposed to honour them They received only a small part of their due, and the privates scarcely anything. (H L O)

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STRUGGLE FOR NATIONAL GOVERNMENT, 1783–1865

The long struggle to secure the ratification of the Articles of Confederation had given time for careful consideration of the new scheme of government Maryland's persistent criticism had prepared men to find defects in them Conventions of New England States, pamphlets, and private correspondence had found flaws in the new plan; but a public trial of it was a necessary preliminary to getting rid of it. The efforts of the individual States to maintain the war, the disposition of each State to magnify its own share in the result, the popular jealousy of a superior power, transferred now from parliament to the central government, were enough to ensure the articles some lease of life.

Territorial Cessions.—Congress and its committees had already begun to declare that it was impossible to carry on a government efficiently under the articles Its expostulations were to be continued for several years before they were heard In the meantime it did not neglect the great subject which concerned the essence of nationality—the western territory. Virginia had made a first offer to cede her claims, but it was not accepted. A committee of Congress now made a report (1782) maintaining the validity of the rights which New York had transferred to Congress; and in the next year Virginia made an acceptable offer. Her deed was accepted (March 1, 1784); the other claimant States followed, and Congress, which was not authorized by the articles to hold or govern territory, became the sovereign of a tract of some 430,000 square miles

In this territory Congress had now on its hands the same question of colonial government in which the British Parliament had so signally failed The manner in which Congress dealt with it has made the United States the country that it is. The leading feature of its plan was the erection, as rapidly as possible, of States, similar in powers to the original States. The power of Congress over the territories was to be theoretically absolute, but it was to be exerted in encouraging the development of thorough self-government, and in granting it as fast as the settlers should become capable of exercising it Copied in succeeding acts for the organization of territories, and still controlling the spirit of such acts, the ordinance of 1787 (July 13, 1787) is the foundation of almost everything which makes the American system peculiar.

Difficulties of the Confederation.—In the interval of the settlement of the territorial question the affairs of the "league of friendship," known as the United States, had been going from bad to worse, reaching a crisis in 1786. The public debt amounted in 1783 to about $42,000,000, of which $8,000,000 was owed abroad—in Holland, France and Spain. Congress had no power to levy taxes for the payment of interest or principal; it could only make requisitions on the States. In the four years ending in 1786 requisitions had been made for $10,000,000 and the receipts from them had amounted to but one-fourth of what had been called for Even the interest on the debt was falling into arrears, and the first instalment of the principal fell due in 1787. To pay this, and subsequent annual instalments of $1,000,000, was quite impossible. Robert Morris, the financier of the War of Independence, resigned in 1783 rather than "be the minister of injustice," hoping thus to force upon the States the necessity of granting taxing powers to Congress Washington, on retiring from the command-in-chief, wrote a circular letter to the governors of all the States, urging the necessity of granting to Congress some power to provide a national revenue. Congress (April 18, 1783) appealed to the States for power to levy specific duties on cer-

tain enumerated articles, and 5% on others It was believed that with these duties and the requisitions, which were now to be met by internal taxation, $2,500,000 per annum could be raised The proposal never received the necessary ratification of all the States The obedience to the requisitions grew more lax. In 1786 a committee of Congress reported that any further reliance on requisitions would be "dishonourable to the understandings of those who entertain such confidence."

The States and Congress.—In the States the case was even worse. Some of them had been seduced into issuing paper currency in such profusion that they were almost bankrupt. Great Britain, in the treaty of peace, had recognized the independence of the individual States, naming them in order; and her Government followed the same system in all its intercourse with its late Colonies. Its restrictive system was maintained, and the States, competing with each other for more commerce, could adopt no system of counteracting measures. Every possible burden was thus shifted to American commerce; and Congress could do nothing, for, though it asked for the power to regulate commerce for 15 years, the States refused it. Several States, towards the end of this period, began to prepare or adopt systems of protection of domestic productions or manufactures, aimed at preventing competition by neighbouring States The Tennessee settlers were in insurrection against the authority of North Carolina; the Kentucky settlers were disposed to cut loose from Virginia Poverty, with the rigid execution of process for debt, drove the farmers of western Massachusetts into an insurrection (Shays's Insurrection) which the State had much difficulty in suppressing; and Congress was so incompetent to aid Massachusetts that it was driven to the expedient of imagining an Indian war in that direction, in order to transfer troops thither. Congress itself was in danger of disappearance from the scene. The necessity for the votes of nine of the 13 States for the passage of important measures made the absence of a State's delegation quite as effective as a negative vote. Congress even had to make repeated appeals to obtain a quorum for the ratification of the treaty of peace with Great Britain. In 1784 Congress broke up in disgust, and the French minister reported to his government—"There is now in America no general government—neither Congress, nor president, nor head of any one administrative department."

Congress was evidently incompetent to frame a new plan of national government; its members were too dependent on their States, and would be recalled if they took part in framing anything stronger than the articles. The idea of a convention of the States, independent of Congress, was in the minds and mouths of many; Thomas Paine had suggested it as long ago as his *Common Sense* pamphlet: "Let a continental conference be held . . . to frame a continental charter."

Convention of 1786.—The country drifted into a convention by a roundabout way. The navigation of Chesapeake Bay and the Potomac needed regulation; and the states of Maryland and Virginia, having plenary power in the matter, appointed delegates to arrange such rules. The delegates met (1785) at Alexandria (Va.), and at Washington's house, Mount Vernon (Va), in adopting their report, proposed that Pennsylvania and Delaware be asked to nominate commissioners. Virginia went further and proposed a meeting of commissioners from all the States to frame commercial regulations for the whole. The convention met (1786) at Annapolis (Md), but only five States were represented, and their delegates adjourned, after recommending another convention at Philadelphia in May 1787.

Constitutional Convention.—Congress had failed in its last resort—a proposal that the States should grant it the impost power alone; New York's veto had put an end to this last hope. Confessing its helplessness, Congress approved the call for a second convention; 12 of the States (all but Rhode Island) chose delegates, and the convention met at Philadelphia (May 25, 1787) with an abler body of men than had been seen in Congress since the first two Continental Congresses. Among others, Virginia sent Washington, James Madison, Edmund Randolph, George Mason and George Wythe; Pennsylvania Franklin, Robert, Gouverneur Morris and James Wilson; Massachusetts: Rufus King, Elbridge Gerry and Caleb Strong; Connecticut: William S Johnson, Roger Sherman and Oliver Ellsworth, New York. Alexander Hamilton, New Jersey. William Paterson, and South Carolina the two Pinckneys and John Rutledge With hardly an exception the 55 delegates were clear-headed, moderate men, with positive views of their own and firm purpose, but with a willingness to compromise.

The Virginia Plan.—Washington was chosen to preside, and the convention began the formation of a new Constitution, instead of proposing changes in the old one Two parties were formed at once. The Virginia delegates offered a plan proposing a Congress, of two houses, having power to legislate on national subjects, and to compel the States to fulfil their obligations This was a "large-State" plan, proposed by those States which had or hoped for a large population It meant to base representation in both houses on population, so that the large States could control both of them, and it left the appointment of the president or other executive and the Federal judges to Congress—so that the whole administration of the new government would fall under large-State control

The New Jersey Plan.—On behalf of the "small States" Paterson of New Jersey brought in another plan. It continued the old Confederation, with its single house and equal State vote, but added the power to regulate commerce and raise a revenue, and to compel the States to obey requisitions The large States had a general majority of six to five, but the constant dropping off of one or more votes, on minor features, from their side to that of the small States prevented the hasty adoption of any radical measures. Nevertheless, the final collision could not be evaded, the basis of the two plans was in the question of one or two houses, of equal or proportionate State votes, of large-State supremacy or of State equality. In July the large States began to show a disposition to force their plan through, and the small States began to threaten a concerted withdrawal from the convention

The Compromise.—The Connecticut delegates, from their first appearance in the convention, had favoured a compromise They had been trained under the New England system, in which the assemblies were made up of two houses, one representing the people of the whole State, according to population, and the other giving an equal representation to the towns. They proposed that the new Congress should be made up of two houses, one representing the States in proportion to their population, the other giving an equal vote to each State. At a deadlock the convention referred the proposition to a committee, and it reported in favour of the Connecticut compromise. Connecticut had been voting in the large-State list, and the votes of her delegates could not be spared from their slender majority; now another of the large States, North Carolina, came over to Connecticut's proposal, and it was adopted. Thus the first great struggle of the convention resulted in a compromise, which took shape in an important feature of the Constitution, the Senate.

The small States were still anxious, in every new question, to throw as much power as possible into the hands of their special representative, the Senate; and that body thus obtained its power to act as an executive council as a restraint on the President in appointments and treaties. This was the only survival of the first alignment of parties; but new divisions arose on almost every proposal introduced. The election of the President was given at various times to Congress and to electors chosen by the State legislatures; and the final mode of choice, by electors chosen by the States, was settled only two weeks before the end of the convention, the office of vice president coming in with it The opponents and supporters of the slave trade compromised by agreeing not to prohibit it for 20 years. Another compromise included three-fifths of the slaves in enumerating population for representation. This provision gave the slave-holders abnormal power as the number of slaves increased.

Any explanation of the system introduced by the Constitution must start with the historical fact that, while the national Government was practically suspended, from 1776 until 1789, the only power to which political privileges had been given by the people was the States, and that the State legislatures were, when

the convention met, politically omnipotent, with the exception of the few limitations imposed on them by the early State constitutions. The general rule, then, is that the Federal Government has only the powers granted to it by the Federal Constitution, while the State has all governmental powers not forbidden to it by the State or the Federal Constitution. But the phrase defining the Federal Government's powers is no longer "expressly granted," as in the Articles of Confederation, but merely "granted," so that powers necessary to the execution of granted powers belong to the Federal Government, even though not directly named in the Constitution. This question of the interpretation or "construction" of the Constitution is at the bottom of real national politics in the United States

The Constitution.—Popular sovereignty, then, is the basis of the American system. But it does not, as does the British system, choose its legislative body and leave unlimited powers to it. It makes its "Constitution" the permanent medium of its orders or prohibitons to all branches of the Federal Government and to many branches of the State Governments. they must do what the Constitution directs and leave undone what it forbids The people, therefore, are continually laying their commands on their governments; and they have instituted a system of Federal courts to ensure obedience to their commands A British court must obey the Act of parliament, the American court is bound and sworn to obey the Constitution first, and the Act of Congress or of the State legislature only so far as it is warranted by the Constitution. But the American court does not deal directly with the act in question; it deals with individuals who have a suit before it. One of these individuals relies on an Act of Congress or of a State legislature; the act thus comes before the court for examination; and it supports the act or disregards it as "unconstitutional," or in violation of the Constitution. If the court is one of high rank, or one to which a decision may be appealed, as the U S. Supreme Court, other courts follow the precedent, and the law falls to the ground.

The preamble states that "we, the people of the United States," establish and ordain the Constitution Events have shown that it was the people of the whole United States that established the Constitution, but the people of 1787 seem to have inclined to the belief that it was the people of each State for itself. This belief was never changed in the south; and in 1861 the people of that section believed that the ordinances of secession were merely a repeal of the enacting clause by the power which had passed it, the people of the State. For an account of the form of Government established by the Constitution *see* UNITED STATES· *Constitution and Government*.

The Constitution's leading difference from the Confederation is that it gives the national government power over individuals. The Federal courts are the principal agents in securing this essential power; without them, the Constitution might easily have been as dismal a failure as the Confederation. It has also been a most important agent in securing to the national government its supremacy over the States From this point of view the most important provision of the Constitution is the grant of jurisdiction to Federal courts in cases involving the construction of the Constitution or of laws or treaties made under it. The 25th section of the Judiciary Act of 1789 permitted any Supreme Court justice to grant a writ of error to a State court in a case in which the constitutionality of a Federal law or treaty had been denied, or in which a State law objected to as in violation of the Federal Constitution had been maintained. In such cases, the defeated party had the right to carry the "Federal question" to the Federal courts. It was not until 1816 that the Federal courts undertook to exercise this power; it raised a storm of opposition, but it was maintained, and has made the Constitution what it professed to be—"the supreme law of the land."

Sovereignty.—The system of the United States is almost the only national system, in active and successful operation, as to which the exact location of the sovereignty is still a mooted question. The contention of the Calhoun school—that the separate States were sovereign before and after the adoption of the Constitution, that the Union was purely voluntary, and that the whole people, or the people of all the other States, had no right to maintain or enforce the Union against any State—has been ended by the Civil War. But that did not decide the location of the sovereignty The prevalent opinion is still that first formulated by Madison that the States were sovereign before 1789; that they then gave up a part of their sovereignty to the Federal Government, that the Union and the Constitution were the work of the States, not of the whole people, and that reserved powers are reserved to the people of the States, not to the whole people.

By whatever sovereignty the Constitution was framed and imposed, it was meant only as a scheme in outline, to be filled up afterwards, and from time to time, by legislation The idea is most plainly carried out in the Federal judiciary. the Constitution only directs that there shall be a Supreme Court, and marks out the general jurisdiction of all the courts, leaving Congress, under the restriction of the President's veto power, to build up the system of courts. But the same idea is visible in every department, and it has carried the Constitution safely through a period which has radically altered every other civilized Government It has combined elasticity with the limitations necessary to make democratic government successful over a vast territory, having infinitely diverse interests, and needing, more than almost anything else, positive opportunities for sober second thought by the people. A sudden revolution of popular thought or feeling is enough to change the House of Representatives from top to bottom; it must continue for several years before it can make a radical change in the Senate, and for years longer before it can carry this change through the judiciary, which holds for life; and all these changes must take place before the full effects upon the laws or Constitution are accomplished. But minor changes are reached easily and naturally in the course of legislation

Submission to Congress.—The convention adjourned on Sept. 17, 1787, having adopted the Constitution. Its last step was a resolution that the Constitution be sent to the Congress of the Confederation, with the recommendation that it be submitted to conventions elected by the people of each State for ratification or rejection; that, if nine States should ratify it, Congress should appoint days for the popular election of electors, and that then the new Congress and President should, "without delay, proceed to execute this Constitution." Both Congress and the convention were careful not to open the dangerous question, How was a Government which was not to be changed but by the legislatures of all the States to be entirely supplanted by a different system through the approval of conventions in three-fourths of them?

Action of the States.—Before the end of the year Delaware, Pennsylvania and New Jersey had ratified; and Georgia, Connecticut and Massachusetts followed during the first two months of 1788. Thus far the only strong opposition had been in Massachusetts, a "large State." In it the struggle began between the friends and the opponents of the Constitution, with its introduction of a strong Federal power; and it raged in the conventions, legislatures, newspapers and pamphlets. In a classic series of papers, the *Federalist*, Alexander Hamilton, with the assistance of James Madison and John Jay, explained the new Constitution and defended it.

The seventh and eighth States—Maryland and South Carolina—ratified in April and May 1788; and, while the conventions of Virginia and New York were still wrangling over the great question, the ninth State, New Hampshire, ratified, and the Constitution passed out of theory into fact. The Anti-Federalists of the Virginia and New York conventions offered conditional ratifications of all sorts, but the Federalists stubbornly refused to consider them, and at last, by very slender majorities, these two states ratified North Caroina for a time refused to ratify the Constitution In Rhode Island it was referred to the several towns instead of to a convention and was at first rejected by a majority, the Federalists, who advocated the calling of a convention, refraining from voting Congress named the first Wednesday of January 1789 as the day for the choice of electors, the first Wednesday in February for the choice of President and vice president, and the first Wednesday in March for

the inauguration of the new Government, at New York city. The last date fell on March 4, which continued the limit of each President's term for a century and a half.

When the votes of the electors were counted before Congress, it was found that Washington had been unanimously elected President, and that John Adams, standing next on the list, was vice president. Long before the inauguration the Congress of the Confederation had expired of mere inanition; its attendance simply ran down until (Oct. 21, 1788) its record ceased, and the United States got on without any national government for nearly six months The struggle for nationality had been successful, and the old order faded out of existence.

Slavery.—The first census (1790) followed so closely upon the inauguration of the Constitution that the country may fairly be said to have had a population of near four millions in 1789 Something over half a million of these were slaves, of African birth or blood Slavery of this sort had taken root in almost all the Colonies its original establishment being everywhere by custom. When the custom had been sufficiently established statutes came in to regulate a relation already existing But it is not true, as the Dred Scott decision held long afterwards, that the belief that slaves were chattels simply, things, not persons, held good at the time of the adoption of the Constitution. Times had changed somewhat. The peculiar language of the Constitution itself, describing a slave as a "person held to service or labour," under the laws of any State, puts the general feeling exactly: slaves were persons from whom the laws of some of the States withheld personal rights for the time. In accordance with this feeling most of the Northern States were on the high road towards abolition of slavery. Vermont had never allowed it. In Massachusetts it was swept out by a summary court decision that it was irreconcilable with the new State Constitution. Other States soon began systems of gradual abolition, which finally extinguished slavery north of Maryland, but so gradually that there were still 18 apprentices for life in New Jersey in 1860, the last remnants of the former slave system. In the new States north of the Ohio slavery was prohibited by the ordinance of 1787 and the prohibition was maintained in spite of many attempts to get rid of it and introduce slavery.

The sentiment of thinking men in the south was exactly the same, or in some cases more bitter from their personal entanglement with the system. Jefferson's language as to slavery is irreconcilable with the chattel notion; no abolitionist agitator ever used warmer language than he Washington, George Mason and other southern men were almost as warm against slavery as Jefferson, and there were societies for the abolition of slavery in the south In the Constitutional Convention of 1787 the strongest opposition to an extension of the period of non-interference with the slave trade from 1800 to 1808 came from Virginia, whereas every one of the New England States voted for this extension. Like most slave laws, the laws of the southern states were harsh: rights were almost absolutely withheld from the slave, and punishments of the severest kind were legal, but the execution of the system was milder than its legal possibilities might lead one to imagine. The country was as yet so completely agricultural that southern slavery kept all the patriarchal features possible to such a system.

Industries.—Indeed, the whole country was almost exclusively agricultural, and, in spite of every effort to encourage manufactures by State bounties, they formed the meagrest element in the national production Connecticut, which now teems with manufactures, was just beginning the production of tinware and clocks; Rhode Island and Massachusetts were just beginning to work in cotton from models of jennies and Arkwright machinery surreptitiously obtained from England, and other States, beyond local manufactures of paper, glass and iron, were almost entirely agricultural, or were engaged in industries directly dependent on agriculture.

Population.—There were but five cities in the United States having a population of more than 10,000—New York (33,000), Philadelphia (28,500), Boston (18,000), Charleston (16,000) and Baltimore (13,000). The revenues of the new Government in 1790 were only $4,000,000, the expenditures, excluding interest on the public debt, but $1,000,000. It is not easy for the modern American to realize the poverty and weakness of his country at the inauguration of the new Government

Travel.—Outside the cities communication was slow. One stage a week was enough for the connection between the great cities; and communication elsewhere depended on private conveyance. The western settlements were just beginning to make the question more serious Enterprising land companies were the moving force which had impelled the passage of the ordinance of 1787; and the first column of their settlers was pouring into Ohio and forming connection with their predecessors in Kentucky and Tennessee Marietta and Cincinnati had been founded But the intending settlers were obliged to make the journey down the Ohio river from Pittsburgh in bullet-proof flat-boats, for protection against the Indians, and the return trip depended on the use of oars. For more than 20 years these flat-boats were the chief means of river commerce in the West; and in the longer trips, as to New Orleans the boats were generally broken up at the end and sold for lumber. John Fitch and others were already experimenting on what was soon to be the steamboat; but the statesman of 1789, looking at the task of keeping under one government a country of such distances, with such difficulties of communication, naturally felt anxiety as to the future.

Literature.—The comparative isolation of the people everywhere, the lack of books, the poverty of the schools and newspapers, were all influences which worked strongly against any pronounced literary development. Poems, essays and paintings were feeble imitations of European models; history was annalistic, if anything, and the drama hardly existed In two points the Americans were strong, and had done good work. Such men as Jonathan Edwards had excelled in various departments of theology, and American preaching had reached a high degree of quality and influence, and, in the line of politics, the American State papers rank among the very best of their kind. Having a very clear perception of their political purposes, and having been restricted in study and reading to the great masters of pure and vigorous English, and particularly to the English translators of the Bible, the American leaders came to their work with an English style which could hardly have been improved The writings of Franklin, Washington, the Adamses, Hamilton, Jefferson, Madison, Jay and others show the secret of their strength in every page. Much the same reasons, with the influences of democracy, brought oratory, as represented by Patrick Henry, Fisher Ames, John Randolph and others, to a point not very far below the mark afterwards reached by Daniel Webster The effect of these facts on the subsequent development of the country is not often estimated at its full value

Limits of Settlement.—The cession of the "North-west Territory" by Virginia and New York had been followed by similar cessions by Massachusetts (1785), Connecticut (1786) and South Carolina (1787) North Carolina did not cede Tennessee until early in 1790, nor Georgia her western claims until 1802 Settlement in all these regions was still very sparse The centres of western settlement, in Tennessee and Kentucky, had become more firmly established, and a new one, in Ohio, had just been begun. The whole western limits of settlement of the old 13 States had moved much nearer their present boundaries; and the acquisition of the western title, with the liberal policy of organization and government which had been begun, was to have its first clear effects during the first decade of the new government. Almost the only obstacle to its earlier success had been the doubts as to the attitude which the Spanish authorities, at New Orleans and Madrid, would take towards the new settlements. They had already asserted a claim that the Mississippi was an exclusively Spanish stream from its mouth up to the Yazoo, and that no American boat should be allowed to sail on this part of it. To the western settler the Alleghenies and bad roads were enough to cut him off from any other way to a market than down the Mississippi; and it was not easy to restrain him from a forcible defiance of the Spanish claim. The northern States were willing to allow the Spanish claim for

a period of years in return for a commercial treaty; the southern States and the western settlers protested angrily; and once more the spectre of dissolution appeared, not to be laid again until the new Government had made a treaty with Spain in 1795 securing common navigation of the Mississippi.

The Development of Democracy, 1789–1801.—All the tendencies of political institutions in the United States had been towards democracy; but the leading men were not unanimous in their agreement with this tendency. Not a few of them were pronounced republicans even before 1775, but the mass of them had no great objections to a monarchical form of government until the war spirit had converted them The Declaration of Independence had been directed rather against *the* King than against *a* king Even after popular sovereignty had pronounced against a king, class spirit was for some time a fair substitute for aristocracy As often happens, democracy at least thought of a Caesar when it apprehended class control. Certain discontented officers of the Continental Army proposed to Washington that he become king, but he promptly and indignantly put the offer by.

The State constitutions were democratic, except for property or other restrictions on the right of suffrage, or provisions carefully designed to keep the control of at least one house of the State legislature "in the hands of property" The Federal Constitution was so drawn that it would have lent itself kindly either to class control or to democracy. The electoral system of choosing the President and vice president was altogether anti-democratic, though democracy has conquered it· not an elector, since 1796, has disobeyed the purely moral claim of his party to control his choice. Since the Senate was to be chosen by the State legislatures, "property," if it could retain its influence in those bodies, could control at least one house of Congress. Whether the Constitution was to have a democratic or an anti-democratic interpretation was to be settled in the next 12 years.

Immigration.—The States were a strong factor in the final settlement, from the fact that the Constitution had left to them the control of the elective franchise: they were to make its conditions what each of them saw fit Religious tests for the right of suffrage had been quite common in the Colonies; property tests were almost universal. The religious tests disappeared shortly after the War of Independence; the property tests survived in some of the States far into the constitutional period. But the desire to attract immigration was always a strong impelling force to induce States, especially frontier States, to make the acquisition of full citizenship and political rights as easy and rapid as possible. This force was not so strong at first as it was after the great stream of immigration began about 1848, but it was enough to tend constantly to the development of democracy.

Organization of the New Government.—The Anti-Federalists had been a political party, but a party with but one principle. The absolute failure of that principle deprived the party of all cohesion; and the Federalists controlled the first two Congresses almost entirely Their pronounced ability was shown in their organizing measures, which still govern the American system very largely. The departments of State, of the Treasury, of War, of Justice and of the Post Office were rapidly and successfully organized; acts were passed for the regulation of seamen, commerce, tonnage duties, lighthouses, intercourse with the Indians, territories and the militia; a national capital was selected; a national bank was chartered; the national debt was funded, and the State debts were assumed as part of it. The first four years of the new system showed that the States had now to deal with a very different power from the impotent Congress of the Confederation. The new power was even able to exert pressure upon the two States which had not ratified the Constitution. As a first step, the higher duties imposed on imports from foreign countries were expressly directed to apply to imports from North Carolina and Rhode Island. North Carolina having called a second convention, her case was left to the course of nature; the second convention ratified the Constitution (Nov. 21, 1789). The Rhode Island legislature asked that their State might not be considered altogether foreigners, made their duties agree with those of the new government, and reserved the proceeds for "continental" purposes. Still no further steps were taken. A bill was therefore introduced, directing the President to suspend commercial intercourse with Rhode Island, and to demand from her her share of the continental debt. This was passed by the Senate, and needed but two steps further to become law Newspaper proposals to divide the little State between her two nearest neighbours were stopped by her ratification of the Constitution (May 29, 1790). The "old 13" were thus united under the Constitution; and yet, so strong is the American prejudice for the autonomy of the States that these last two were allowed to enter in the full conviction that they did so in the exercise of sovereign freedom of choice.

Protection.—Protection was begun in the first tariff act, whose object, said its preamble, was the protection of domestic manufactures. The duties, however, ranged only from 7½ to 10%, averaging about 8½% The system, too, had rather a political than an economic basis. Until 1789 the States had controlled the imposition of duties. The separate State feeling was a factor so strong that secession was a possibility which every statesman had to take into account Hamilton's object, in introducing the system, seems to have been to create a class of manufacturers, running through all the States, but dependent for prosperity on the new Federal Government and its tariff. This would be a force which would make strongly against any attempt at secession. The same feeling seems to have been at the bottom of his establishment of a national bank, his assumption of State debts, and most of the general scheme which his influence forced upon the Federalist Party.

The First Cabinet.—In forming his cabinet Washington had paid attention to the opposing elements which had united for the temporary purpose of ratifying the Constitution. The national element was represented by Hamilton, secretary of the Treasury, and Henry Knox, secretary of War; the particularist element (using the term to indicate support of the States, not of a State) by Jefferson, secretary of State, and Edmund Randolph, Attorney General At the end of 1792 matters were in train for the general recognition of the existence of two parties, whose struggles were to decide the course of the Constitution's development. The occasion came in the opening of 1793, when the new nation was first brought into contact with the French Revolution

Jefferson.—The controlling tendency of Jefferson and his school was to the maintenance of individual rights at the highest possible point, as the Hamilton school was always ready to assert the national power to restrict individual rights for the general good The Jefferson school supported the States, in the belief that they were the best bulwarks for individual rights When the French Revolution began its course in America by agitation for the "rights of man," it met a sympathetic audience in the Jefferson party and a cold and unsympathetic hearing from the Hamilton school of Federalists, who were far more interested in securing the full recognition of the power and rights of the nation than in securing the individual against imaginary dangers, as they thought them. For ten years the surface marks of distinction between the two parties were to be connected with the course of events in Europe.

Hamilton.—The new Government was not yet four years old; it was not familiar, nor of assured permanency. The only national governments of which Americans had had previous experience were the British Government and the Confederation: in the British they had had no share, and the Confederation had had no power. The only places in which they had had long-continued, full and familiar experience of self-government were their State Governments. The governing principle of the Hamilton school, that the construction or interpretation of the terms of the Constitution was to be such as to broaden the powers of the Federal Government, necessarily involved a corresponding trenching on the powers of the States. It was natural, then, that the Jefferson school should look on every feature of the Hamilton programme as "anti-republican." The disposition of the Jefferson school to claim for themselves a certain peculiar title to the position of "republicans" developed into the appearance of the first Repub-

lican, or the Democratic-Republican, Party, about 1793.

Parties.—Many of the Federalists were shrewd and active business men, who naturally took prompt advantage of the opportunities which the new system offered The Republicans therefore believed and asserted that the whole Hamilton programme was dictated by selfish or class interest, and they added this to the accusation of monarchical tendencies These charges, with the fundamental differences of mental constitution, exasperated by the passion which differences as to the French Revolution seemed to carry with them everywhere, made the political history of this decade a very unpleasant record The provision for establishing the national capital on the Potomac (1790) was declared to have been carried by a corrupt bargain; and accusations of corruption were renewed at every opportunity In 1793 a French agent, Edmond Charles Edouard Genet (1765–1834), appeared to claim the assistance of the United States for the French republic, and went to the length of commissioning privateers, and endeavouring to secure recruits. Washington decided to issue a proclamation of neutrality, the first act of the kind in American history. It was the first indication, also, of the policy which has made the course of every President, with the exception of Polk, a determined leaning to peace, even when the other branches of the Government have been intent on war. Genet, however, continued his activities, and made outrageous demands upon the Government, so that finally Washington demanded and secured (1794) his recall The proclamation of 1793 brought about the first distinctly party feeling; and it was intensified by Washington's charge that popular opposition in western Pennsylvania (1794) to the new excise law (*see* WHISKY INSURRECTION) had been fomented by the extreme French party. Their name, Democrat, was applied by the Federalists to the whole Republican Party as a term of contempt, but it was not accepted by the party for some 20 years; then the compound title "Democratic-Republican" became, as it long remained, the official title of the party. There was no party opposition, however, to the re-election of Washington in 1792, or to the admission of Vermont (1791), Kentucky (1792) and Tennessee (1796) as new States

Jay's Treaty.—The British Government had accredited no minister to the United States, and it refused to make any commercial treaty or to give up the forts in the western territory of the United States, through which its agents still exercised a commanding influence over the Indians In the course of its war with France, the neutral American vessels, without the protection of a national navy, fared badly. A treaty negotiated in 1794 by Chief Justice John Jay settled these difficulties for the following 12 years. But, as it engaged the United States against any intervention in the war on behalf of France, was silent on the subject of the right of search, and agreed to irksome limitations on the commercial privileges of the United States, the Republicans made it very unpopular, and the bitter personal attacks on Washington grew out of it. In spite of occasional Republican successes, the Federalists retained a general control of national affairs; they elected John Adams President in 1796, though Jefferson was chosen vice president with him; and the national policy of the Federalists kept the country out of entangling alliances with any of the European belligerents. To the Republicans, and to the French republic, this last point of policy was only a practical intervention against France and against the rights of man

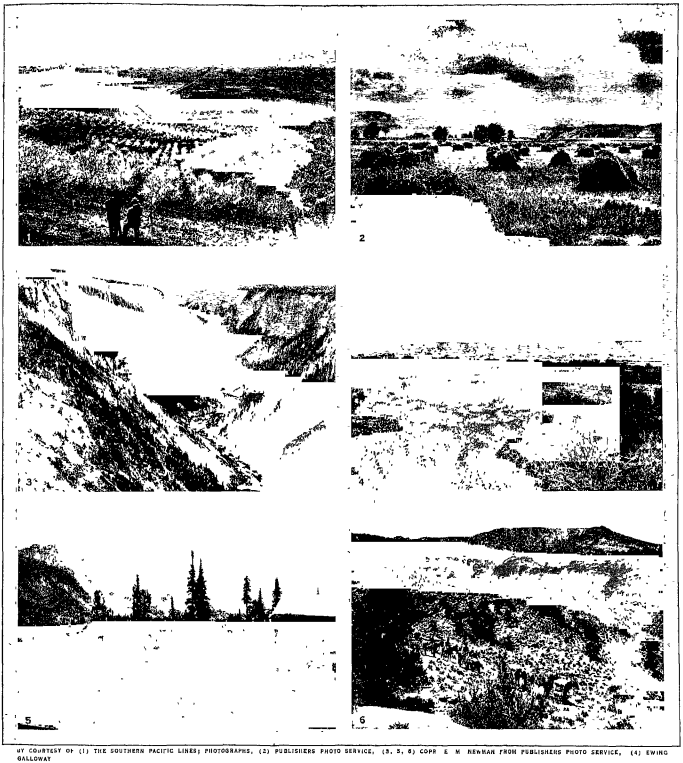
At the end of Washington's Administration the French Directory broke off relations with the United States, demanding the abrogation of Jay's treaty and a more pronounced sympathy with France. Adams sent three envoys, C. C Pinckney, John Marshall and Eibridge Gerry, to endeavour to re-establish the former relations; they were met by demands for "money, a great deal of money," as a prerequisite to peace. They refused; their letters home were published, and the Federalists at last had the opportunity of riding the whirlwind of an intense popular desire for war with France. Intercourse with France was suspended by Congress (1798); the treaties with France were declared at an end; American frigates were authorized to capture French vessels guilty of depredations on American commerce, and the President was authorized to issue letters of marque and reprisal; and an American Army was formed, Washington being called from his retirement at Mount Vernon to command it. The war never went beyond a few sea fights, in which the little American Navy did itself credit, and Napoleon, seizing power the next year, renewed the peace which should never have been broken

Decline of the Federalists.—The reaction in Great Britain against the indefinite "rights of man" had led Parliament to pass an alien law, a sedition law suspending the writ of *habeas corpus* and an act giving wide and loosely defined powers to magistrates for the dispersion of meetings to petition for redress of grievances The Federalists were in control of a Congress of limited powers; but they were strongly tempted by sympathies and antipathies of every sort to form their programme on the model furnished from England. The measures which they actually passed were based only on that construction of the Constitution which is at the bottom of all American politics; they only tended to force the Constitution into an anti-democratic direction But it was the fixed belief of their opponents that they meant to go farther, and to secure control by some wholesale measure of political persecution

The Alien and Sedition Laws.—Three alien laws were passed in June and July, 1798. The first (repealed in April, 1802) raised the number of years necessary for naturalization from five to 14 The third permitted the arrest or removal of subjects of any foreign power with which the United States should be at war. The second, which is usually known as the Alien Law, was limited to a term of two years; it permitted the President to arrest or order out of the country any alien whom he should consider dangerous to the country. As many of the Republican editors and local leaders were aliens, this law really put a large part of the Republican organization in the power of the President The Sedition Law (to be in force until March, 1801, and not renewed) made it a crime, punishable by fine and imprisonment, to publish or print any false, scandalous and malicious writings against the Government of the United States, either house of Congress, or the President, or to stir up sedition or opposition to any lawful act of Congress or of the President, or to aid the designs of any foreign power against the United States. In its first form the bill was even more sweeping than this and alarmed the opposition.

Most of the ability of the country was in the Federalist ranks; the Republicans had but two first-rate men—Jefferson and Madison. In the sudden issue thus forced between individual rights and national power, Jefferson and Madison could find but one bulwark for the individual—the power of the States; and their use of it gave their party a pronounced list to State sovereignty from which it did not recover for years They objected to the Alien Law on the grounds that aliens were under the jurisdiction of the State, not of the Federal Government, that the jurisdiction over them had not been transferred to the Federal Government by the Constitution, and that the assumption of it by Congress was a violation of the Constitution's reservation of powers to the States; and, further, because the Constitution reserved to every "person," not to every citizen, the right to a jury trial. They objected to the Sedition Law on the grounds that the Constitution had specified exactly the four crimes for whose punishment Congress was to provide; that criminal libel was not one of them; and that the 1st amendment forbade Congress to pass any law restricting freedom of speech or of the press

Virginia and Kentucky Resolutions.—The Republican objections might have been made in court, on the first trial. But the Republican leaders had strong doubts of the impartiality of the Federal judges, who were Federalists. They resolved to entrench the party in the State legislatures The Virginia legislature in 1798 passed a series of resolutions prepared by Madison, and the Kentucky legislature in the same year passed a series prepared by Jefferson Neglected or rejected by the other States, they were passed again by their legislatures in 1799. The leading idea expressed in both was that the Constitution was a "compact" between the States, and that the powers (the States) which had made the compact had reserved the power to restrain the creature of the compact, the Federal Government, whenever it undertook

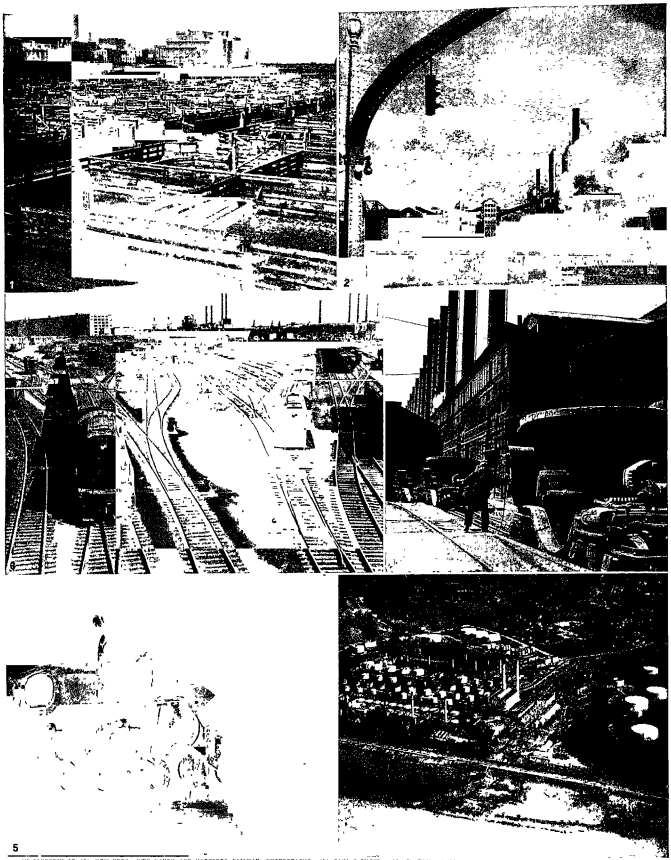


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VIEWS IN WESTERN UNITED STATES

1 Looking down on a large prune orchard in blossom in the Santa Clara Valley of California
2 Harvest scene in Colorado at twilight
3 Deep canyon in the Yellowstone National Park in Wyoming
4. Cultivated field in an arid western region, surrounded by sagebrush
5. A horse corral in the Glacier National Park, Montana
6. Pack train travelling through the arid foothills of the mountains in Arizona

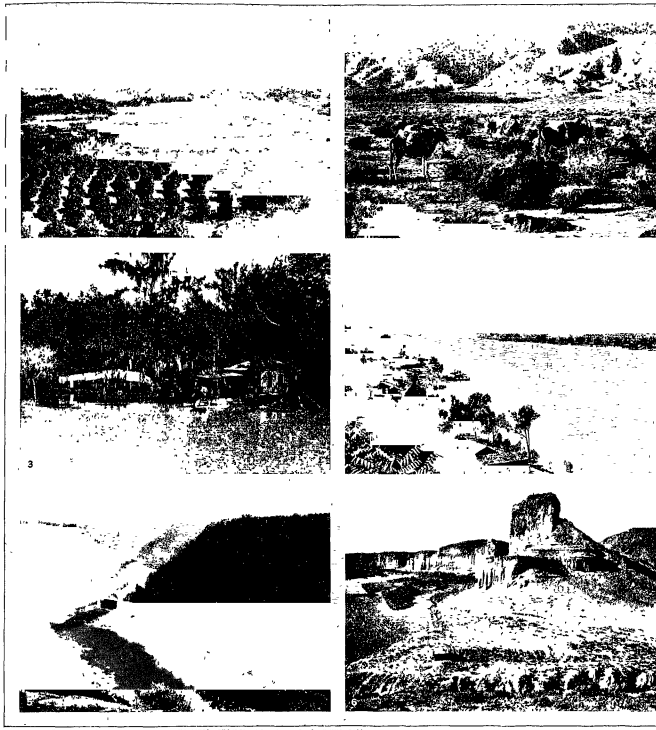
UNITED STATES OF AMERICA



BY COURTESY OF (3) NEW YORK, NEW HAVEN AND HARTFORD RAILWAY; PHOTOGRAPHS, (1) PAUL S PHOTOS, (2, 4) SWING GALLOWAY, (4) KNOPF PIX FROM PUBLIX, (5) ALBERT FENN-PIX FROM PUBLIX

INDUSTRIAL SCENES IN THE UNITED STATES

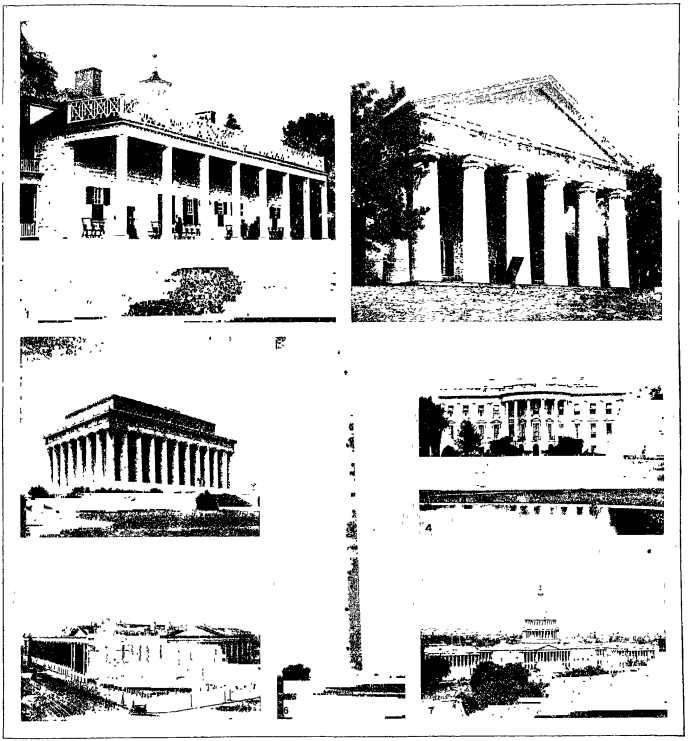
1. Cattle pens at the Union stockyards, Chicago
2. Part of the River Rouge plant of the Ford Motor company, Detroit. This and all other motor car factories were converted to munitions production in World War II
3. Railroad yards at Boston
4. Carnegie-Illinois Steel corporation plant at Homestead, Pennsylvania
5. Assembling tanks in a U S factory during World War II. In 1942, U S heavy industries, and many of the lighter industries, were geared to war production
6. Airview of a petroleum refinery, Independence, Missouri



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VIEWS IN DIFFERENT SECTIONS OF THE UNITED STATES

1. View from Smiley Heights near Redlands, Calif.; immense orange groves in the foreground, snow capped mountain peaks in the background
2. A burro pack train in Death Valley, Mojave desert, California
3. Picturesque lumberjack houseboat at the edge of a Louisiana swamp. When work in that immediate section is finished, the lumberjack puts out in his houseboat and drifts down the swamp to the next job
4. The broad Mississippi river near Natchez, Mississippi. A ferryboat and two old style river steamers of the stern wheel type are tied alongside the bank
5. Kanawha river winding its way through a valley in the Blue Ridge mountains of Fayette county, West Virginia
6. Buttes of the Green River in Wyoming. Mountain sides have been cut away by centuries of erosion



PHOTOGRAPHS, (1, 3, 4) BROWN BROTHERS, (2, 5, 6, 7) UNDERWOOD AND UNDERWOOD

PUBLIC BUILDINGS IN WASHINGTON D. C. AND VICINITY

1. The Mansion at Mt Vernon, Virginia, about 15 miles south of Washington, D C. Long owned by members of the Washington family, this property in 1761 came into the possession of George Washington, who in 1785–86 greatly enlarged and improved it, and made it his home until his death in 1799
2. The Lee Mansion at Arlington, Virginia, opposite Washington, D C., built in 1802 by George Washington Parke Custis, the adopted son of George Washington George Hadfield, architect At the beginning of the Civil War it was the property of Robert E Lee, son-in-law of Custis, who became commander-in-chief of the Confederate Army. This mansion, the Tomb of the Unknown Soldier and the Memorial Amphitheatre, are now notable features of Arlington National Cemetery
3. The Lincoln Memorial, designed by Henry Bacon. There are 36 columns, one for each state in the union at the time of the death of Abraham Lincoln in 1865
4. The Garden front of the Executive Mansion, Washington, D.C., better known as "The White House." George Washington was present at the laying of the corner stone in 1792 and John Adams was the first president to live in the building. Architect, James Hoban
5. The United States Treasury building completed in 1869. The site was selected by President Jackson and the structure now covers 120,000 square feet of ground. Robert Mills, architect
6. Washington Monument, 555 feet high, erected as a memorial to George Washington. It was begun in 1848 and completed in 1884. Robert Mills, architect
7. The Capitol building at Washington The southeast corner stone of the original building was laid by President Washington in 1793 and the first building was completed in 1827 The present dome was completed in 1865. William Thornton, Stephen Hallet, B. H. Latrobe, Charles Bulfinch and Thomas U. Walter, architects

UNITED STATES OF AMERICA


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UNITED STATES PRESIDENTS FROM 1789 TO 1881

1 George Washington (term, 1789–97). Portrait by Gilbert Stuart
2 John Adams (1797–1801) by James Sharpless
3 Thomas Jefferson (1801–09) by Rembrandt Peale
4 James Madison (1809–17) by Asher B. Durand
5 James Monroe (1817–25) by Gilbert Stuart
6 John Quincy Adams (1825–29) by Chester Harding
7 Andrew Jackson (1829–37) by E. F. Andrews
8 Martin Van Buren (1837–41) by Henry Inman
9 William Henry Harrison (1841 for one month) by George Catlin
10 John Tyler (1841–45) by George P. A. Healy
11 James Knox Polk (1845–49) by George P A Healy
12 Zachary Taylor (1849–50) by George P. A. Healy
13 Millard Fillmore (1850–53) by George P A Healy
14 Franklin Pierce (1853–57) by George P A. Healy
15 James Buchanan (1857–61) by E. F Andrews
16 Abraham Lincoln (1861–65) by J. Redding Kelly
17 Andrew Johnson (1865–69) by E F. Andrews
18 Ulysses Simpson Grant (1869–77) by Thomas LeClear
19 Rutherford Birchard Hayes (1877–81) by Daniel Huntington
20 James Abram Garfield (1881 for six months) by E F Andrews


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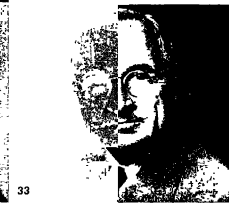

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UNITED STATES PRESIDENTS FROM 1881

21. Chester Alan Arthur (1881–85) by Daniel Huntington
22, 24. Grover Cleveland (1885–89, 1893–97) by Eastman Johnson
23. *Benjamin Harrison (1889–93) by Eastman Johnson*
25. William McKinley (1897–1901) by William D. Murphy
26. Theodore Roosevelt (1901–09) by John Singer Sargent
27. William Howard Taft (1909–13) by Anders Zorn
28. Woodrow Wilson (1913–21) by Stanley G. Middleton
29. Warren Gamaliel Harding (1921–23) by Howard Chandler Christy
30. Calvin Coolidge (1923–29) by Ercole Carteto
31. Herbert Clark Hoover (1929–33)
32. Franklin Delano Roosevelt (1933–45)
33. Harry S Truman (1945–53)
34. Dwight D. Eisenhower (1953–)

UNITED STATES OF AMERICA



PHOTOGRAPHS, (1, 2, 4, 7, 8, 10, 12, 15) EWING GALLOWAY, (3, 5, 6, 9, 11, 13, 14, 16) CULVER SERVICE

VICE-PRESIDENTS OF THE UNITED STATES

1 John Adams (term of office, 1789–97) 2 Thomas Jefferson (1797–1801), painting by Rembrandt Peale 3. Aaron Burr (1801–05) 4. George Clinton (1805–12) 5. Elbridge Gerry (1813–14), miniature by John Ramage 6 Daniel D Tompkins (1817–25) 7 John C Calhoun (1825–32) 8 Martin Van Buren (1833–37) painting by Henry Inman 9 Richard M Johnson (1837–41) 10 John Tyler (1841) 11 George M Dallas (1845–49), 12 Millard Fillmore (1849–50), 13 William R King (1853), 14 John C Breckinridge (1857–61) 15 Hannibal Hamlin (1861–65) 16 Andrew Johnson (1865)


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VICE-PRESIDENTS OF THE UNITED STATES

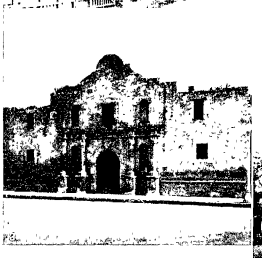
1. Schuyler Colfax (term of office, 1869–73). 2. Henry Wilson (1873–75) 3. William A Wheeler (1877–81). 4. Chester A. Arthur (1881). 5. Thomas A Hendricks (1885) 6. Levi P Morton (1889–93). 7. Adlai E. Stevenson (1893–97). 8 Garret A Hobart (1897–99). 9. Theodore Roosevelt (1901). 10 Charles W Fairbanks (1905–09) 11. James S. Sherman (1909–12). 12 Thomas Marshall (1913–21). 13. Calvin Coolidge (1921–23). 14 Charles G. Dawes (1925–29). 15. Charles Curtis (1929–33). 16 John N Garner (1933–41) 17. Henry A. Wallace (1941–45) 18 Harry S. Truman (1945). 19 Alben W. Barkley (1949–53). 20. Richard M. Nixon (1953–)

UNITED STATES OF AMERICA



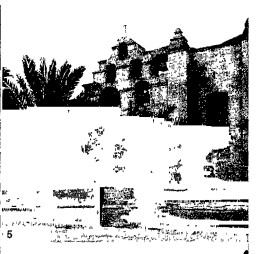


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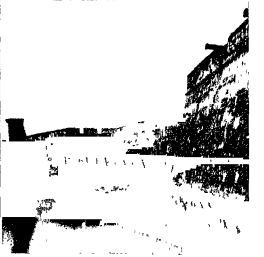


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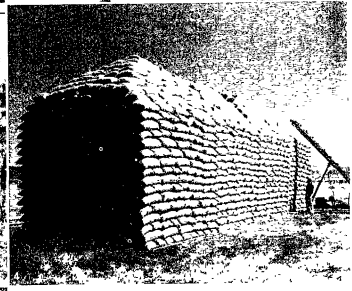
FAMOUS LANDMARKS IN UNITED STATES HISTORY

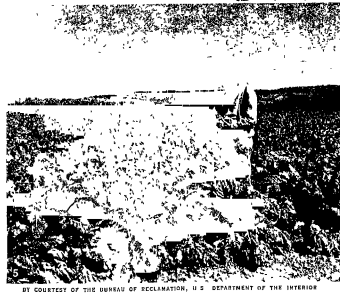
1. The Nelson House at Yorktown, Va , home of Governor Thomas Nelson, built in 1740. During the Revolutionary War it was used as staff headquarters by Lord Cornwallis A cannon ball can be seen embedded under the apex of the gable
2. The Ford House at Morristown, N.J , where General Washington and his staff made their headquarters for a time during the Revolutionary War Preserved by the Daughters of the American Revolution
3. The Alamo, formerly a Franciscan mission, at San Antonio, Tex. There in 1836, in the war for Texan Independence, Colonels Travis, Crockett and Bowie, with 180 men, withstood 4,000 Mexicans for 13 days, killing 500 attackers before being overpowered and slain
4. Independence Hall, Philadelphia, Pa Begun in the year 1729 and completed in 1734 this building was known as the States House until the adoption of the Declaration of Independence within its walls in 1776. Originally designed by Dr. John Kearsley
5. San Gabriel Mission, one of a chain of Franciscan missions between San Diego and San Francisco, Calif It was founded in 1771
6. Fort McHenry, Locust Point, Baltimore, Md During the bombardment of this fort by the British in 1814 Francis Scott Key composed *The Star-Spangled Banner*
7. Liberty Bell in Independence Hall. The bell was rung after the signing of the Declaration of Independence in 1776 It cracked in 1835 when it was rung at the death of Chief Justice John Marshall
8. A section of the moat of Fort Marion, St Augustine, Fla. This fort is a fairly well preserved specimen of Spanish military architecture. Begun about 1638 and completed in 1756

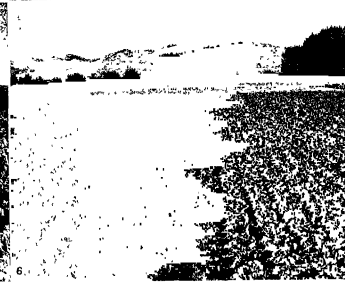












BY COURTESY OF THE BUREAU OF RECLAMATION, U S DEPARTMENT OF THE INTERIOR

CROPS HARVESTED FROM FORMER DESERT LAND IN THE WESTERN UNITED STATES

1 Irrigating for a row crop in the Salt river project, Ariz
2 Young tomato plants covered with "white caps" in a field near Yettum, Calif., in the Central valley irrigation project
3 Baled hay in stack near Stronghold, Calif., in the Klamath irrigation project
4 A pile of barley grown from irrigated land in the Klamath project
5 Irrigated field of sugar beets near Tulelake, Calif
6 Cabbage grown on irrigated land near Klamath Falls, Ore.

UNITED STATES OF AMERICA

to assume powers not granted to it. Madison's idea seems to have been that the restraint was to be imposed by a second convention of the States. Jefferson's idea is more doubtful; if it meant that the restraint should be imposed by any state which should feel aggrieved, his scheme was merely Calhoun's idea of nullification; but there are some indications that he agreed with Madison.

The first Congress of Adams's term of office ended in 1799. Its successor, elected in the heat of the French war excitement, kept the Federalist policy up to its first pitch. Out of Congress the execution of the objectionable laws had taken the shape of political persecution. Men were arrested, tried and punished for writings which the people had been accustomed to consider within legitimate political methods. The Republican leaders made every trial as public as possible, and gained votes constantly, so that the Federalists began to be shy of the very powers which they had sought Every new election was a storm signal for the Federalist Party, and the danger was increased by schism in their own ranks

Election of 1800.—Hamilton was now a private citizen of New York, but he had the confidence of his party more largely than its nominal head, the President, and he maintained close and confidential relations with the cabinet which Adams had taken unchanged from Washington. The Hamilton faction saw no way of preserving and consolidating the newly acquired powers of the Federal Government but by keeping up and increasing the war feeling against France; Adams had the instinctive leaning of an American President towards peace. Amid cries of wrath and despair from his party he accepted the first overtures of the new Napoleonic Government, sent envoys to negotiate a peace, and ordered them to depart for France when they delayed. Then, discovering flat treachery in his cabinet, he dismissed it and blurted out a public expression of his feeling that Hamilton and his adherents were "a British faction." Hamilton retorted with a circular letter to his party friends, denouncing the President; the Republicans intercepted it and gave it a wider circulation than its author had intended. The result depended on the electoral vote of New York; and Aaron Burr, who had introduced the drill and machinery of a modern American political party there, had made the State Republican and secured a majority for the Republican candidates These (Jefferson and Burr) received the same number of electoral votes (73) and the House of Representatives (controlled by the Federalists) was thus called upon to decide which should be President There was an effort by the Federalists to disappoint the Republicans by making Burr President, but Jefferson obtained that office, Burr becoming vice president for four years. This disputed election, however, led to the adoption in 1804 of the 12th amendment to the Constitution, which prescribed that each elector should vote separately for president and vice president, and thus prevent another tie vote of this kind.

The "Revolution of 1800" decided the future development of the United States. The new dominant party entered upon its career weighted with the theory of State sovereignty; and a civil war was necessary before this dogma, put to use again in the service of slavery, could be banished But the democratic development never was checked As the Republicans obtained control of the States they altered the State constitutions so as to cut out all the arrangements that favoured property or class interests, and reduced political power to the dead level of manhood suffrage. In most of the States outside of New England this process was completed before 1815; but New England tenacity was proof against the advancing revolution until about 1820 For 20 years after its downfall of 1800 the Federalist party maintained its hopeless struggle, and then it faded away into nothing, leaving as its permanent memorial the excellent organization of the Federal Government, which its successful rival hardly changed. Its two successors—the Whig and the second Republican party—have also been broad-constructionist parties, but they have admitted democracy as well.

The New Capital.—The disputed election of 1800 was decided in the new capital city of Washington, to which the Government had just been removed, after having been for ten years at Philadelphia Its streets and parks existed only on paper. The Capitol had been begun; the Executive Mansion was unfinished, and its audience room was used by Mrs. Adams as a drying room for clothes; the congressmen could hardly find lodgings The inconveniences were only an exaggeration of the condition of other American cities. Their sanitary conditions were bad, and yellow fever and cholera from time to time reduced several of them almost to depopulation. More than once during this decade the fever visited Philadelphia and New York, drove out most of the people, and left grass growing in the streets. The communication between the cities was still wretched The traveller was subject to every danger that bad roads, bad carriages, bad horses, bad inns and bad police protection could combine to inflict upon him.

The West.—About this time the term "the West" appears. It meant then the western part of New York, the new territory north of the Ohio, and Kentucky and Tennessee. In settling land boundaries New York had transferred (1786) to Massachusetts, whose claims crossed her territory, the right to (but not jurisdiction over) a large tract of land in central New York, and to another large tract in the Erie basin The sale of this land had carried population considerably west of the Hudson. Between 1790 and 1800 the population of Ohio had risen from almost nothing to 45,000, that of Tennessee from 36,000 to 106,000, and that of Kentucky from 74,000 to 221,000—the last-named State now exceeding six of the "old 13" in population. The difficulties of the western emigrant, however, were still enormous. He obtained land of his own, fertile land and plenty of it, but little else. The produce of the soil had to be consumed at home, or near it; ready money was scarce and distant products scarcer; and comforts, except the very rudest substitutes of home manufacture, were unobtainable. The number of post offices rose during these ten years from 75 to 903; the miles of post routes from 1,900 to 21,000, and the revenue from $38,000 to $231,000.

Patents.—The power of Congress to regulate patents was already bearing fruit. Until 1789 this power was in the hands of the States, and the privileges of the inventor were restricted to the territory of the patenting State. Now he had a vast and growing territory within which all the profits were his own. Twenty patents were issued in 1793, and 23,471 100 years later. One of the inventions of 1793 was Eli Whitney's cotton gin

Cotton.—When the Constitution was adopted it was not known that the cultivation of cotton could be made profitable in the southern States. The "roller gin" could clean only 6 lb. a day by slave labour. In 1784 eight bags of cotton, landed in Liverpool from an American ship, had been seized on the ground that so much cotton could not be the produce of the United States. Eli Whitney invented the saw-gin, by which the cotton was dragged through parallel wires with openings too narrow to allow the seeds to pass; and one slave could now clean 1,000 lb. a day. The exports of cotton leaped from 189,000 lb. in 1791 to 21,000,000 lb. in 1801, and doubled in three years more. The influence of this one invention, combined with the wonderful series of British inventions which had paved the way for it, can hardly be estimated in its commercial aspects. Its political influences were even wider, but more unhappy. The introduction of the commercial element into the slave system of the South robbed it at once of the patriarchal features which had made it tolerable; while it developed in slaveholders a new disposition to defend a system of slave labour as a "positive good."

Slavery.—The development of a class whose profits were merely the extorted natural wages of the black labourer was certain; and its political power was as certain, though it never showed itself clearly until after 1830. And this class was to have a peculiarly distorting effect on the political history of the United States. Aristocratic in every sense but one, it was ultra-Democratic (in a purely party sense) in its devotion to State sovereignty, for the legal basis of the slave system was in the laws of the several States. In time the aristocratic element got control of the party which had originally looked to State rights as a bulwark of individual rights; and the party was finally committed to the employment of its original doctrine for an entirely different purpose—the suppression of the black labourer's wages.

Democracy and Nationality, 1801–29.—When Jefferson took office in 1801 his party, ignoring the natural forces which

tied the States together even against their wills, insisted that the legal basis of the bond was in the power of any State to withdraw at will This was no nationality; and foreign nations naturally refused to take the American national coin at any higher valuation than that at which it was current in its own country The urgent necessity was for a reconciliation between democracy and nationality; and this was the work of this period. An underlying sense of all this has led Democratic leaders to call the war of 1812–15 the "Second War of Independence"; the result was Independence of past ideas as the first had been of Great Britain

Louisiana.—The first force in the new direction was the acquisition of Louisiana in 1803. Napoleon had acquired it from Spain, and, fearing an attack upon it by Great Britain, offered it to the United States for $15,000,000. The Constitution gave the Federal Government no power to buy and hold territory, and the party was based on a strict construction of the Constitution. Possession of power forced the strict-construction party to broaden its ideas, and Louisiana was bought, though Jefferson quieted his conscience by talking for a time of a futile proposal to amend the Constitution so as to grant the necessary power. The acquisition of the western Mississippi basin more than doubled the area of the United States, and gave them control of all the great river systems of central North America The difficulties of using these rivers were removed almost immediately by Robert Fulton's utilization of steam in navigation (1807). Within four years steamboats were at work on western waters, and thereafter the increase of steam navigation and that of population stimulated one another. The centre of population during this period advanced from about the middle of Maryland to its earlier extreme western limit; that is, the centre of population was in 1830 nearly at the place which had been the western limit of population in 1770

The Oregon Country.—Jefferson also laid the basis for a further acquisition in the future by sending an expedition under Meriwether Lewis and William Clark to explore the territory north of the then Spanish territory of California and west of the Rocky Mountains—the "Oregon country" as it was afterwards called. The explorations of this party (1804–06), with Capt. Robert Gray's discovery of the Columbia river (1792), made the best part of the claims of the United States to the country 40 years later.

Election of 1804.—Jefferson was re-elected in 1804. His great success as President was the acquisition of Louisiana, which was a violation of his party principles; but all his minor successes were, like this, recognitions of the national sovereignty which he disliked so much. After a short and brilliant naval war the Barbary pirates were reduced to submission (1805). The long-continued control of New Orleans by Spain, and the persistent intrigues of the Spanish authorities, looking towards a separation of the whole western country from the United States, had been ended by the acquisition of Louisiana. There still existed a dangerous ignorance of Federal power and control, of which Aaron Burr took advantage (1806–07). Organizing an expedition in Kentucky and Tennessee, probably for the conquest of the Spanish colony of Mexico, he was arrested on the lower Mississippi and brought back to Virginia He was acquitted; but the incident opened up a vaster view of the national authority than democracy had yet been able to take.

Jefferson and his party persistently refused to recognize the inherent power of the nation in international affairs. The Jay treaty expired in 1806 and American commerce was left to the course of events, Jefferson refusing to accept the only treaty which the British Government was willing to make. All the difficulties which followed may be summed up in a few words: the British Government was then the representative of the ancient system of restriction of commerce, and had a powerful Navy to enforce its ideas; the American Government was endeavouring to force into international recognition the system of neutral rights and unrestricted commerce, but its suspicious democracy refused to give it a navy sufficient to command respect.

Neutral Commerce.—Great Britain was now at war, from time to time, with almost every other nation of Europe. In time of peace European nations followed generally the old restrictive principle of allowing another nation, like the United States, no commercial access to their colonies; but, when they were at war with Great Britain, whose Navy controlled the ocean, they were very willing to allow the neutral American merchantmen to carry away their surplus colonial produce. Great Britain had insisted for 50 years that the neutral nation, in such cases, was really intervening in the war as an ally of her enemy; but she had so far modified her claim as to admit that "transhipment," or breaking bulk, in the United States was enough to qualify the commerce for recognition. The neutral nation thus gained a double freight, and grew rich in the traffic; the belligerent nations no longer had commerce afloat for British vessels to capture, and the "frauds of the neutral flags" became a standing subject of complaint among British merchants and naval officers. About 1805 British prize courts began to disregard transhipment and to condemn American vessels which made the voyage from a European colony to the mother country by way of the United States.

Impressment.—The question of expatriation, too, furnished a good many burning grievances. Great Britain maintained the old German rule of perpetual allegiance, though she had modified it by allowing the right of emigration. The United States, founded by immigration, was anxious to establish the right of the subject to divest himself of allegiance by naturalization under a foreign jurisdiction. Four facts thus tended to break off friendly relations: (1) Great Britain's claim to allegiance over American naturalized subjects; (2) her claim to the belligerent right of search of neutral vessels; (3) her claim of right to impress for her vessels of war her subjects who were seamen wherever found; and (4) the difficulty of distinguishing native-born American from British subjects, even if the right to impress naturalized American subjects were granted. British naval officers even undertook to consider all who spoke the English language as British subjects, unless they could produce proof that they were native-born Americans. The American sailor who lost his papers was thus open to impressment. A particularly flagrant case of seizure of Americans occurred in 1807. On June 27 the British ship "Leopard" fired upon the American frigate "Chesapeake," which, after having lost three men killed and 18 wounded, hauled down its flag; the British commander then seized four of the "Chesapeake's" crew. This action aroused intense anger throughout the country, and but for the impotence of the Government would undoubtedly have led to immediate war. The American Government in 1810 published the cases of such impressments since 1803 as numbering over 4,000, about one-third of the cases resulting in the discharge of the impressed man.

In May, 1806, the British Government, by orders in council, declared a blockade of the whole continent of Europe from Brest to the Elbe, about 800 miles. In November, after the battle of Jena, Napoleon answered by the "Berlin decree," in which he assumed to blockade the British Isles, thus beginning his "continental system." A year later the British Government answered by further orders in council, forbidding American trade with any country from which the British flag was excluded, allowing direct trade from the United States to Sweden only, in American products, and permitting American trade with other parts of Europe only on condition of touching in England and paying duties. Napoleon retorted with the "Milan decree," declaring good prize any vessel which should submit to search by a British ship; but this was evidently a vain fulmination.

The Navy.—The Democratic Party of the United States was almost exclusively agricultural and had little sympathy with commercial interests; it was pledged to the reduction of national expenses and the debt, and did not wish to take up the responsibility for a navy; and, as the section of country most affected by the orders in council, New England, was Federalist, a tinge of political feeling could not but colour the decisions of the dominant party. Various ridiculous proposals were considered as substitutes for a necessarily naval war; and perhaps the most ridiculous was adopted. Since the use of non-intercourse agreements as revolutionary weapons against Great Britain, an overweening confidence in such measures had sprung up, and one of them was now resorted to—the embargo of Dec. 22, 1807, forbidding foreign commerce altogether. It was expected to starve Great Britain

into a change of policy; and its effects may be seen by comparing the $20,000,000 exports of 1790, $49,000,000 of 1807 and $9,000,000 of 1808. It does not seem to have struck those who passed the measure that the agricultural districts also might find the change unpleasant; but that was the result, and their complaints reinforced those of New England. The pressure had been slightly relieved by the substitution of the Non-Intercourse Law of March 1, 1809; it prohibited commercial intercourse with Great Britain and France and their dependencies, leaving other foreign commerce open, prohibited the importation from any quarter of British and French goods, and forbade the entrance of British or French vessels, public or private, into any port of the United States. Madison, Jefferson's secretary of State, who succeeded Jefferson in 1809, assumed in the Presidency a burden which was not enviable New England was in a ferment, and was suspected of designs to resist the restrictive system by force; and the Administration did not face the future with confidence.

The War of 1812.—The Non-Intercourse Law was to be in force only "until the end of the next session of Congress" and was to be abandoned as to either belligerent which should abandon its attacks on neutral commerce, and maintained against the other. In 1810 the American Government was led to believe that France had abandoned its system. Napoleon continued to enforce it in fact; but his official fiction served its purpose of limiting the non-intercourse for the future to Great Britain, and thus straining relations between that country and the United States still further. The elections of 1811–12 resulted everywhere in the defeat of "submission men" and in the choice of new members who were determined to resort to war against Great Britain. Henry Clay, John C. Calhoun, William H. Crawford and other new men seized the lead in the two houses of Congress, and forced Madison, it is said, to agree to a declaration of war as a condition of his renomination in 1812. Madison sent to Congress a confidential "war message" on June 1 and on the 18th war was declared. The national democracy meant to attack Great Britain in Canada, partly to gratify its western constituency, who had been harassed by Indian attacks, asserted to have been instigated from Canada. Premonitions of success were drawn from the battle of Tippecanoe, in which William Henry Harrison had defeated in 1811 the north-western league of Indians formed by Tecumseh. Between the solidly settled Atlantic States and the Canadian frontier was a wide stretch of unsettled or thinly settled country, which was itself a formidable obstacle to war. Ohio had been admitted as a State in 1802, and Louisiana was admitted in 1812; but their admission had been due to the desire to grant them self-government rather than to their full development in population and resources. Cincinnati was a little settlement of 2,500 inhabitants; the fringe of settled country ran not very far north of it; all beyond was a wilderness. The case was much the same with western New York. It would have been far less costly, as events proved, to have entered at once upon a naval war; but the crusade against Canada had been proclaimed all through Kentucky and the west, and their people were determined to wipe out their old scores before the conclusion of the war. (For the military and naval events of the war *see* WAR OF 1812, THE.)

The war opened with disaster—Gen William Hull's surrender of Detroit; and disaster attended it for two years Political appointments to positions in the regular army were numerous and such officers were worse than useless. Futile attempts at invasion were followed by defeat or abortion, until the political officers were weeded out at the end of the year 1813, and Jacob Brown, Winfield Scott, E. W. Ripley and others who had fought their way up were put in command. Then for the first time the men were drilled and brought into effective condition; two successful battles in 1814—Chippewa and Lundy's Lane—threw some glory on the end of the war So weak were the preparations even for defence that a British expedition in 1814 met no effective resistance when it landed and burned Washington.

The American Navy was but a puny adversary for the British Navy, which had captured or shut up in port all the other navies of Europe. But the small number of American vessels, with the superabundance of trained officers, gave them one great advantage: the training and discipline of the men, and the equipment of the vessels, had been brought to the very highest point. "The art of handling and fighting the old broadside sailing frigate" had been carried in the little American Navy to an excellence which unvarying success and a tendency to fleet-combats had now made far less common among British captains. Altogether the American vessels gave a remarkably good account of themselves.

Hartford Convention.—The home dislike to the war had increased steadily with the evidence of incompetent management by the administration The Federalists, who had always desired a navy, pointed to the naval successes as the best proof of folly with which the war had been undertaken. New England Federalists complained that the Federal Government utterly neglected the defence of their coast, and that southern influence was far too strong in national affairs. They showed at every opportunity a disposition to adopt the furthest stretch of State sovereignty, as stated in the Kentucky resolutions; and every such development urged the national democracy unconsciously further on the road to nationality. When the New England States sent delegates to meet at Hartford (Conn), and consider their grievances and the best remedies, treason was suspected, and a readiness to suppress it by force was plainly shown. The recommendations of the convention came to nothing; but the attitude of the dominant party towards it is one of the symptoms of the manner in which the trials of actual war were steadily reconciling democracy and nationality. The object which Hamilton had sought by high tariffs and the development of national classes had been attained by more natural and healthy means.

Peace.—In April, 1814, the first abdication of Napoleon took place, and Great Britain was able to give more attention to her American antagonist The main attack was to be made on Louisiana, the weakest and most distant portion of the Union. A fleet and army were sent thither, but the British assault was completely repulsed (Jan. 8, 1815) by the Americans under Andrew Jackson Peace had been made at Ghent 15 days before the battle was fought, but the news of the battle and the peace reached Washington almost together.

The United States secured a fairly good treaty. It is true that it said not a word about the questions of impressment, search and neutral rights, the grounds of the war; Great Britain did not abandon her position on any of them. But everybody knew that circumstances had changed. The new naval power whose frigates alone in the past 20 years had shown their ability to fight Engiish frigates on equal terms was not likely to be troubled in future with the question of impressment; and in fact, while not renouncing the right, the British Government no longer attempted to enforce it.

End of Federal Party.—The remainder of this period is one of the barrenest in American history The opposition of the Federalist Party to the war completed the measure of its unpopularity, and it had only a perfunctory existence for a few years longer Scandal, intrigue and personal criticism became the most marked characteristics of American politics until the dominant party broke at the end of the period, and real party conflict was renewed. But the seeds of the final disruption are visible from the peace of 1814. The old-fashioned Republicans looked with intense suspicion on the new form of Republicanism generated by the war, a type which instinctively bent its energies toward the further development of national power. Clay was the natural leader of the new Democracy; but John Quincy Adams and others of Federalist antecedents or leanings took to the new doctrines kindly; and even Calhoun, Crawford and others of the southern interest were at first strongly inclined to support them. One of the first effects was the revival of protection and of a national bank.

The Bank.—The charter of the national bank had expired in 1811, and the dominant party had refused to recharter it. The attempt to carry on the war by loans resulted in almost a bankruptcy and in a complete inability to act efficiently. As soon as peace gave time for consideration, a second bank was chartered (April 10, 1816) for 20 years with a capital of $35,000,000, one-fifth of which was to be subscribed for by the national Govern-

ment It was to have the custody of the Government revenues, but the secretary of the Treasury could divert the revenues to other custodians, giving his reasons for such action to Congress

Protection.—Protection was advocated again on national grounds, but not quite on those which had moved Hamilton. The additional receipts were now to be expended for fortifications and other national defences, and for national roads and canals The war and blockade had been an active form of protection, under which American manufactures had sprung up. As soon as peace was made English manufacturers drove their American rivals out of business or reduced them to desperate straits. Their cries for relief had a double effect. They gave the spur to the nationalizing advocates of protection, and, as most of the manufacturers were in New England or New York, they developed in the citadel of Federalism a class which looked for help to a Republican Congress This was the main force which brought New England into the Republican fold before 1825. An increase in the number of spindles from 80,000 in 1811 to 500,000 in 1815, and in cotton consumption from 500 bales in 1800 to 90,000 in 1815, the rise of manufacturing towns, and the rapid development of the mechanical tendencies of a people who had been hitherto almost exclusively agricultural, were influences which were to be reckoned with in the politics of a democratic country.

Tariff of 1816.—The tariff of 1816 imposed a duty of about 25% on imports of cotton and woollen goods, and specific duties on iron imports, except pig-iron, on which there was an *ad valorem* duty of 20%. In 1818 this duty also was made specific (50 cents a cwt.). The *ad valorem* duties carried most of the manufacturers through the financial crisis of 1818–19, but the iron duties were less satisfactory. In English manufacture the substitution of coke for charcoal in iron production led to continual decrease in price. As the price went down the specific duties were continually increasing the absolute amount of protection. Thus spared the necessity for improvements in production, the American manufacturers felt English competition more keenly as the years went by, and called for more protection

Era of Good Feeling.—James Monroe succeeded Madison as President in 1817, and, re-elected with hardly any opposition in 1820, he served until 1825. So complete was the supremacy of the Republican Party that this is often called "the era of good feeling" It came to an end when a successor to Monroe was to be elected; the two sections of the dominant party then had their first opportunity for open struggle. During Monroe's two terms of office the nationalizing party developed the policy on which it proposed to manage national affairs. This was largely the product of the continually swelling western movement of population. The influence of the steamboat was felt more and more every year, and the want of a similar improvement in land transport was correspondingly evident The attention drawn to western New York by the war had filled that part of the State with a new population. The southern Indians had been completely overthrown by Andrew Jackson during the war of 1812, and forced to cede their lands. The admission of the new States of Indiana (1816), Mississippi (1817), Illinois (1818), Alabama (1819), Maine (1820) and Missouri (1821)—all but Maine the product and evidence of western growth—were the immediate results of the development consequent upon the war. All the territory east of the Mississippi, except the northern part of the North-west Territory, was now formed into self-governing States; the State system had crossed the Mississippi; all that was needed for further development was the locomotive engine. The 4,000,000 of 1790 had grown into 13,000,000 in 1830.

The "American System."—The urgent demand of western settlers for some road to a market led to a variety of schemes to facilitate intercourse between the east and the west—the most successful being that completed in New York in 1825, the Erie canal. The Hudson river forms the great natural breach in the barrier range which runs parallel to the Atlantic coast. When the traveller has passed up the Hudson through that range he sees before him a vast champaign country extending westward to the Great Lakes, and perfectly adapted by nature for a canal. Such a canal, to turn western traffic into the lake rivers and through the lakes, the canal, and the Hudson to New York city, was begun by the State through the influence of De Witt Clinton It was derisively called "Clinton's big ditch" until its completion laid the foundations for the great commercial prosperity of New York State and city Long before it was finished the evident certainty of its success had enticed other States into far less successful enterprises of the kind and had established as a nationalizing policy the combination of high tariffs and expenditures for internal improvements which was long known as the "American system." The tariffs or duties on imports were to be carried as high as revenue results would justify; the superabundant revenues were to be expended on enterprises which would tend to aid the people to subdue the continent Protection was now to be for national benefit, not for the benefit of classes Western farmers were to have manufacturing towns at their doors, as markets for the surplus which had hitherto been rotting on their farms; competition among manufacturers was to keep down prices; and Henry Clay's eloquence was to commend the whole policy to the people The old democracy, particularly in the south, insisted that the whole scheme really had its basis in benefits to classes, that its communistic features were not such as the Constitution meant to cover by its grant of power to Congress to levy taxation for the general welfare. The dissatisfaction in the South rose higher when the tariffs were increased in 1824 and 1828. The proportion of customs revenue to dutiable imports rose to 37% in 1825 and to 44% in 1829; and the ratio to aggregate imports to 33% in 1825 and 37% in 1829

The Monroe Doctrine.—In international relations the action of the Government was strong, quiet and self-respecting. Its first weighty action took place in 1823. It had become pretty evident that the Holy Alliance meant to aid Spain in bringing her revolted South American colonies to obedience. Great Britain had been drifting steadily away from the alliance, and George Canning, the new secretary, determined to call in the weight of the transatlantic power as a check upon it. A hint to the American minister was followed by a few pregnant passages in Monroe's annual message in December. "We could not view," he said, "any interposition for the purpose of oppressing them [the South American States], or controlling in any other manner their destiny by any European power, in any other light than as the manifestation of an unfriendly disposition towards the United States" If both the United States and Great Britain were to take this ground the fate of a fleet sent by the Alliance across the Atlantic was not in much doubt, and the project was at once given up.

It was supposed at the time that Spain might transfer her colonial claims to some stronger power, and Monroe therefore said that "the American continents, by the free and independent condition which they have assumed and maintained, are henceforth not to be considered as subjects for future colonization by any European powers." This declaration and that quoted above constitute together the "Monroe Doctrine" as originally proclaimed. The doctrine has remained the rule of foreign intercourse for all American parties.

Oregon.—By a treaty with Russia (1825) that power gave up all claims on the Pacific coast south of the present limits of Alaska. The northern boundary of the United States had been defined by the treaty of 1783; and, after the acquisition of Louisiana, a convention with Great Britain (1818) settled the boundary on the line of 49° N lat. as far west as the Rocky Mountains. West of these mountains the so-called Oregon country, on whose limits the two powers could not agree, was to be held in common possession for ten years. This common possession was prolonged by another convention (1827) indefinitely, with the privilege to either power to terminate it, on giving 12 months' notice. This arrangement lasted until 1846.

Election of 1824.—Monroe's term of office came to an end in March 1825. He had originally been an extreme Democrat, who could hardly speak of Washington with patience; he had slowly modified his views, and his tendencies were now eagerly claimed by the few remaining Federalists as identical with their own. All the candidates for the Presidency in 1824—Andrew Jackson, a private citizen of Tennessee; William H Crawford, Monroe's

secretary of the treasury; John Quincy Adams, his secretary of State; and Henry Clay, the Speaker of the House of Representatives—claimed to be Republicans alike; but the personal nature of the struggle was shown by the tendency of their supporters to call themselves "Adams men" or "Jackson men," rather than by any real party title. Calhoun was supported by all groups for the vice presidency, and was elected without difficulty. The choice of a president was more doubtful.

Party Changes.—None of the four candidates had anything like a party organization behind him. Adams and Clay represented the nationalizing element, as Crawford and Jackson did not; but there the likeness among them stopped. The strongest forces behind Adams were the new manufacturing and commercial interests of the East; behind Clay were the desires of the West for internal improvements: and the two elements were soon to be united into the National Republican or Whig Party. Crawford was the representative of the old Democratic Party, with all its Southern influences and leanings. Jackson was the personification of the new democracy—not very cultured, perhaps, but honest, and hating every shade of class control instinctively As he became better known the whole force of the new drift of things turned in his direction. Crawford was taken out of the race, just after the electors had cast their votes, by physical failure, and Adams, later, by the revival of ancient quarrels with the Federalists of New England; and the future was to be with Clay or with Jackson. But in 1824 the electors gave no one a majority; and the House of Representatives, voting by States, gave the presidency to Adams

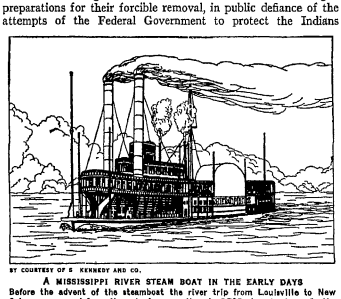
Adams' election in 1825 was due to the fact that Clay's friends in the House—unable to vote for him, as he was the lowest in the electoral vote, and only three names were open to choice in the House—very naturally gave their votes to Adams. As Adams appointed Clay to the leading position in his cabinet, the defeated party at once raised the cry of "bargain and intrigue," one of the most effective in a democracy, and it was kept up throughout Adams' four years of office. Jackson had received the largest number of electoral votes, though not a majority and the hazy notion that he had been injured because of his devotion to the people increased his popularity. Though demagogues made use of it for selfish purposes, this feeling was an honest one, and Adams had nothing to oppose to it. He tried vigorously to uphold the "American system," and succeeded in passing the tariff of 1828, he tried to maintain the influence of the United States on both the American continents; but he remained as unpopular as his rival grew popular. In 1828 Adams was easily displaced by Jackson, the electoral vote being 178 to 83. Calhoun was re-elected vice president.

Triumph of Jackson.—Jackson's inauguration in 1829 closes this period, as it ends the time during which a disruption of the Union by the peaceable withdrawal of any State was even possible. The party which had made State sovereignty its bulwark in 1798 was now in control of the Government again; but Jackson's proclamation in his first term, in which he warned South Carolina that "disunion by armed force is treason," and that blood must flow if the laws were resisted, speaks a very different tone from the speculations of Jefferson on possible future divisions of the United States. Even the sudden attempt of South Carolina to exercise independent action shows that some interest dependent upon State sovereignty had taken alarm at the drift of events, and was anxious to lodge a claim to the right before it should slip from its fingers for ever.

Slavery.—When the vast territory of Louisiana was acquired in 1803 the new owner found slavery already established there. Congress tacitly ratified existing law by taking no action; slavery continued legal, and spread further through the territory; and the State of Louisiana entered as a slave State in 1812. The next State to be carved out of the territory was Missouri, admitted in 1821. A territory, on applying for admission as a State, brings a Constitution for inspection by Congress; and when it was found that the new State of Missouri proposed to recognize and continue slavery, a vigorous opposition spread through the North and West, and carried most of the senators and representatives from those sections with it. In the House of Representatives these two sections had a greatly superior number of members; but, as the number of Northern and Southern States had been kept about equal, the compact Southern vote, with one or two Northern allies, generally retained control of the Senate. Admitted by the Senate and rejected by the House, Missouri's application hung suspended for two years until it was successful by the admission of Maine, a balancing Northern State, and by the following arrangement, known as the Missouri Compromise of 1820. Missouri was to enter as a slave State; slavery was forever prohibited throughout the rest of the Louisiana Purchase north of lat. 36° 36′, the main southern boundary of Missouri; and, though nothing was said of the territory south of the compromise line, it was understood that any State formed out of it was to be a slave State, if it so wished. Arkansas entered under this provision in 1836.

The question of slavery was thus set at rest for the present, though a few agitators were roused to more zealous opposition to the essence of slavery itself. In the next decade these agitators succeeded only in the conversion of a few recruits, but these recruits were the ones who took up the work at the opening of the next period. It is plain now, however, that North and South had already drifted so far apart as to form two sections, and it became evident during the next forty years that the wants and desires of these two sections were so divergent that it was impossible for one Government to make satisfactory laws for both.

The Settled Area.—The vast flood of human beings which had been pouring westward for years had now pretty well occupied the territory east of the Mississippi, while, on the west side of that stream, it still showed a disposition to hold to the river valleys. The settled area had increased from 240,000sq m. in 1790 to 633,000sq.m in 1830, with an average of 20·3 persons to the sq mile. There was still a great deal of Indian territory in the Southern States of Georgia, Alabama, Mississippi and Florida, for the Southern Indians were among the finest of their race; they had become semi-civilized, and were formidable antagonists to the encroaching white race. The States interested had begun preparations for their forcible removal, in public defiance of the attempts of the Federal Government to protect the Indians



BY COURTESY OF S. KENNEDY AND CO.

A MISSISSIPPI RIVER STEAM BOAT IN THE EARLY DAYS

Before the advent of the steamboat the river trip from Louisville to New Orleans consumed from three to four months. In 1820 steamboats made the trip in less than 20 days; and in 1836, in 6 days. This improved facility of transportation was influential in increasing the population of the Mississippi Valley

(1827); but the removal was not completed until 1835. In the North, Wisconsin and Michigan, with the northern halves of Illinois and Indiana, were still very thinly settled, but everything indicated early increase of population. The first lake steamboat, the "Walk-in-the-Water," had appeared at Detroit in 1818, and the opening of the Erie canal in 1825 added more vessels.

The land system of the United States had much to do with the early development of the West. From the first settlement, the universally recognized rule had been that of absolute individual property in land, with its corollary of unrestricted competitive

or "rack" rents; and this rule was accepted fully in the national land system. The public lands were to be divided into "hundreds" each ten miles square and containng 100 mile-square plots The hundred was called a "township," and was afterwards reduced to six miles square, of 36 mile-square plots of 640ac each. From time to time principal meridians and east and west base lines have been run, and townships have been determined by their relations to these lines. The price fixed in 1790 as a minimum was $2 per ac ; in 1820 it was reduced to $1.25 per ac ; it has tended to decrease, and no effort has ever been made to gain a revenue from it When the nation acqured its western terntory it secured its title to the soil, and always made it a fundamental condition of the admission of a new State that it should not tax United States lands. To compensate the new States for the freedom of unsold public lands from taxation, one township in each 36 was reserved to them for educational purposes; and the excellent public school systems of the Western States have been founded on this provision. The cost of obtaining a quarter section (160ac.), under the still later homestead system of granting lands to actual settlers, came to be only about $26 to cover fees for filing claim and granting title; the interest on this, at 6%, represents an annual rent of one cent per acre—making this, says F A. Walker, as nearly as possible the "no-rent land" of the economists.

The bulk of the early westward migration was of home production; the great immigration from Europe did not begin until about 1847 The West as well as the East thus had its institutions fixed before being called upon to absorb an enormous foreign element.

Industrial Development and Sectional Divergence, 1829–50.—The years 1829–37 have been called "the reign of Andrew Jackson"; his popularity, long struggle for the presidency, and his feeling of his official ownership of the subordinate offices gave to his administration at least an appearance of Caesarism. But it was a strictly constitutional Caesarism; the restraints of written law were never violated, though the methods adopted within the law were new to national politics. Since about 1800 State politics in New York and Pennsylvania had been noted for the systematic political use of the offices. The presence of New York and Pennsylvania politcians in Jackson's cabinet taught him to use the same system Removals, except for cause, had been relatively rare before; but under Jackson men were removed almost exclusively for party purposes and a clean sweep was made in the civil service. Other parties adopted the system, and it remained the rule at a change of administration until near the end of the century.

Parties.—The system brought with it a semi-military reorganization of parties. Hitherto nominations for the more important offices had been made mainly by legislative caucuses; candidates for president and vice-president were nominated by caucuses of congressmen, and candidates for the higher State offices by caucuses of the State legislatures. Late in the preceding period "conventions" of delegates from the members of the party in the State were held in New York and Pennsylvania; and in 1831–32 this became the rule for presidential nominations. It rapidly developed into systematic State, county and city "conventions"; and the result was the appearance of that complete political machnery, the American political party The Democratic machinery was the first to appear, in Jackson's second term (1833–37). Its workers were paid in offices, or hopes of office, so that it was said to be built on the "cohesive power of public plunder"; but its success was immediate and brilliant. The opposing party, the Whig Party, had no chance of victory in 1836; and its complete overthrow drove its leaders into the organization of a simllar machinery of their own, which scored its first success in 1840.

Bank of the U.S.—The Bank of the United States had hardly been heard of in politics until the new Democratic organization came into hostile contact with it. A semi-official demand upon it for a political appointment was met by a refusal; and the party managers called Jackson's attention to an institution which he could not but dislike the more he considered it. His first message spoke of it in unfriendly terms, and every succeeding message brought a more open attack. The old party of Adams and Clay had by this time taken the name of Whigs, probably from the notion that they were struggling against "the reign of Andrew Jackson," and they adopted the cause of the bank with eagerness The bank charter did not expire until 1836, but in 1832 Clay brought up a bill for a new charter. It was passed and vetoed; and the Whigs made the veto an important issue of the presidential election of that year. They were beaten; Jackson was re-elected, receiving 219 electoral votes, and Clay, his Whig opponent, only 49, and the bank party could never again get a majority in the House of Representatives. But the President could not obtain a majority in the Senate. He determned to take a step which would give him an initiative, and which his opponents could not induce both houses to unite in overriding or punishing. Taking advantage of the provision that the secretary of the Treasury might order the public funds to be deposited elsewhere than in the bank or its branches, he directed the secretary to deposit *all* the public funds elsewhere. Thus deprived of its great source of dividends, the bank fell into difficultues, became a State bank after 1836, and then went into bankruptcy.

All the political conflicts of Jackson's terms of office were close and bitter. Loose in his ideas before 1829, Jackson showed a steady tendency to adopt the strictest construction of the powers of the Federal Government, except in such official perquisites as the offices. He grew into strong opposition to all traces of the "American system," and vetoed bills for internal improvements unsparingly; his feeling of dislike to all forms of protection is as evident, though he took more care not to make it too public.

Nullification. Calhoun and Jackson.—Calhoun and Jackson were of the same stock—Scottish-Irish—much alike in appearance and characteristics, Calhoun representing the trained and educated logic of the race, Jackson its instincts and passions. Jackson was led to break off his friendly relations with Calhoun in 1830, and he had been led to do so more easily because of the appearance of the doctrine of nullification which was generally attributed, correctly enough, to Calhoun Asserting, as the Republican Party of 1798 had done, the sovereign powers of each State, Calhoun held that, as a means of avoiding secession and violent struggle upon every occasion of the passage of an act of Congress which should seem unconstitutional to any State, the State might properly suspend or "nullify" the operation of the law within its jurisdiction The passage of the tariff act of 1832, which organized and systematized the protective system, forced his party into action. A State convention in South Carolina on Nov. 24, 1832, declared the tariff act null, and made ready to enforce the declaration

But the time was past when the power of a single State could withdraw it from the Union. The President issued a proclamation, warning the people of South Carolina against any attempt to carry out the ordinance of nullification; he ordered a naval force to take possession of Charleston Harbour to collect the duties under the act; he called upon Congress for additional executive powers, and Congress passed what nullifiers called the "bloody bill," putting the land and naval forces at the disposal of the president, and he is said to have announced, privately and profanely, his intention of making Calhoun the first victim of any open conflict. Affairs looked so threatening that an unofficial meeting of "leading nullifiers" agreed to suspend the operation of the ordinance until Congress should adjourn, whence it derived the right to suspend has never been stated.

Tariff of 1833.—The President had already asked Congress to reduce the duties; and many Democratic members of Congress, who had yielded to the popular clamour for protection, were very glad to use "the crisis" as an excuse for now voting against it. A compromise tariff act, scaling down all duties over 20% by one-tenth of the excess every two years until 1842, when the remaining excess over 20% should be dropped, was introduced by Clay and became law. Calhoun and his followers claimed this as all that the nullification ordinance had aimed at; and the ordinance was formally repealed But nullification had received its death-blow, even those southern leaders who maintained the right of secession refused to recognize the right of a State to remain in the Union while nullifying its laws.

Railways.—All the internal conditions of the United States were completely altered by the introduction of railways. For 20

years past the Americans had been pushing in every direction which offered a hope of the means of reconciling vast territory with enormous population. Stephenson's invention of the locomotive came just in time, and Jackson's two terms of office marked the outburst of modern American life. The miles of railway were 23 in 1830, 1,098 in 1835, some 2,800 in 1840, and thereafter they about doubled every five years until 1860

A railway map of 1840 shows a fragmentary system, designed mainly to fill the gaps left by the means of communication in use in 1830. One or two short lines run back into the country from Savannah and Charleston; another runs north along the coast from Wilmington to Baltimore; several lines connect New York with Washington and other points; and short lines elsewhere mark the openings which needed to be filled at once—a number in New England and the Middle States, three in Ohio and Michigan, and three in Louisiana Year after year new inventions came in to increase and aid this development. The anthracite coal of the Middle States was now successfully applied to railways (1836), and to the manufacture of iron (1837) Steam navigation across the Atlantic was established in 1838. The telegraph came next, S F B Morse's line being erected in 1844. No similar period in American history of the 19th century is so extraordinary for material development as the decade 1830–40. At its beginning the country was an overgrown type of colonial life; at its end American life had been shifted to entirely new lines, which it has since followed

Western Settlements.—The steamboat had aided western development, but the railway aided it far more. The steamboat influenced the railway, and the railway gave the steamboat new powers. Vacant places in the States east of the Mississippi were filling up; the long lines of emigrant wagons gave way to the new and better methods of transport. Chicago was but a frontier fort in 1832; within a half-dozen years it was a flourishing town, with eight steamers connecting it with Buffalo, with dawning ideas of its future development of railway connections. Two new States, Arkansas and Michigan, were admitted (1836 and 1837) The population of Ohio grew from 900,000 to 1,500,000, that of Michigan from 32,000 to 212,000, and that of the country from 13,000,000 to 17,000,000, between 1830 and 1840.

Social Conditions.—With the change of material surroundings and possibilities came a steady amelioration of social conditions and a development of social ideals. Such features of the past as imprisonment for debt and the cruel indifference of old methods of dealing with crime began to disappear, the time was past when a State could use an abandoned copper mine as its State prison, as Connecticut had formerly done. The domestic use of gas and anthracite coal, the introduction of expensive aqueducts for pure water, and the changing life of the people forced changes in the interior and exterior of American dwellings. Wood was still the common building material; imitations of Greek architecture still retained their vogue; but the interiors were models of comfort in comparison with the houses even of 1810 In the "new" regions this was not yet the case, and here social restraints were still so few that society seemed to be reduced almost to its primitive elements Western steamers reeked with gambling, swindling, duelling and every variety of vice. Public law was almost suspended in some regions; and organized associations of counterfeiters and horse-thieves terrorized whole sections of the country. But this state of affairs was altogether temporary, as well as limited in its area; the older and more densely settled States had been well prepared for the change and had never lost command of the social forces, and the process of settling down went on, even in the newer States, with far more rapidity than could have been expected.

Literature.—A distinct American literature dates from this period. Most of the publications in the United States were still cheap reprints of foreign works; but native productions no longer followed foreign models with servility. Between 1830 and 1840 Whittier, Longfellow, Holmes, Poe, Hawthorne, Emerson, Bancroft and Prescott joined the advance-guard of American writers —Bryant, Dana, Halleck, Drake, Irving and Cooper; and even those writers who had already made their place in literature showed the influence of new conditions by their growing tendency to look less to foreign models and methods. Popular education was improved The new States had from the first endeavoured to secure the best possible system of common schools The attempt came naturally from the political instincts of the class from which the migration came; but the system which resulted was to be of incalculable service during the years to come. Their absolute democracy and their universal use of the English language have made the common schools most successful machines for converting the raw material of immigration into American citizens This supreme benefit is the basis of the system and the reason for its existence and development, but its incidental advantage of educating the people has been beyond calculation. It was an odd symptom of the general change that American newspapers took a new form during these ten years. The old "blanket-sheet" newspaper, cumbrous to handle and slow in all its ways, met its first rival in the type of newspaper which appeared first in New York city, in the *Sun*, the *Herald* and the *Tribune* (1833, 1835 and 1841). Swift and energetic in gathering news, and fearless, sometimes reckless, in stating it, they burst into American life, with very much that is evil, a great preponderance of good

Speculation.—The chaos into which a part of American society had been thrown had a marked effect on the financial institutions of the country, which went to pieces before it for a time. It had not been meant to make the public lands of the United States a source of revenue so much as a source of development. The sales had touched their high-water mark during the speculative year 1819, when receipts from them had amounted to $3,274,000; in other years they seldom went above $2,000,000 When the railway set the stream of migration moving faster than ever, and cities began to grow like mushrooms, it was natural that speculation in land should feel the effects. Sales rose to $3,200,000 in 1831, and to $25,000,000 in 1836. In 1835 the President announced to Congress that the public debt was extinguished, and that some way of dealing with the surplus should be found. Calhoun's proposal, that after the year 1836 any surplus in excess of $5,000,000 should be divided among the States as a loan, was adopted, as regards the surplus (almost $37,000,000) of that year; and some $28,000,000 were actually distributed before the crisis of 1837 put an end to the surplus and to the policy The States had already taken a hand in the general speculation by beginning works of public improvement. Foreign, particularly English, capital was abundant; and States which had been accustomed to think a dozen times over a tax of $100,000 now began to negotiate loans of millions of dollars and to appropriate the proceeds to the digging of canals and the construction of railways. Their enterprises were badly conceived and badly managed. The imaginations of individuals ran riot. Every one wanted to buy; prices rose, and every one was growing richer on paper. The assessed value of real estate in New York city in 1832 was $104,000,000; in 1836 it had grown to $253,000,000. In Mobile the assessed value rose from $1,000,000 to $27,000,000.

When Jackson in 1833 ordered the Government revenues to be deposited elsewhere than in the Bank of the United States, there was no Government agent to receive them The secretary of the Treasury selected banks at various points in which the revenue should be deposited by the collecting officers, but these banks were organized under charters from their States. The Democratic feeling was that the privilege of forming banking corporations should be open to all citizens, and it soon became so. Moreover, it was not until after the crash that New York began the system of compelling such deposits as would really secure circulation. In most of the States banks could be freely organized with or without tangible capital, and their notes could be sent to the West for the purchase of Government lands, which needed to be held but a month or two to gain a handsome profit. "Wild-cat banks" sprang up all over the country; and the "pet banks," as those chosen for the deposit of Government revenues were called, went into speculation as eagerly as the banks which hardly pretended to have capital.

Panic of 1837.—The Democratic theory denied the power of Congress to make anything but gold or silver coin legal tender. There have been "paper-money heresies" in the party; but there was none such among the new school of Democratic leaders which came in in 1829; they were "hard-money men." In July 1836

Jackson's secretary of the Treasury ordered land agents to take nothing in payment for lands except gold or silver In the following spring the full effects of the order became evident; they fell on the administration of Van Buren, Jackson's successor Van Buren had been Jackson's secretary of State, the representative man of the new Democratic school, and it seemed to the Whigs poetic justice that he should bear the weight of his predecessor's errors The "specie circular" turned the tide of paper back to the East, and when it was presented for payment most of the banks suspended specie payment There was no longer a thought of buying; everyone wanted to sell, and prices ran down with a rapidity even more startling than that with which they had risen Failures on a scale unprecedented in the United States made up the "panic of 1837" Many of the States had left their bonds in the hands of their agents, and, on the failure of the agents, found that the bonds had been hypothecated or disposed of, so that the States got no return from them except a debt which was to them enormous. Saddled suddenly with such a burden, and unable even to pay interest, some of the States "repudiated" their obligations; and repudiation was made successful by the fact that a State could not be sued except by its own consent. Even the U S Government felt the strain, for its revenues were locked up in suspended banks. A little more than a year after Congress had authorized the distribution of its surplus revenues among the States, Van Buren was forced to call it into special session to provide some relief for the Government itself.

The Sub-treasury.—Van Buren held manfully to the strictest construction of the powers of the Federal Government. He insisted that the panic would best right itself without Government interference, and, after a four years' struggle, he succeeded in making the "sub-treasury scheme" law (1840) It cut off all connection of the Government with banks, putting collecting and disbursing officers under bonds to hold money safely and to transfer it under orders from the Treasury, and restricting payments to or by the United States to gold and silver coin Its passage had been preceded by another commercial crisis (1839), more limited in its field, but more discouraging to the people

Election of 1840.—Van Buren's firmness was unpopular, and the Whig Party now adopted methods which were popular if somewhat demagogical. It nominated William H Harrison in 1840, it contrasted his homely frontier virtues with Van Buren's "ostentatious indifference to the misfortunes of the people" and after the first of the modern "campaigns" of mass meetings and processions Harrison was elected, receiving 234 electoral votes and Van Buren only 60. He died only a month after his inauguration, and the vice-president, John Tyler, became President.

Tyler was of the extreme Calhoun school, which had shown some disposition to grant to Van Buren a support which it had refused to Jackson; and the Whigs had nominated Tyler to retain his faction with them. Now he was the nominal leader of the party, while his politics were opposite to theirs, and the real leader of the party, Clay, was ready to force a quarrel upon him. The quarrel took place; the Whig majority in Congress was not large enough to pass any measures over Tyler's veto; and the first two years of his administration were passed in barren conflict with his party The "sub-treasury" law was repealed (1841); the tariff of 1842 introduced a modified protection; and there the Whigs were forced to stop. Their dissensions made Democratic success comparatively easy. The success of the Democratic machinery, and the reflex of its temporary check in 1840, with the influences brought to bear on it by the returning Calhoun faction, were such as to take the control of the party out of the hands of the leaders who had formed it. They had had high regard for political principle, even though they were willing to use doubtful methods for its propagation; these methods had now brought out new men, who looked mainly to success, and to close connection with the controlling political element of the South as the easiest means of attaining success. When the Democratic convention of 1844 met it was expected to renominate Van Buren, but James K. Polk was nominated. The Whigs nominated Clay.

Abolitionist Movement.—The beginning of the abolitionist movement in the United States, the establishment of the *Liberator* (1831), and of the American Anti-slavery Society (1833), and the subsequent divisions in it, are dealt with elsewhere (*see* GARRISON, WILLIAM LLOYD) Up to that time "abolition" had meant *gradual* abolition, Garrison called for *immediate* abolition The basis of the American system was in the reserved rights of the States, and slavery rested on their will. The mission of the Abolitionists was to force the people to think of the question; and, in spite of riots, assaults and persecution of every kind, they fulfilled it manfully. In truth, slavery was more and more out of harmony with the new economic conditions which were taking complete control of the North and West, but had hardly been felt in the South Thus the two sections, North and South, were more and more disposed to take opposite views of everything in which slavery was involved, and it had a faculty of involving itself in almost everything The status of slavery in the Territories had been settled in 1820; that of slavery in the States had been settled by the Constitution; but even in minor questions the intrusive element had to be reckoned with The Abolitionists sent their documents through the mails, and the South wished the Federal Government to stop the practice. The Abolitionists persisted in petitioning Congress for the passage of various measures which Congress regarded as utterly unconstitutional, and the disposition of Congress to deny or regulate the right of petition in such matters excited the indignation of Northern men who had no sympathy with abolition. But the first occasion on which the views of the two sections came into flat contrast was on the question of the annexation of Texas.

Texas and Oregon.—The United States had had a vague claim to Texas until 1819, when the claim was surrendered to Spain in part compensation for Florida. On the revolt of Mexico, Texas became a part of that republic. It was colonized by Americans, mainly southerners and slave-holders, seceded from Mexico in 1835, and defeated the Mexican armies and established its independence in the following year. Southern politicians desired its annexation to the United States. People in the North were either indifferent or hostile to the proposal; Van Buren had declared against it, and his action was a reason for his defeat in the Democratic convention. On the other hand, there were indications that the joint occupation of the Oregon country could not last much longer American immigration into it had begun, while the Hudson's Bay Company, the British tenant of the soil was the natural enemy of immigration The two points were coupled; and the Democratic convention declared for the reannexation of Texas and the reoccupation of Oregon.

Election of 1844.—One of the cardinal methods of the political Abolitionists was to nominate candidates of their own against a doubtful friend, even though this secured the election of an open enemy. Clay's efforts to guard his condemnation of the Texas annexation project were just enough to push the Liberty party, the political Abolitionists, into voting for candidates of their own in New York; on a close vote their loss was enough to throw the electoral votes of that State to Polk, and its votes decided the result. Polk was elected (Nov. 1844); and Texas was annexed to the United States in the following spring. At the next meeting of Congress (1845) Texas was admitted as a State.

West of Texas the northern prolongation of Mexico ran right athwart the westward movement of American population; and though the movement had not yet reached the barrier the Polk Administration desired further acquisitions from Mexico. The western boundary of Texas was undefined; a strip of territory claimed by Texas was settled exclusively by Mexicans; but the Polk Administration directed Gen. Zachary Taylor, the American commander in Texas, to cross the Nueces river and seize the disputed territory Collisions with Mexican troops followed; they were beaten in the battles of Palo Alto and Resaca de la Palma, and were chased across the Rio Grande. Taylor followed and took the city of Monterrey.

War with Mexico.—On the news of the first bloodshed, Congress declared war against Mexico, over the opposition of the Whigs A land and naval force took possession of California, and a land expedition occupied New Mexico, so that the authority of Mexico over all the soil north of her present boundaries was

abruptly terminated (1846). At the opening of 1847 Taylor fought the last battle in northern Mexico (Buena Vista), defeating the Mexicans, and Gen Winfield Scott, with a new army, landed at Vera Cruz for a march upon the City of Mexico. Scott's march was marked by one successful battle after another, usually against heavy odds; and in September he took the capital city and held it until peace was made (1848) by the Treaty of Guadalupe Hidalgo. Among the terms of peace was the cession of the present California, Utah, Arizona and New Mexico, the consideration being a payment of $15,000,000 by the United States and the assumption of some $3,000,000 of debts due by Mexico to American citizens. With a subsequent rectification of frontier (1853) by the Gadsden Treaty (*see* GADSDEN, JAMES), this cession added some 500,000sq m to the area of the United States; Texas itself made up a large additional area. The settlement of the north-east and north-west boundaries by the Webster-Ashburton and Buchanan-Pakenham treaties (1842, 1846) with the Texas and Mexican cessions, gave the United States the complete territorial form retained until the annexation of Alaska in 1867.

Slavery in the New Territory.—In the new territory slavery had been forbidden under Mexican law; and its annexation brought up the question of its status under American law. If slavery was to be excluded from the new territory, the States which should ultimately be formed out of it would enter as free States, and the influence of the South in the Senate would be decreased For the first time the South appears as a distinct *imperium in imperio*.

"Squatter Sovereignty."—The first appearance of these difficulties brought out in the Democratic Party a solution which was so closely in line with the prejudices of the party that it bade fair to carry the party through the crisis without the loss of its Southern vote. This was "squatter sovereignty," the notion that it would be best for Congress to leave the people of each Territory to settle the question of the existence of slavery for themselves. The broader and democratic ground for the party would have been that which it at first seemed likely to take—the "Wilmot Proviso," a condition proposed to be added to the act authorizing acquisitions of territory, providing that slavery should be forbidden in all territory to be acquired under the act. In the end apparent expediency carried the dominant party off to "squatter sovereignty," and the Democratic adherents of the Wilmot Proviso, with the Liberty Party and the anti-slavery Whigs, united in 1848 under the name of the Free Soil Party. The Whigs had no solution to offer; their entire programme consisted in a persistent effort to evade or ignore all difficulties connected with slavery.

Election of 1848.—Taylor, after the battle of Buena Vista, resigned and came home, considering himself ill-used by the Administration. He refused to commit himself to any party; and the Whigs were forced to accept him as their candidate in 1848. The Democrats nominated Lewis Cass; the "Free-Soilers" nominated Van Buren. Taylor was elected President, receiving 163 electoral votes, while Cass received 127. Taking office in March 1849, he had on his shoulders the whole burden of the territorial difficulties, aggravated by the discovery of gold in California and the sudden rise of population there. Congress was so split into factions that it could for a long time agree upon nothing; and the Californians, with the approval of the President, proceeded to form a Constitution and apply for admission as a State. They had so framed their Constitution as to forbid slavery; and this was really the application of the Wilmot Proviso to the richest part of the new territory, and the South felt that it had been robbed of the cream of what it alone had fought cheerfully to obtain.

Compromise of 1850.—The admission of California was not secured until Sept. 1850, soon after Taylor's sudden death (July 9), and then only by the addition of a bonus to Texas, the division of the rest of the Mexican cession into the Territories of Utah and New Mexico without prohibition of slavery, and the passage of a fugitive slave law. The slave trade, but not slavery, was forbidden in the District of Columbia. The whole was generally known as the Compromise Measures of 1850. Two of its features need notice As has been said, slavery was not mentioned in the act; and the status of slavery in the Territories was thus left uncertain. Congress can veto any legislation of a Territorial legislature but, in fact, the two houses of Congress were hardly ever able to unite on anything after 1850, and both these Territories did establish slavery before 1860, without a congressional veto. The advantage here was with the South. The other point, the fugitive slave law was a special demand of the South. The Constitution contained clauses directing that fugitive criminals and slaves should be delivered up, on requisition, by the State to which they had fled. In the case of criminals the delivery was directed to be made by the executive of the State to which they had fled; in the case of slaves no delivering authority was specified, and an act of Congress in 1793 had imposed the duty on Federal judges or on local State magistrates. Some of the States had passed "personal liberty laws," forbidding or limiting the action of their magistrates in such cases, and the act of 1850 transferred the decision of such cases to United States commissioners, with the assistance of United States marshals.

Tariff of 1846.—The question of slavery had taken up so much time in Congress that its other legislation was comparatively limited. The rates of postage were reduced to five and ten cents for distances less and greater than 300m. (1845); and the naval school at Annapolis was established in the same year. The military academy at West Point had been established as such in 1802. When the Democratic Party had obtained complete control of the Government, it re-established (by act of Aug 6, 1846), the "subtreasury," or independent Treasury. In the same year, a tariff bill was passed; it reduced duties, and moderated the application of the protective principle Apart from a slight reduction of duties in 1857, this remained in force till 1861.

New States.—Five States were admitted during the last ten years of this period: Florida (1845), Texas (1845), Iowa (1846), Wisconsin (1848) and California (1850). The early entrance of Iowa, Wisconsin and Florida had been due largely to Indian wars, after each of which the defeated Indians were compelled to cede lands The extinction of Indian titles in northern Michigan brought about the discovery of the great copper fields of that region. Elsewhere settlement followed the lines already marked out, except in the new possessions on the Pacific coast, whose full possibilities were not yet known Railways in the Eastern States were beginning to show something of a connected system; in the South they had hardly changed since 1840; in the West they had been prolonged only on their original lines. The telegraph was brought into use in 1844; but it was not until the census of 1860 that its effects were seen in the fully connected network of railways which then covered the whole North and West.

Invention.—The sudden development of wealth in the country gave an impetus to the spirit of invention. Charles Goodyear's method of vulcanizing rubber (1839) had come into use Cyrus Hall McCormick had made an invention the results of which have been hardly less than that of the locomotive in their importance to the United States He had patented a reaping machine in 1834, and this, further improved and supplemented by other inventions, had brought into play the whole system of agricultural machinery A successful sewing-machine came in 1846; the power-loom and the surgical use of anaesthetics in the same year; and the rotary press for printing in 1847.

The Mormons.—All the conditions of life were changing so rapidly it was natural that the minds of men should change with them. This was the era of new sects, of communities, of transcendentalism in literature, religion and politics. The most successful of these was the sect of Mormons. They settled in Utah in 1847, calling their capital Salt Lake City, and spread through the neighbouring Territories. They became a menace to the American system; their numbers were so great that it was against American instincts to deprive them of self-government; while their polygamy and total submission to their hierarchy made it impossible to erect them into a State having complete control of marriage and divorce. The difficulty was lessened by their renunciation of polygamy in 1890.

The South.—The material development of the United States since 1830 had been extraordinary, but every year made it more evident that the South was not sharing in it. It is plain now that

the fault was in her labour system. her only labourers were slaves, and a slave who was fit for anything better than field labour was *prima facie* a dangerous man The divergence had as yet gone only far enough to awaken intelligent men in the South to its existence, and to stir them to efforts as hopeless as they were earnest, to find some artificial stimulus for Southern industries. In the next ten years the process was to show its effects on the national field

Slavery had put the South out of harmony with its surroundings Even in 1850, though they hardly yet were aware of it, the two sections had drifted so far apart that they were practically two different countries.

The Slave Power.—The South remained much as in 1790, while other parts of the country had developed, it had stood still. The remnants of colonial feeling, of class influence, which advancing democracy had wiped out elsewhere, retained their force here. The ruling class had to maintain a military control over the labouring class, and a class influence over the poorer whites. It had even secured in the Constitution provision for its political power in the representation given to three-fifths of the slaves. The 20 additional members of the House of Representatives were not simply a gain to the South; they were still more a gain to the "black districts," where whites were few, and the slave-holder controlled the district. Slave-owners and slave-holders together, there were but 350,000 of them; but they had common interests, the intelligence to see them, and the courage to contend for them The first step of a rising man was to buy slaves; and this was enough to enroll him in the dominant class. From it were drawn the representatives and senators in Congress, the governors and all the holders of offices over which the "slave power," as it came to be called, had control.

Immigration.—Immigration into the United States was not an important factor in its development till about 1847. The immigrants, so late as 1820, numbered but 8,000 per annum; their number did not touch 100,000 till 1842, and then it fell for a year or two almost to half that number. In 1847 it rose again to 235,000, in 1849 to 300,000, and in 1850 to 428,000, all told, more than 2,225,000 persons from abroad settled in the United States between 1847 and 1854. Leaving out the dregs of the immigration, which settled down in the seaboard cities, its best part was a powerful nationalizing force. It had not come to any particular State, but to the United States, yet all the influences of this enormous immigration were confined to the North and West; the immigration avoided slave soil as if by instinct And as the sections began to differ further in aims and policy the North began to gain heavily in ability to ensure its success.

Congress.—Texas was the last slave State ever admitted; and, as it refused to be divided, the South had no further increase of numbers in the Senate. Until 1850 the admission of a free State had been so promptly balanced by the admission of a slave State that the senators of the two sections had remained about equal in number: in 1860 the free States had 36 senators and the slave States only 30. As the representation in the House had changed from 35 free State and 30 slave State members in 1790 to 147 free State and 90 slave State in 1860, and as the number of presidential electors is the sum of the numbers of senators and representatives, political power had passed away from the South in 1850. If at any time the free States should unite they would be supreme.

Tendencies to Disunion.—In circumstances so critical a cautious quiescence and avoidance of public attention was the only safe course for the "slave power," but that course had become impossible. The numbers interested had become too large to be subject to complete discipline; not all could be held in cautious reserve; and when an advanced proposal came from any quarter of the slave-holding lines the whole army was shortly forced up to the advanced position. If collision came it must be on some question of the rights of the States; and on such a question the whole South would move as one man.

The Protestant churches of the United States had reflected in their organization the spirit of the political institutions under which they lived. Acting as purely voluntary associations, they had been organized into governments by delegates, much like the "conventions" which had been evolved in the political parties The omnipresent slavery question intruded into these bodies, and split them Only the Episcopal and Roman Catholic Churches retained their national character

Party Changes.—The political parties showed the same tendency. Each began to shrivel up in one section or the other The notion of "squatter sovereignty," attractive at first to the Western democracy, and not repudiated by the South, enabled the Democratic Party to pass the crisis of 1850 without losing much of its Northern vote, while Southern Whigs began to drift in, making the party continually more pro-slavery. This could not continue long without beginning to decrease its Northern vote, but this effect did not become plainly visible until after 1852. The efforts of the Whig Party to ignore the great question alienated its anti-slavery members in the North, while they did not satisfy its Southern members The Whig losses were not at first heavy, but, as the electoral vote of each State is determined by the barest plurality they were enough to defeat the party almost everywhere in the presidential election of 1852 The Whigs nominated Gen Winfield Scott and the Democrats Franklin Pierce; Pierce carried all but four of the 31 States, and was elected, receiving 254 out of the 296 electoral votes. This revelation of hopeless weakness was the downfall of the Whig Party; it maintained its organization for four years longer, but the life had gone out of it. The future was with the Free Soil Party, though it had polled but few votes in 1852.

During the Administration of Taylor (and vice-president Millard Fillmore, who succeeded him) Clay, Webster, Calhoun, Polk and Taylor were removed by death, and there was a steady drift of other political leaders out of public life New men were pushing in everywhere, and in both sections they showed the prevailing tendency to disunion The best of them were unprecedentedly radical. Charles Sumner, William H Seward and Salmon P. Chase came into the Senate, bringing the first accession of recognized force and ability to the anti-slavery feeling in that body. The new Southern men, such as Jefferson Davis, and the Democratic recruits from the Southern Whig Party, such as Alexander H Stephens, were ready to take the ground on which Calhoun had always insisted—that Congress was bound not merely to the negative duty of not attacking slavery in the Territories, but to the positive duty of protecting it. This, if it should become the general Southern position, was certain to destroy the notion of "squatter sovereignty," and thus to split the Democratic Party, which was almost the last national ligament that now held the two fragments of the Union together.

Progress of Disunion.—The social disintegration was as rapid. Northern men travelling in the South were naturally looked upon with increasing suspicion, and were made to feel that they were on a soil alien in sympathies Some of the worst phases of democracy were called into play in the South; and, in some sections, law openly yielded supremacy to popular passion in the cases of suspected Abolitionists. Southern conventions, on all sorts of subjects, became common; and, permeated by a dawning sense of Southern nationality, hardly any proposition looking to Southern independence of the North was met with disfavour.

Calhoun, in his last and greatest speech, called attention to the manner in which one tie after another was snapping But he ignored the real peril of the situation—its dangerous facts: that the South was steadily growing weaker in comparison with the North, and more unable to secure a wider area for the slave system; that it was therefore being steadily forced into demanding active Congressional protection for slavery in the Territories; that the North would never submit to this; and that the South must submit or bring about a collision by attempting to secede.

Kansas-Nebraska Act.—Anti-slavery feeling in the North was stimulated by the manner in which the fugitive slave law was enforced immediately after 1850. The chase after fugitive slaves was prosecuted in many cases with circumstances of revolting brutality The added feeling showed its force when the Kansas-Nebraska Act was passed by Congress (1854). It organized the two new Territories of Kansas and Nebraska. Both of them were

forever free soil by the terms of the Missouri Compromise But the success of the notion of squatter sovereignty in holding the Democratic Party together while destroying the Whig Party had intoxicated Stephen A Douglas and other Northern Democrats, and they now applied the doctrine to these Territories Thus did not desire "to vote slavery up or down," but left the decision to the people of the two Territories

The Republican Party.—The Kansas-Nebraska Act was the grossest political blunder in American history. The status of slavery had been settled, by the Constitution or by the compromises of 1820 and 1850, on every square foot of American soil; right or wrong, the settlement was made. The new act took a great mass of territory out of the settlement and flung it down as a prize for which the sections were to struggle. The first result of the act was to throw parties into chaos. An American or "Know-Nothing" Party, a secret oath-bound organization, pledged to oppose the influence or power of foreign-born citizens, had been formed to take the place of the defunct Whig Party It had been quite successful in State elections for a time, and was now beginning to have larger aspirations. It like the Whig Party, intended to ignore slavery, but, after a few years of life, the questions complicated with slavery divided it also. Even in 1854 many of its leaders in the North were forced to take position against the Kansas-Nebraska Act, while hosts of others joined in the opposition without any party organization. No American party ever rose so swiftly as this; with no other party name than the awkward title of "Anti-Nebraska men," it carried the congressional elections of 1854 in the North, forced many of the former Know-Nothing leaders into union with it, and controlled the House of Representatives of the Congress which met in 1855. The Democratic Party, which had been practically the only party since 1852, had now to face the latest and strongest of its broad-constructionist opponents. It acknowledged, at first. no purpose aimed at slavery, only an intention to exclude slavery from the Territories, but, under such principles, it was the only party which was potentially an anti-slavery party. The new party had grasped the function which belonged of right to its great opponent, and it seized with it its opponent's original title. The name Democrat had quite taken the place of that first used—Republican—but Republican had never passed out of popular remembrance and liking in the North The new party took quick and skilful advantage of this by assuming the old name, and early in 1856 the two great parties of the present—Democratic and Republican—were drawn up against one another.

Foreign Relations.—The foreign relations during Pierce's term of office were overshadowed by the domestic difficulties, but were of importance. In the Koszta case (1853) national protection had been afforded on foreign soil to a person who had taken only the preliminary steps to naturalization Japan had been opened to American intercourse and commerce (1854). But the question of slavery was more and more thrusting itself even into foreign relations A great Southern republic, to be founded at first by the slave States, but to take in gradually the whole territory around the Gulf of Mexico and include the West Indies, was soon to be a pretty general ambition among slave-holders, and its first phases appeared during Pierce's administration Efforts were begun to obtain Cuba from Spain; and the three leading American ministers abroad, meeting at Ostend, united in declaring the possession of Cuba to be essential to the well-being of the United States (1854). "Filibustering" expeditions against Cuba or the smaller South American States, intended so to revolutionize them as to lay a basis for an application to be annexed to the United States, became common. But these yielded in importance to the affairs in Kansas.

Kansas.—Nebraska was then supposed to be a desert, and attention was directed almost exclusively to Kansas. No sooner had its organization left the matter of slavery to be decided by its "people" than the anti-slavery people of the North and West felt it to be their duty to see that the "people" of the Territory should be anti-slavery in sympathy. Emigrant associations were formed, and these shipped men and families to Kansas, arming them for their protection in the new country. Southern newspapers called for similar measures in the South, but the call was less effective Southern men without slaves, settling a new State, were uncomfortably apt to prohibit slavery, as in California. Only slave-holders were trusty pro-slavery men, and such were not likely to take slaves to Kansas and risk their ownership But for the people of Missouri, Kansas would have been free soil at once. Lying across the direct road to Kansas, the Missouri settlers blockaded the way of free-State settlers, crossed into Kansas, and voted profusely at the first Territorial election. The struggle passed into a real civil war, the two powers fighting battles, capturing towns and paroling prisoners The struggle was really over in 1857, and the South was beaten. There were, however, many obstacles yet to be overcome before the new State of Kansas was recognized by Congress, after the withdrawal of the senators of the seceding States (1861).

Election of 1856.—In the heat of the Kansas struggle came the presidential election of 1856. The Democrats nominated James Buchanan, declaring, as usual, for the strictest limitations of the powers of the Federal Government and reaffirming the principle of the Kansas-Nebraska act—the settlement of slavery by the people of a Territory. The remnant of the Whig Party, including the Know-Nothings of the North and those Southern men who wished no further discussion of slavery, nominated Millard Fillmore The Republican Party nominated John C. Frémont; the bulk of its manifesto was taken up with protests against attempts to introduce slavery into the Territories; but it showed its broad-construction tendencies by declaring for appropriations of Federal moneys for internal improvements. The Democrats were successful in electing Buchanan; but the position of the party was quite different from the triumph with which it had come out of the election of 1852 It was no longer master of 27 of the 31 States, all the free States but five had gone against it; its candidate no longer had a majority of the popular vote. For the first time in the history of the country a distinctly anti-slavery candidate had obtained an electoral vote, and had even come near obtaining the Presidency Fillmore had carried but one State, Maryland; Buchanan had carried the rest of the South, with a few States in the North, and Frémont the rest of the North and none of the South.

Dred Scott.—Oddly enough the constitutionality of the Compromise of 1820 had never happened to come before the Supreme Court for consideration. In 1856-57 it came up for the first time. One Dred Scott, a Missouri slave who had been taken in 1834 to Illinois, a free State, and in 1836 to Minnesota, within the territory covered by the compromise, and had some years after being taken back to Missouri in 1838 sued for his freedom, was sold (1852) to a citizen of New York. Scott then transferred his suit from the State to the Federal courts, under the power given them to try suits between citizens of different States, and the case came by appeal to the Supreme Court. Its decision, announced on March 6, 1857, put Scott out of court on the ground that a slave, or the descendant of slaves, could not be a citizen of the United States or have any standing in Federal courts The opinion of Chief Justice Taney went on to attack the validity of the Missouri Compromise, for the reasons that one of the Constitutional functions of Congress was the protection of property, that slaves had been recognized as property by the Constitution, and that Congress was bound to protect, not to prohibit, slavery in the Territories Most of the Northern people held that slaves were looked upon by the Constitution not as property but as "persons held to service or labour" by State laws. A large part of the North flouted the decision of the Supreme Court, and the storm of angry dissent which it aroused did the disunionists good service in the South From this time the leading newspapers in the South maintained that the radical Southern view first advanced by Calhoun, and but slowly accepted by other Southern leaders, as to the duty of Congress to protect slavery in the Territories, had been confirmed by the Supreme Court; that the Northern Republicans had rejected it; even the "squatter sovereignty" of Northern Democrats could no longer be submitted to by the South

John Brown.—The population of the United States in 1860

was over 31,000,000, an increase of more than 8,000,000 in ten years As the decennial increases of population became larger, so did the divergence of the sections in population, and still more in wealth and resources Two more free States came in during this period—Minnesota (1858) and Oregon (1859)—and Kansas was clamouring loudly for the same privilege The free and slave States, which had been almost equal in population in 1790, stood now as 19 to 12 And of the 12,000,000 in slave States, the 4,000,000 slaves and the 250,000 free blacks were not so much a factor of strength as a possible source of weakness and danger No serious slave rising had ever taken place in the South, but John Brown's attack (1859) on Harper's Ferry, as the first move in a project to rouse the slaves and the alarm which it carried through the South, were tokens of a danger which added a new horror to the chances of civil war.

Democratic Party Split.—Northern Democrats, under the lead of Douglas, had been forced already almost to the point of revolt by the determination of Southern senators to prevent the admission of Kansas as a free State, if not to secure her admission as a slave State. When the Democratic convention of 1860 met at Charleston the last strand of the last national political organization parted; the Democratic Party itself was split by the slavery question. The Southern delegates demanded a declaration in favour of the duty of Congress to protect slavery in the Territories. It was all that the Douglas Democrats could then do to maintain themselves in a few Northern States; such a declaration meant political suicide everywhere, and they voted it down The convention divided into two bodies. The Southern body adjourned to Richmond, and the Northern and border State convention to Baltimore Here the Northern delegates, by seating some delegates friendly to Douglas, provoked a further secession of border State delegates, who, in company with the Richmond body, nominated John C. Breckinridge and Joseph Lane for President and vice-president The remainder of the original convention nominated Douglas and H. V Johnson

The remnant of the old Whig and Know-Nothing parties, now calling itself the Constitutional Union Party, met at Baltimore and nominated John Bell and Edward Everett. The Republican convention met at Chicago. Its "platform" of 1856 had been somewhat broad-constructionist but a strong Democratic element in the party had prevented it from going too far. The election of 1856 had shown that, with the votes of Pennsylvania and Illinois, the party would have then been successful, and the Democratic element was now ready to take almost anything which would secure the votes of these States. This state of affairs will go to explain the nomination of Abraham Lincoln, of Illinois, for President, with Hannibal Hamlin, a former Democrat, for vice-president, and the declaration of the platform in favour of a protective tariff. The mass of the platform was still devoted to the necessity of excluding slavery from the Territories.

Election of 1860.—No candidate received a majority of the popular vote, Lincoln standing first and Douglas second. But Lincoln and Hamlin had a clear majority of the electoral vote, and so were elected, Breckinridge and Lane coming next. It is worthy of mention that, up to the last hours of Lincoln's first term of office, Congress would always have contained a majority opposed to him but for the absence of the members from the seceding States. The interests of the South and even of slavery were thus safe enough under an anti-slavery president. But the drift of events was too plain. Nullification had come and gone, and the nation feared it no longer Even secession by a single State was now almost out of the question; the letters of Southern governors in 1860, in consultation on the state of affairs, agree that no State would secede without assurances of support by others. If this crisis were allowed to slip by without action, even a sectional secession would soon be impossible.

Secession.—In Oct. 1860 Gov. W. H Gist of South Carolina sent a letter to the governor of each of the other cotton States except Texas, asking co-operation in case South Carolina should resolve upon secession, and the replies were favourable The democratic revolution which, since 1829, had compelled the legislature to give the choice of presidential electors to the people of the States had not affected South Carolina, her electors were still chosen by the legislature. That body, after having chosen the State's electors on Nov. 6, remained in session until the telegraph had brought assurances that Lincoln had been elected; it then (on the 10th) summoned a State convention and adjourned The State convention on Dec 20 unanimously passed an "ordinance of secession," repealing the acts by which the State had ratified the Constitution and its amendments, and dissolving "the union now subsisting between South Carolina and other states, under the name of the 'United States of America'" The convention took all steps necessary to prepare for war, and adjourned. Similar ordinances were passed by conventions in Mississippi (Jan 9, 1861), Florida (Jan 10), Alabama (Jan 11), Georgia (Jan. 19), Louisiana (Jan. 26) and Texas (Feb. 1)

The Confederate States.—The opposition in the South did not deny the right to secede, but the expediency of its exercise. Their effort was to elect delegates to the State conventions who would vote not to secede They were beaten, says A H. Stephens, by the cry, originally uttered by T. R. R. Cobb before his State legislature (Nov. 12, 1860), "We can make better terms out of the Union than in it." That is, the States were to withdraw individually, suspend the functions of the Federal government within their jurisdiction for the time, consider maturely any proposals for guarantees for their rights in the Union, and return as soon as satisfactory guarantees should be given. When the conventions of the seceding States had adopted the ordinances of secession, they proceeded to other business. They appointed delegates, who met at Montgomery, the capital of Alabama, formed a provisional Constitution (Feb 8) for the "Confederate States," chose a provisional President and vice-president (Jefferson Davis and A H Stephens), and established an Army, Treasury, and other executive departments. The president and vice-president were inaugurated on Feb. 18 The permanent Constitution, adopted on March 11, was copied from that of the United States, with variations meant to maintain state Sovereignty, to give the Cabinet seats in Congress, and to prevent the grant of bounties or any protective features in the tariff or the maintenance of internal improvements at general expense; and it expressly provided that in all the territory belonging to the Confederacy but lying without the limits of the several States "the institution of negro slavery, as it now exists in the Confederate States, shall be recognized and protected by Congress and by the Territorial Government"

Under what claim of constitutional right all this was done passes comprehension. That a State convention should have the final power of decision on the question which it was summoned to consider is quite as radical doctrine as has yet been heard of; that a State convention, summoned to consider the one question of secession, should go on, with no appeal to any further popular authority or mandate, to send delegates to meet those of other States and form a new National Government, which could only exist by warring on the United States, is a novel feature in American constitutional law. It was revolution or nothing. Only in Texas, where the call of the State convention was so irregular that a popular vote could hardly be escaped, was any popular vote allowed. Elsewhere the functions of the voter ceased when he voted for delegates to the State convention.

The Border States.—The border States were in two tiers—North Carolina, Tennessee and Arkansas next to the seceding States, and Delaware, Maryland, Virginia, Kentucky and Missouri next to the free States. None of these was willing to secede. There was, however, one force which might draw them into secession. A State which did not wish to secede, but believed in State sovereignty and the abstract right of secession, would be inclined to take up arms to resist any attempt by the Federal Government to coerce a seceding State. In the following spring, the original seven seceding States were reinforced by four border States.

In the North and West surprisingly little attention was given to the systematic course of procedure along the Gulf. The people of those sections were very busy, they had heard much of this talk before, and looked upon it as a kind of stage thunder. Republican politicians, with the exception of a few, were inclined to refrain from public declarations of intention. Some of them such

as Seward, showed a disposition to let the "erring sisters" depart in peace, expecting to make the loss good by accessions from Canada. A few, like Senator Zachariah Chandler, believed that there would be "blood-letting," but most of them were still doubtful as to the future. In the North the leaders and the people generally shrank from the prospect of war Among the various proposals to this end, that offered in the Senate by John J Crittenden, of Kentucky, and known as the Crittenden compromise, was perhaps received with most favour. This took the form of six proposed amendments to the Constitution, of which two were virtually a re-phrasing of the essential feature of the Missouri Compromise and of the principle of squatter sovereignty, and others provided that the National Government should pay to the owner of any fugitive slave, whose return was prevented by opposition in the North, the full value of such slave, and prohibited the abolition of slavery in the District of Columbia "so long as it exists in the adjoining states of Virginia and Maryland or either." This proposed compromise was rejected by the Senate by a close vote on March 2, 1861 A peace congress, called by Virginia, met in Washington from Feb 4 to 27, 1861, 21 States being represented, and proposed a constitutional amendment embodying changes very similar to those of the Crittenden compromise, but its proposal was not acted upon by Congress Congress did nothing, except to admit Kansas as a free State and adopt the protective Morrill tariff; even after its members from the seceding States had withdrawn, those who remained made no preparations for conflict, and, at their adjournment in March 1861, left the Federal Government naked and helpless.

The War Governors.—The only sign of life in the body politic, the half-awakened word of warning from the Democracy of the North and West, was its choice of governors of States.[1] A remarkable group of men, soon to be known as the "war governors"—Israel Washburn of Maine, Erastus Fairbanks of Vermont, Ichabod Goodwin of New Hampshire, John Albion Andrew of Massachusetts, William Sprague of Rhode Island, William Alfred Buckingham of Connecticut, Edwin Dennison Morgan of New York, Charles Smith Olden of New Jersey, Andrew Gregg Curtin of Pennsylvania, William Dennison of Ohio, Oliver Perry Morton of Indiana, Richard Yates of Illinois, Austin Blair of Michigan, Alexander Williams Randall of Wisconsin, Samuel Jordan Kirkwood of Iowa, and Alexander Ramsey of Minnesota —held the executive powers of the Northern States in 1861–62 Some of these governors, such as Andrew and Buckingham, as they saw the struggle come nearer, went so far as to order the purchase of warlike material for their States on their private responsibility, and their action saved days of time.

U.S. Property Seized.—The little Army of the United States had been almost put out of consideration; wherever its detachments could be found in the South they were surrounded and forced to surrender and were transferred to the North. After secession, and in some of the States even before it, the forts, arsenals, munts, custom-houses, shipyards and public property of the United States had been seized by authority of the State, and these were held until transferred to the new Confederate States organization.

Only a few forts, of all the magnificent structures with which the nation had dotted the Southern coast, remained to it—the forts near Key West, Fortress Monroe at the mouth of Chesapeake Bay, Ft. Pickens at Pensacola and Ft. Sumter in Charleston Harbour. Both the last-named were beleaguered by hostile batteries, but the Administration of President Buchanan, intent on maintaining the peace until the new Administration should come in, instructed their commanding officers to refrain from any acts tending to open conflict. The Federal officers, therefore, were obliged to look idly on while every preparation was made for their destruction, and even while a vessel bearing supplies for Ft. Sumter was driven back by the batteries between it and the sea.

The divergence between the two sections of the country had thus passed into disunion, and was soon to pass into open hostility. The legal recognition of the custom of slavery, acting upon and reacted upon by every step in their economic development and every difference in their natural characteristics and institutions, had carried North and South farther and faster apart, until the elements of a distinct nationality had appeared in the South.

Secession had taken away many of the men who had for years managed the Federal Government, and who understood its workings. Lincoln's party was in power for the first time; his officers were new to the routine of Federal Administration; and the circumstances with which they were called upon to deal were such as to daunt any spirit The Government had become so nearly bankrupt in the closing days of Buchanan's Administration that it had escaped only by paying double interest. The Army had been almost broken up by captures of men and material and by resignations of competent and trusted officers The Navy had come to such a pass that, in Feb 1861, a House committee reported that only two vessels, one of 20, the other of two guns, were available for the defence of the entire Atlantic coast And, to complicate all difficulties, a horde of clamorous office-seekers crowded Washington

Civil War, 1861–65.—Soon after Lincoln's Administration began, the starting of an expedition to provision Ft. Sumter brought on an attack by the batteries around the fort, and after a bombardment of 36 hours the fort surrendered (April 14, 1861). It is not necessary to rehearse the familiar story of the outburst of feeling which followed this event and the proclamation of President Lincoln calling for volunteers. The 75,000 volunteers called for were supplied three or four times over.

There had been some belief in the South that the North-west would take no part in the impending conflict, and that its people could be persuaded to keep up friendly relations with the new nationality. In the spring months of 1861 Douglas, who had long been denounced as the tool of the Southern slave-holders, was spending the closing days of life in expressing the determination of the North-west that it would never submit to have "a line of custom-houses" between it and the ocean. The batteries which Confederate authority was erecting on the banks of the Mississippi were fuel to the flame. California, considered neutral by all parties, pronounced as unequivocally for the national authority.

The shock of arms put an end to opposition in the South as well. The peculiar isolation of life in the South precluded the more ignorant voter from any comparisons of the power of his State with any other; to him it was almost inconceivable that his State should own or have a superior. The better educated men, of wider experience, had been trained to think State sovereignty the foundation of civil liberty, and, when their State spoke, they felt bound to "follow their State." The president of the Confederate States issued his call for men, and it also was more than met.

The Border States.—Lincoln's call for troops met with an angry reception wherever the doctrine of State sovereignty had a foothold. The governors of the border States generally returned it with a refusal to furnish any troops. Two States, North Carolina and Arkansas, seceded and joined the Confederate States. In two others, Virginia and Tennessee, the State politicians formed "military leagues" with the Confederacy, allowing Confederate troops to take possession of the States and then submitted the question of secession to "popular vote" The secession of these States was thus accomplished, and Richmond became the Confederate capital. The same process was attempted in Missouri, but failed, and the State remained loyal. The politician class in Maryland and Kentucky took the extraordinary course of attempting to maintain neutrality; but the growing power of the Federal Government soon enabled the people of the two States to resume control of their governments and give consistent support to the Union. Kentucky, however, had troops in the Confederate armies; and one of her citizens, the late vice-president, John C Breckinridge, left the Senate and became an officer in the Confederate service. Delaware cast her lot from the first with the Union.

Civil War.—The first blood of the war was shed in the streets of Baltimore, when a mob attempted to stop Massachusetts troops on their way to Washington (April 19). For a time there was difficulty in getting troops through Maryland because of the active hostility of a part of its people, but this was overcome, and the national capital was made secure. The Confederate lines had been pushed up to Manassas Junction, about 30m. from Washington. When Congress, called into special session by the President for

July 4, came together, the outline of the Confederate States had been fixed. The length of the line, including also the Atlantic and Gulf coasts, has been estimated at 11,000 miles The territory within it comprised about 800,000sq m, with a population of over 9,000,000 and great natural resources Its cotton was almost essential to the manufactories of the world, in exchange for it every munition of war could be procured, and it was hardly possible to blockade a coast over 3,000m in length, on which the blockading force had but one port of refuge, and that at about the middle of the line. Nevertheless, President Lincoln issued his first call for troops on April 15 President Davis then issued a proclamation (on the 17th) offering letters of marque and reprisal against the commerce of the United States to private vessels, and on the 19th Lincoln answered with a proclamation announcing the blockade of the Southern coast The news brought out proclamations of neutrality from Great Britain and France.

The President found himself compelled to assume powers never granted to the executive authority, trusting to the subsequent action of Congress to validate his action He had to raise and support armies and navies; he even had to authorize seizures of necessary property, of railroad and telegraph lines, arrests of suspected persons, and the suspension of the writ of *habeas corpus* in certain districts Congress supported him, and proceeded in 1863 to give the President power to suspend the writ anywhere in the United States; this power he promptly exercised The Supreme Court, after the war, in the Milligan case (4 Wallace, 133) decided that no branch of the Government had power to suspend the writ in districts where the courts were open—that the *privilege* of the writ might be suspended as to persons properly involved in the war, but that the writ was still to issue, the court deciding whether the person came within the classes to whom the suspension applied.

When Congress met (July 4, 1861) the absence of Southern members had made it heavily Republican It decided to consider no business but that connected with the war, authorized a loan and the raising of 500,000 volunteers, and made confiscation of property a penalty of rebellion. While it was in session the first serious battle of the war—Bull Run, or Manassas—took place (July 21), and resulted in the defeat of the Federal Army.

The "Trent" Case.—The over-zealous action of a naval officer in taking the Confederate envoys James M. Mason and John Slidell out of the British steamer "Trent" sailing between two neutral ports almost brought about a collision between the United States and Great Britain in November. But the American precedents were all against the United States, and the envoys were given up.

The broad-construction tendencies of the Republican party showed themselves more plainly as the war grew more serious; there was an increasing disposition to cut every knot by legislation, with less regard to the constitutionality of the legislation A paper currency commonly known as "greenbacks," was adopted and made legal tender (Feb. 25, 1862). Slavery was prohibited (April 16) in the District of Columbia and the Territories (June 19); the Army was forbidden to surrender escaped slaves to their owners; and slaves of insurgents were ordered to be confiscated. In addition to a homestead act giving public lands to actual settlers at reduced rates, Congress began a further development of the system of granting public lands to railways. Another important act (1862) granted public lands for the establishment of agricultural and mechanical colleges.

Railways.—The railway system of the United States was but 20 years old in 1850, but it had begun to assume some consistency. The day of short and disconnected lines had passed, and the connections which were to develop into railway systems had appeared Consolidation of smaller companies had begun; the all-rail route across the State of New York was made up of more than a dozen original companies at its consolidation in 1853. The Erie railway, chartered in 1832, was completed from Piermont to Dunkirk (N.Y.), in 1851; and another line—the Pennsylvania—was completed from Harrisburg to Pittston (Pa.), in 1854. These were at least the germs of great trunk lines. The cost of American railways has been only from one-half to one-fourth of the cost of European railways, but an investment in a Far-western railway in 1850–60 was an extra-hazardous risk. Not only did social conditions make any form of business hazardous, the new railway often had to enter a territory bare of population, and there create its own towns, farms and traffic Whether it could do so was so doubtful as to make additional inducements to capital necessary. The means attempted by Congress in 1850, in the case of the Illinois Central railroad, was to grant public lands to the corporation, reserving to the United States the alternate sections. At first grants were made to the States for the benefit of the corporations; the act of 1862 made the grant directly to the corporation

The vital military and political necessity of an immediate railway connection with the Pacific coast was hardly open to doubt in 1862, but the necessity scarcely justified the terms which were offered and taken. The Union Pacific railroad was incorporated; the United States Government was to issue to it bonds, on the completion of each 40m, to the amount of $16,000 per mile, to be a first mortgage, through Utah and Nevada the aid was to be doubled, and for some 300m of mountain building to be trebled, and, in addition to this, alternate sections of land were granted The land-grant system, thus begun, was carried on extensively, the largest single grants being those of 47,000,000ac. to the Northern Pacific (1864) and of 42,000,000ac. to the Atlantic and Pacific line (1866)

Paper Prices.—Specie payments had been suspended almost everywhere towards the end of 1861; but the price of gold was but 102 5 at the beginning of 1862 About May its price in paper currency began to rise It touched 170 during the next year, and 285 in 1864; but the real price probably never went much above 250 Other articles felt the influence in currency prices

Tariff and Taxes.—The duties on imports were driven higher than the original Morrill tariff had ever contemplated The average rates, which had been 18% on dutiable articles and 12% on the aggregate in 1860–61, rose, before the end of the war, to nearly 50% on dutiable articles and 35% on the aggregate Domestic manufactures sprang into new life under such encouragement, everyone who had spare wealth converted it into manufacturing capital. The probability of such a result had been the means of getting votes for an increased tariff; free traders had voted for it as well as protectionists For the tariff was only a means of getting capital into positions in which taxation could be applied to it, and the "internal revenue" taxation was merciless beyond precedent The annual increase of wealth from capital was then about $550,000,000; the internal revenue taxation on it rose in 1866 to $310,000,000, or nearly 60%.

Bonds.—The stress of all this upon the poor must have been great, but it was relieved in part by the bond system on which the war was conducted While the armies and navies were shooting off large blocks of the crops of 1880 or 1890, work and wages were abundant for all who were competent for them. It is true, then, that the poor paid most of the cost of the war; it is also true that the poor had shared in that anticipation of the future which had been forced on the country, and that, when the drafts on the future came to be redeemed, it was done mainly by taxation on luxuries. The destruction of a Northern railway meant more work for Northern iron mills and their workmen The destruction of a Southern road was an unmitigated injury; it had to be made good at once, by paper issues; the South could make no drafts on the future, by bond issues, for the blockade had put cotton out of the game, and Southern bonds were hardly salable. Every expense had to be met by paper issues; each issue forced prices higher. *A Rebel War-Clerk's Diary* gives the following as the prices in the Richmond market for May 1864: "Boot, $200; coats, $350; pantaloons, $100; shoes, $125; flour, $275 per barrel; meal, $60 to $80 per bushel; bacon, $9 per pound, no beef in market; chickens, $30 per pair; shad, $20; potatoes, $25 per bushel; turnip greens, $4 per peck; white beans, $4 per quart or $120 per bushel; butter, $15 per pound; wood, $50 per cord."

Manufactures.—The complete lack of manufactures told heavily against the South from the beginning As men were drawn from agriculture in the North and West, the increased de-

mand for labour was shaded off into an increased demand for agricultural machinery; every increased percentage of power in reaping-machines liberated so many men for service at the front. The reaping-machines of the South—the slaves—were incapable of any such improvement and, besides, required the presence of a portion of the possible fighting men at home to watch them. But no insurrection took place

The pressing need for men in the Army made the Confederate Congress utterly unable to withstand the growth of executive power. Its bills were prepared by the Cabinet, and the action of Congress was quite perfunctory. The suspension of the writ of *habeas corpus*, and the vast powers granted to President Davis, or assumed by him, made the Confederate Government almost a despotism. It was not until the closing months of the war that the expiring Confederate Congress mustered up courage enough to oppose the President's will.

Banking.—Another act of Federal legislation—the National Bank Act (Feb. 25, 1863; supplemented by the act of June 3, 1864)—should be mentioned here, as it was closely connected with the sale of bonds The banks were to be organized and, on depositing United States bonds at Washington, were to be permitted to issue notes up to 90% of the value of the bonds deposited. As the redemption of the notes was thus assured, they circulated without question all over the United States. By a subsequent act (1865) the remaining State bank circulation was taxed out of existence.

West Virginia.—At the beginning of 1862 the lines of demarcation between the two powers had become plainly marked. The western part of Virginia had separated itself from the parent State, and was admitted as a State (1863) under the name of West Virginia. It was certain that Delaware, Maryland, Kentucky and Missouri had been saved to the Union, and that the battle was to be fought out in the territory to the south of them.

The Emancipation Proclamation.—At the beginning of the war the people and leaders of the North had not desired to interfere with slavery, but circumstances had been too strong for them. Lincoln had declared that he meant to save the Union as best he could—by preserving slavery, by destroying it or by destroying part and preserving part. Just after the battle of Antietam (Sept. 17, 1862) he issued his proclamation calling on the revolted States to return to their allegiance before the next year, otherwise their slaves would be declared free men. No State returned and the threatened declaration was issued on Jan 1, 1863. As President, Lincoln could issue no such declaration; as commander-in-chief of the armies and navies of the United States he could issue directions only as to the territory within his lines; but the Emancipation Proclamation applied only to territory outside of his lines. It has therefore been debated whether the proclamation was in reality of any force It may fairly be taken as an announcement of the policy which was to guide the Army and as a declaration of freedom taking effect as the lines advanced At all events, this was its exact effect. Its international importance was far greater. The locking up of the world's source of cotton supply had been a general calamity, and the Confederate Government and people had steadily expected that the English and French Governments would intervene in the war. The conversion of the struggle into a crusade against slavery made intervention impossible.

Confederate Privateers.—Confederate agents in England were numerous and active. Taking advantage of every loophole in the British Foreign Enlistment Act, they built and sent to sea the "Alabama" and "Florida," which for a time almost drove Federal commerce from the ocean Whenever they were closely pursued by United States vessels they took refuge in neutral ports until a safe opportunity occurred to put to sea again. Another, the "Georgia," was added in 1863. All three were destroyed in 1864. Confederate attempts to have iron-clads equipped in England and France were unsuccessful.

The Victory of the North.—The turning-point of the war was evidently in the early days of July 1863, when the victories of Vicksburg and Gettysburg came together. The National Government had at the beginning cut the Confederate States down to a much smaller area than might well have been expected; its armies had pushed the besieging lines far into the hostile territory; and the war itself had developed a class of generals who cared less for the conquest of territory than for destroying the opposing armies. The great drafts on the future which the credit of the Federal Government enabled the North to make gave it also a startling appearance of prosperity; so far from feeling the war, it was driving production of every kind to a higher pitch than ever before.

The war had not merely developed improved weapons and munitions of war; it had also spurred the people on to a more careful attention to the welfare of the soldiers, the fighting men drawn from their own number. The sanitary commission, the Christian commission, and other voluntary associations for the physical and moral care of soldiers, received and disbursed very large sums. The National Government was paying an average amount of $2,000,000 per day for the prosecution of the war and, in spite of the severest taxation, the debt grew to $500,000,000 in June 1862, to twice that amount a year later, to $1,700,000,000 in June 1864 and reached its maximum on Aug. 31, 1865—$2,845,907,626. But this lavish expenditure was directed with energy and judgment. The blockading fleets were kept in perfect order and with every condition of success. The railway and telegraph were brought into systematic use for the first time in modern warfare. Late in 1863 Edwin M. Stanton, the secretary of War, moved two corps of 23,000 men from Washington to Chattanooga, 1,200m., in seven days.

Conscription.—On the other hand, the Federal Armies now held almost all the great southern through lines of railway, except the Georgia lines and those which supplied Lee from the South. The want of the Southern people was merely growing in degree, not in kind. The conscription, sweeping from the first, had become omnivorous; towards the end of the war every man between 17 and 55 was legally liable to service, and in practice the only limit was physical incapacity. In 1863 the Federal Government also was driven to conscription. The first attempts to carry it out resulted in forcible resistance in several places, the worst being the "draft riots" in New York (July), when the city was in the hands of the mob for several days All the resistance was put down, but exemptions and substitute purchases were so freely permitted that the draft in the North had little effect except as a stimulus to the States in filling their quotas of volunteers by voting bounties.

Election of 1864.—In 1864 Lincoln was re-elected with Andrew Johnson as vice-president. The Democratic convention had declared that, after four years of failure to restore the Union by war, during which the Constitution had been violated in all its parts under the plea of military necessity, a cessation of hostilities ought to be obtained, and had nominated Gen. George B. McClellan and G. H. Pendleton. Farragut's victory in Mobile Bay (Aug. 5), by which he sealed up the last port, except Wilmington, of the blockade-runners, and the evidently staggering condition of the Confederate resistance in the East and the West, were the sharpest commentaries on the Democratic platform, its candidates carried only three of the 25 states taking part in the election. The 36th State—Nevada—had been admitted in 1864.

Surrender of Lee.—The actual fighting of the war ended with the surrender of Gen. Robert E. Lee to Gen. U.S Grant at Appomattox, Va., April 9, 1865. All the terms of surrender named by Grant were generous: no private property was to be surrendered; both officers and men were to be dismissed on parole, not to be disturbed by the United States Government so long as they preserved their parole and did not violate the laws; and he instructed the officers appointed to receive the paroles "to let all the men who claim to own a horse or mule take the animals home with them to work their little farms." Gen. Joseph E. Johnston, with the only other considerable army in the field, surrendered on much the same terms at Durham Station, N.C. (April 26), after an unsuccessful effort at a broader settlement. All organized resistance had now ceased; Union cavalry were ranging the South, picking up Government property or arresting leaders; but it was not until May that the last detached parties

of Confederates gave up the contest.

Death of Lincoln.—Just after Lee's surrender President Lincoln died by assassination (April 15), the crime of a half-crazed enthusiast Even this event did not impel the U S people to any vindictive use of their success for the punishment of individuals. In the heat of the war, in 1862, congress had so changed the criminal law that the punishment of treason and rebellion should no longer be death alone, but death or fine and imprisonment. Even this modified punishment was not inflicted. There was no hanging; some of the leaders were imprisoned for a time, but never brought to trial

The Armies.—The Armies of the Confederacy are supposed to have been at their strongest (700,000) at the beginning of 1863; and it is doubtful whether they contained 200,000 men in March 1865. The dissatisfaction of the southern people at the manner in which Davis had managed the war seems to have been profound; and it was converted into hero worship only by the ill-advised action of the federal government in arresting and imprisoning him. Desertion had become so common in 1864, and the attempts of the Confederate government to force the people into the ranks had become so arbitrary, that the bottom of the Confederacy had dropped out of it before Sherman moved northward from Savannah, Ga. On the contrary, the numbers of the Federal armies increased steadily until March 1865, when they were a few hundreds more than 1,000,000. As soon as organized resistance ceased, the disbanding of the men began; they were sent home at the rate of about 300,000 a month, about 50,000 being retained in service as a standing army.

Cost of the War.—The direct cost of the Civil War has been variously estimated, the best estimate including the first three years of reconstruction being $5,000,000,000 to the North and $3,000,000,000 to the South. But if pensions, interest and other such items up to 1910 are included, the result is a total of between $11,000,000,000 and $12,000,000,000 for the North alone. But the cost to the South also was enormous; $4,000,000,000 cannot be an exaggeration.

(A. J.; X.)

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(E. E. R.)

FROM 1865 TO 1910

The capitulation of Lee (April 9, 1865), followed by the assassination of Lincoln (April 15) and the surrender of the last important Confederate army, under J. E. Johnston, marked the end of the era of war and the beginning of that of reconstruction, which involved a revolution in the social and political structure of the South, in the relation of state and nation in the American federal union, and in the economic life of the whole country.

Condition of the South.—Economically the condition of the

South was desperate. The means of transport were destroyed; railways and bridges were ruined; Southern securities were valueless; the Confederate currency system was completely disorganized. Emancipated negroes wandered idly from place to place, trusting the Union armies for sustenance, while their former masters toiled in the fields to restore their plantations.

The social organization of the South had been based on negro slavery. Speaking generally, the large planters had constituted the dominant class, especially in the cotton States; and in the areas of heaviest negro population these planters had belonged for the most part to the old Whig Party. Outside of the larger plantation areas, especially in the hill regions and the pine barrens, there was a population of small planters and poor whites who belonged in general to the Democratic Party. In the mountain regions, where slavery had hardly existed, there were Union areas, and from the poor whites of this section had come Andrew Johnson, senator and war governor of Tennessee, who was chosen vice-president on the Union ticket with Lincoln in 1864 as a recognition of the Union men of the South.

The North.—The importance of personality in history was clearly illustrated when the wise and sympathetic Lincoln, who had the confidence of the masses of the victorious North, was replaced by Johnson, opinionated and intemperate, whose antecedents as a Tennessean and Democrat, and whose State rights principles and indifference to Northern ideals of the future of the negro made him distrusted by large numbers of the Union Republican Party.

The composition of this party was certain to endanger its stability when peace came. It had carried on the war by a coalescence of Republicans, War Democrats, Whigs, Constitutional Unionists and Native Americans, who had rallied to the cause of national unity At the outset it had asserted that its purpose was not to interfere with the established institutions in slave States, but to defend the Constitution, and to preserve the Union. But the war had destroyed slavery, as well as preserved the Union, and the civil status of the negro and the position of the revolted States now became burning questions To the extremists of the Radical wing it seemed in accordance with the principles of human liberty that the negro should not only be released from slavery but should also receive full civil rights, including the right to vote. This group was also ready to revolutionize Southern society by destroying the old ascendancy of the great planter-class.

For many years before the war, parties had differed on such important questions as the tariff, internal improvements and foreign policy, and the South had used its alliance with the Northern Democracy to resist the economic demands of the industrial interests of the North. A return of Southern congressmen might mean a revival of the old political situation, with the South and the Northern Democracy once more in the saddle.

Attitude of the Two Sections.—Any attempt to restore the South to full rights, therefore, without further provision for securing for the freedmen the reality of their freedom, and without some means of establishing the political control of the victorious party, would create party dissension Even Lincoln had aroused the bitter opposition of the radical leaders by his generous plan of reconstruction Johnson could have secured party support only by important concessions to the powerful leaders in Congress; and these concessions he was temperamentally unable to make. The masses of the North, especially in the first rejoicings over the peace, were not ungenerous in their attitude; and the South as a whole, accepted the results of defeat in so far as to acquiesce in the permanence of the Union and the emancipation of the slaves, the original issues of the war.

Reconstruction.—In the settlement of the details of reconstruction, however, there were abundant opportunities for the hatred engendered by the war to flame up once more. As it became clear that the Northern majority was determined to exclude the leaders of the South from political rights in the reconstruction of the Union, and especially as the radicals disclosed their purpose to ensure Republican ascendancy by subjecting the section to the rule of the loyalist whites and, later to that of the emancipated negroes, good will disappeared, and the South entered upon a fight for its social system. The natural leaders of the people, men of intelligence and property, had been the leaders of the section in the war. Whatever their views had been at first as to secession, the great majority of the Southern people had followed the fortunes of their States. To disfranchise their leaders was to throw the control into the hands of a less able and small minority of whites; to enfranchise the blacks while disfranchising the white leaders was to undertake the task of subordinating the former political people of a section to a different race, just released from slavery, ignorant, untrained and without property.

These underlying forces were in reality more influential than the constitutional theories which engaged so much of the discussion in Congress, theories which, while they afford evidence of the characteristic desire to proceed constitutionally were really urged in support of, or opposition to, the interests just named.

The most extreme Northern Democrats, and their Southern sympathizers, starting from the premise that constitutionally the Southern States had never been out of the Union, contended that the termination of hostilities restored them to their former rights in the Federal Union unimpaired and without further action This theory derived support from President Lincoln's view that not States, but assemblages of individuals, had waged war against the Government. The theory of the extreme Republican Radicals was formulated by Sumner and Stevens. Sumner contended that, while the States could not secede, they had by waging war reduced themselves to mere Territories, entitled only to the rights of Territories. Stevens, appealing to the facts of secession, declared the Southern States conquered provinces, subject to be disposed of at the will of the conqueror. In the end Congress adopted a middle ground, holding that while the States could not leave the Union, they were, in fact, out of normal relations, and that the constitutional right of the Federal Government to guarantee republican Governments to the various States gave to Congress the power to impose conditions precedent to their rehabilitation.

It is necessary to recall the initiation of reconstruction measures by President Lincoln rightly to understand the position which was taken by President Johnson. Impatient of theoretical discussion, Lincoln laid down practical conditions of restoration in his proclamation of Dec. 8, 1863 In this he offered amnesty to those who would take an oath of loyalty for the future and accept the acts of Congress and the proclamation of the President with reference to slaves. From the amnesty he excepted the higher military, civil and diplomatic officers of the Confederacy as well as those who had relinquished judicial stations, seats in Congress, or commissions in the Army or Navy and those who had treated persons in the Federal service otherwise than lawfully as prisoners of war. The proclamation provided, further, that when in any of the seceding States (except Virginia, where the President had already recognized the loyal Government under Gov. Francis H Pierpont) a number of persons not less than one-tenth of the voters in 1860 should have taken the above described oath, and, being qualified voters under the laws of the State in 1860, should have established a State Government, republican in form, it should be recognized

The First Reconstruction Bill.—Although Lincoln expressly pointed out that the admission of the restored States to representation in Congress rested exclusively with the respective houses, and announced his readiness to consider other plans for reconstruction, heated opposition by the radicals in Congress was called out by this proclamation. They feared that it did not sufficiently guarantee the abolition of slavery, which up to this time rested on the war powers of the President, and they asserted that it was the right of Congress, rather than of the President, to determine the conditions and the process of reconstruction. In a bill which passed the House by a vote of 73 to 59 and was concurred in by the Senate, Congress provided that reconstruction was to be begun only when a majority of the white male citizens of any one of the Confederate States should take oath to support the Constitution of the United States. The President should then invite them to call a Constitutional Convention. The electors of this convention would be required to take an oath of

allegiance which excluded a much larger class than those deprived of the benefit of the amnesty proclamation, for it eliminated all who had voluntarily borne arms against the United States, or encouraged hostility to it, or voluntarily yielded support to any of the Confederate Governments The bill also required that the State Constitution should exclude a large proportion of the civil and military officers of a Confederate Government from the right of voting, and that it should provide that slavery be forever abolished and that State and Confederate debts of the war period should never be paid. In July 1864 Lincoln gave a "pocket veto" to the bill and issued a proclamation explaining his reasons for refusing to sign The triumph of Lincoln in the election of 1864 did not clearly signify the will of the people upon the conditions of reconstruction, for the declaration of the Democratic convention that the war was a failure overshadowed the issue, and the Union Party which supported Lincoln was composed of men of all parties

Thirteenth Amendment.—On Jan. 31, 1865, the House concurred in the vote of the Senate in favour of the 13th amendment to the Constitution abolishing slavery throughout the Union Four years earlier Congress had submitted to the States another 13th amendment by the terms of which no amendment should ever authorize Congress to interfere with slavery within the States But owing to the war this amendment had remained unratified, and now Congress proposed to place beyond constitutional doubt, or the power of States to change it, the emancipation of slaves By Dec 18, 1865, the amendment had been ratified and was proclaimed in force.

In the meantime, Louisiana, in accordance with Lincoln's proclamation, had adopted a Constitution and abolished slavery within the State. Owing to the obstructive tactics of Sumner, aided by Democrats in the Senate, Congress adjourned on March 4, 1865, without having recognized this new State Government as legitimate "If we are wise and discreet," said Lincoln, "we shall reanimate the states and get their governments in successful operation with order prevailing and the Union re-established before Congress comes together in December."

President Johnson.—Such was the situation when Johnson took up the Presidency upon Lincoln's death. After an interval of uncertainty in which he threatened vengeance against various Southern leaders, President Johnson accepted the main features of Lincoln's policy. Congress not being in session, he was able to work out an executive reconstruction on the lines of Lincoln's policy during the summer and autumn of 1865. On May 29, he issued a proclamation of amnesty, requiring of those who desired to accept its provisions an oath to support the Constitution and Union, and the laws and proclamations respecting the emancipation of slaves. Certain specified classes of persons were excepted, including certain additions to those excluded by Lincoln, especially "all persons who have voluntarily participated in said rebellion and the estimated value of whose taxable property is over twenty thousand dollars" This provision was characteristic of Johnson, who disliked the Southern planting aristocracy, and aimed at placing the preponderant power in the hands of the Democratic small farmers. As part of his system he issued another proclamation in which he appointed a governor for North Carolina and laid down a plan for reconstruction By this proclamation it was made the duty of the governor to call a convention chosen by the loyal people of the State, for the purpose of altering the State Constitution and establishing a State Government. The right to vote for delegates to this convention was limited to those who had taken the oath of amnesty and who had been qualified to vote prior to the secession of the State.

Already Virginia, Tennessee, Louisiana and Arkansas had Governments which had been recognized by Lincoln. Between June 13 and July 13, 1865, Johnson applied the same process which he had outlined for North Carolina to the remaining States of the Confederacy. Before Congress met in December all the Confederate States, except Texas (which delayed until the spring of 1866), had formed Constitutions and elected Governments in accordance with the presidential plan. All of their legislatures, except that of Mississippi, ratified the 13th amendment.

Gradually, however, the South turned to its former leaders to shape its policy, and the radical Republicans of the North were alarmed at the rapidity of the process of restoration on these principles. The disorganized and idle condition of the former slaves constituted a serious element in the Southern situation, as Lincoln had foreseen. The negroes expected a grant of land from confiscated Southern estates, and it was difficult to preserve order and to secure a proper labour supply.

Under these conditions the efforts of the South to provide security for their communities by bodies of white militia were looked upon with apprehension by the North, and there was sufficient conflict between the two races to give colour to charges that the South was not accepting in good faith the emancipation of the slaves. Especially irritating to Northern sentiment were the so-called "black codes" or "peonage laws," passed by the newly elected Southern legislatures. They rested on the belief that it was necessary that the former slaves should be treated as a separate and dependent class. Some of these imposed special disabilities upon the negro in the matter of carrying weapons and serving as witnesses. Vagrancy laws and provisions regarding labour contracts which had precedents in colonial and English legislation, but were specifically framed to restrain the negroes only, were common. Mississippi denied them the right to own land, or even to rent it outside of incorporated towns; South Carolina restricted them to husbandry and to farm or domestic service, unless specially licensed.

The Freedmen's Bureau.—The problem of succouring and protecting the negroes had forced itself upon the attention of the North from the beginning of the war, and on March 3, 1865, Congress had created the Freedmen's Bureau with the power to assign abandoned lands, in the States where the war had existed, to the use of the freedmen; to supervise charitable and educational activities among them; to exercise jurisdiction over controversies in which a freedman was a party, and to regulate their labour contracts. The local agents of the bureau were usually Northern men, some of them gave the worst interpretation to Southern conditions and aroused vain hopes in the negroes that the lands of the former masters would be divided among them; and later many became active in the political organization of the negro.

Although the National Government itself had thus recognized that special treatment of the freedmen was necessary, Congress, on assembling in Dec. 1865, was disposed to regard the course of the South in this respect with deep suspicion Moreover, as the 13th amendment was now ratified, it was seen that the South, if restored according to the presidential policy, would return to Congress with added representatives for the freed negroes. Only three-fifths of the negro slaves had been counted in apportioning representatives in Congress; though now free they were not allowed to vote Under the leadership of the Radicals, Congress refused, therefore, to receive the representatives of the States which had met the conditions of the President's proclamations. A joint committee of 15 took the whole subject of reconstruction under advisement, and a bill was passed continuing the Freedmen's Bureau indefinitely. When this was vetoed by President Johnson (Feb. 19, 1866) Congress retaliated by a concurrent resolution (March 2) against admitting any reconstructed State until Congress declared it entitled to recognition, thus asserting for the legislative body the direction of reconstruction.

While the measure was under consideration the President in an intemperate public address stigmatized the leaders of the Radicals by name as labouring to destroy the principles of the Government and even intimated that the assassination of the President was intended. It was hardly possible to close the breach after this, and the schism between the President and the leaders of the Union Republican Party was completed when Congress passed (April 9, 1866) the Civil Rights bill over Johnson's veto. The act declared the freedmen to be citizens of the United States with the same civil rights as white persons and entitled to the protection of the Federal Government.

The Fourteenth Amendment.—To place this measure beyond the danger of overthrow by courts or by a change of party majority, on June 13, 1866, Congress provided for submitting to

the States a 14th amendment to the Constitution. This gave constitutional guarantee of citizenship and equal civil rights to freedmen, and in effect provided that when in any State the right to vote should be denied to any of the male inhabitants 21 years of age and citizens of the United States, except for participation in rebellion or other crime, the basis of representation in the State should be reduced in the proportion which the number of such citizens bore to the whole number of male citizens 21 years of age in the State. This section of the amendment, therefore, left the States the option between granting the suffrage to the negro or suffering a proportionate reduction in the number of representatives in Congress. It was a fair compromise which might have saved the South from a long period of misrule and the North from the ultimate breakdown of its policy of revolutionizing Southern political control by enfranchisement of the blacks and disfranchisement of the natural leaders of the whites.

In order to ensure the passage of this amendment the radical leaders proposed bills which declared that, after its adoption, any of the seceding States which ratified it should be readmitted to representation. But it also provided that the higher classes of officials of the Confederacy should be ineligible to office in the Federal Government. These bills were allowed to await the issue of the next election.

For further protection of the rights of the negro, Congress succeeded in passing, over President Johnson's veto, an act continuing the Freedmen's Bureau for two years. Tennessee, having ratified the 14th amendment, was (July 24, 1866) restored to representation and Congress adjourned, leaving the issue between the President and the legislative body to the people in the Congressional elections.

Party Changes.—The campaign brought with it some realignment of party. President Johnson, having broken with the leaders of the Union Republican Party, was more and more forced to rely upon Democratic support, although his executive appointments were still made from the ranks of the Republicans. The so-called National Union convention, which met in Philadelphia in midsummer in an effort to abate sectionalism, and to endorse the President's policy, included a large number of war Democrats who had joined the Union party after the secession of the South, many moderate Southerners, a fragment of the Republican Party, and a few Whigs, especially from the border States. They claimed that the Southern States had a right to be represented in Congress. Other meetings friendly to the Radicals were called, and under the designation of Union-Republican Party they declared for the congressional policy. While the campaign for elections to Congress was in progress the President made a journey to Chicago, speaking at various cities *en route* and still further alienating the Republicans by abuse of his opponents. As a result of the autumn elections two-thirds of the members of the House of Representatives were opposed to him. Almost contemporaneously every seceding State except Tennessee rejected the 14th amendment, paving the way for the entire triumph of the Northern extremists.

Tenure of Office Act.—In the ensuing winter and spring Congress completed the conquest of the President, awed the Supreme Court, and provided a drastic body of legislation to impose negro suffrage on the South. By the Tenure of Office Act (March 2, 1867) Congress forbade the President to remove civil officers without the consent of the Senate, and at the same time by another act required him to issue military orders only through the general of the Army (Grant), whom the President was forbidden to remove from command or to assign to duty at another place than Washington, unless at the request of the officer or by the prior assent of the Senate. These extraordinary invasions of the presidential authority were deemed necessary to prevent Johnson from securing control of the military arm of the Government, and to protect Edwin Stanton, the secretary of war, and Gen. Grant. Fearing the President might take advantage of the interim when Congress would not be in session, the 40th Congress was required to meet on March 4, immediately following the expiration of the 39th

Other Legislative Acts.—The Reconstruction Act of March 2, 1867, provided for the military Government of the Southern States while the drastic policy of Congress was being carried out. It was passed over the veto of the President and declared that no legal Governments or adequate protection for life or property existed in the seceding States, except Tennessee. These States it divided into five military districts, each to be placed under the command of a general of the Army, whose duty it was to preserve law and order. But the existing civil Governments were declared provisional only and subject to the paramount authority of the United States to abolish, modify, control, or supersede them. The act further provided that a Constitutional Convention might be elected by the adult male citizens of the State, of whatever race, colour or previous condition, resident in the State for a year, except such as might be disfranchised for rebellion or felony.

When the convention, thus chosen under negro suffrage, and with the exclusion of Confederate leaders, should have framed a State Constitution conforming to the Federal Constitution and allowing the franchise to those entitled to vote for the members of the convention, the Constitution was to be submitted for the approval of Congress If this were obtained and if the State adopted the 14th amendment, and this amendment became a part of the Federal Constitution, then the State should be entitled to representation in Congress; but the senators and representatives sent to Congress were required to take the "iron-clad oath," which excluded those who had fought in the Confederate service, or held office under any Government hostile to the United States, or given support to any such authority.

By the pressure of military control Congress thus aimed at forcing the adoption of the 14th amendment, as well as the acceptance of negro suffrage in the State Constitutions of the South. A supplementary act of March 23, 1867, and an act of interpretation passed on July 19 completed this policy of "thorough." In the registration of voters the district commanders were required to administer an oath which excluded those disfranchised for rebellion and those who after holding State or Federal office had given aid and comfort to the enemies of the United States.

Supreme Court Decisions.—Against this use of military power to govern States in time of peace the Supreme Court interposed no effective obstacle. Like the executive it was subordinated to Congress It is true that in the case *ex parte* Milligan, decided in Dec. 1866, the court held military commissions unlawful where the ordinary civil tribunals were open. In the case of Cummings v. Missouri (Jan. 14, 1867) it decided also that a State test oath excluding Confederate sympathizers from professions was a violation of the prohibition of *ex post facto* laws; and the court (*ex parte* Garland) applied the same rule to the Federal test oath so far as the right of attorneys to practise in Federal courts was concerned.

But threats were made by the radicals in Congress to take away the appellate jurisdiction of the court, and even to abolish the tribunal by constitutional amendment. The judges had been closely divided in these cases and, when the real test came, the court refused to set itself in opposition to Congress. When Mississippi attempted to secure an injunction to prevent the president from carrying out the reconstruction acts, and when Georgia asked the court to enjoin the military officers from enforcing these acts in that State, the Supreme Court refused (April and May 1867), pleading want of jurisdiction. Chief Justice Salmon P. Chase argued that if the President refused to obey, the court could not enforce its decree, while if he complied with the order of the court, and if the House of Representatives impeached him for refusing to enforce the law, the Supreme Court would be forced to the vain attempt to enjoin the Senate from sitting as a court of impeachment.

In one instance it seemed inevitable that the court would clash with Congress; the McCardle case involved an editor's arrest by military authority for criticizing that authority and the reconstruction policy. But Congress, apprehending that the majority of the court would declare the reconstruction acts unconstitutional, promptly repealed that portion of the act which gave the court jurisdiction in the case, and thus enabled the judges to dismiss the appeal. Afterwards, when the reconstruction policy had been accomplished, the court, in the case of Texas v. White

(1869), held that the Constitution looked to "an indestructible Union composed of indestructible states"; and that although the secession acts were null, and the Federal obligations of the seceding States remained unimpaired, yet their rights were suspended during the war

Impeachment of President Johnson.—The powerful leaders of the Republicans in Congress had been awaiting their opportunity to rid themselves of President Johnson by impeachment For full details of these efforts *see* JOHNSON, ANDREW. His trial in the spring of 1868, however, by the Senate resulted in a verdict of acquittal.

"Carpet-baggers."—Meanwhile the military reconstruction of the South and the organization of the negro vote progressed effectively. The party management of the negroes was conducted by "carpet-baggers," as the Northern men who came South to try their fortunes were nicknamed, and by the white loyalists of the South, to whom was given the name "scalawags." In the work of marshalling the freedmen's vote for the Republican Party secret societies like the Loyal League, or Union League played an important part As the newly enfranchised mass of politically untrained negroes passed under Northern influence politically, the Southern whites drew more and more together and although they were unable under the existing conditions to take control, they awaited their opportunity. A "Solid South" was forming in which old party divisions gave way to the one dominant antagonism to Republican ascendancy by negro suffrage. Politically the important fact was that the Republicans had rejected the possibility of reviving the old party lines in the South, and had gambled upon the expectation of wielding the united coloured vote with such leadership and support as might be gained from former Northerners and loyal whites In the end negro rule failed, as was inevitable when legal disabilities and military force were removed; but the masses of the Southern whites emerged with a power which they had not possessed under the old rule of the planting aristocracy. For the time being, however, negro votes gave control to the Republicans. In South Carolina, Florida, Alabama, Mississippi and Louisiana the negroes were in a majority; in Virginia, North Carolina, Arkansas and Texas they were in the minority, while in Georgia the two races were nearly evenly balanced.

Ku-Klux Klan.—The white leaders of the South were divided as to the best means of meeting the problem. Some advocated that those entitled to vote should register, and then refrain from the polls, in order to defeat the Constitutions made under negro suffrage, for the law required them to be ratified by a majority of the qualified voters. Others would have the white race bear no part in the process. Societies such as the "Ku-Klux Klan" and the "Knights of the White Camelia" were organized to intimidate or restrain the freedmen. But for the present the Republicans carried all before them in the South. Some of the new State Constitutions imposed severe disfranchisement upon the former dominant class, and before the end of July 1868 all of the former Confederate States, except Virginia, Mississippi and Texas, had ratified the 14th amendment, which was proclaimed in effect. By the beginning of 1870 these three States had also ratified the amendment, as had Georgia a second time, because of her doubtful status at the time of her first ratification.

The Southern States Restored to the Union.—By the summer of 1868 Arkansas, South Carolina, North Carolina, Georgia, Alabama, Louisiana and Florida, having satisfied the requirements of the reconstruction acts, were entitled to representation in Congress But Georgia did not choose her senators until after the adjournment of Congress, and, inasmuch as the State excluded the negro members of the legislature in September, Congress on reassembling returned the State to military rule until its submission. Alabama was restored in spite of the fact that her white voters had remained away from the polls in sufficient numbers to prevent a majority of all the voters registered from having ratified the constitution. The nominating conventions and the campaign of 1868 gave interesting evidence of the trend of political and economic events. Party lines, which had broken down in the North when all united in saving the Union, were once more reasserting themselves President Johnson, who had been elected by the Union Republican Party, had found his most effective support among the Democrats. The Republicans turned to Gen Grant, a Democrat before the outbreak of the war.

Grant Nominated.—The Republican nominating convention met on May 20, 1868, a few days after the failure of the impeachment proceedings, and it chose Grant as the candidate for the Presidency The platform supported the congressional reconstruction measures. Upon the vital question whether universal negro suffrage should be placed beyond the power of States to repeal it by a new constitutional amendment, the platform declared. "The guarantee by Congress of equal suffrage to all loyal men at the South was demanded by every consideration of public safety, of gratitude and of justice, and must be maintained; while the question of suffrage in all the loyal states properly belongs to the people of those states." Nowhere in the North was the negro an important element in the population, but the North had shown an unwillingness to apply to itself the doctrines of negro rights which had been imposed upon the South. Between 1865 and 1868 Connecticut, Wisconsin, Minnesota, Kansas, Ohio and Michigan had refused to give the negro the right to vote within their own bounds, and this plank was evidence of the unwillingness of the party to make a direct issue of universal negro suffrage. The platform pronounced in favour of payment of the public debt, not only according to the letter but the spirit of the laws under which it was contracted. The significance of this lay in its challenge to the Democratic agitation on the currency question.

It was this question which gave the tone to the proceedings of the Democracy at their convention in July 1868 The situation can best be presented by a brief review of the financial history just preceding the convention. Together with the discussion over political reconstruction in the South, Congress and the Administration had been obliged to deal with the reconstruction of debt, taxation and currency in the nation at the close of four years of expensive war The problems of funding, readjustment of taxation, and resumption of specie payments proved to be so complicated with the industrial growth of the nation that they led to issues destined to exert a long-continued influence.

Finance.—The various war tariffs, passed primarily for the sake of increased revenue, had been shaped for protection under the influence of the manufacturing interests, and they had been framed also with reference to the need of compensating the heavy internal taxes which were imposed upon the manufacturers. When the war ended, public sentiment demanded relief from these heavy burdens, especially from the irksome internal taxes. The rapidly growing grain-raising districts of the Middle West exhibited a lively discontent with the protective tariff, but this did not prevent the passage in 1867 of the Wool and Woollens Act, which discriminated in favour of the woollen manufacturers and raised the *ad valorem* duty on wool. In spite of several large reductions of internal revenue, the national debt was being rapidly extinguished.

The currency question, however, furnished the economic issue which was most debated. One set of interests aimed at rapidly reducing the volume of the currency by retiring the legal tender notes, or "greenbacks" The secretary of the Treasury, Hugh McCulloch, pressed this policy to the foreground, and desired authority to issue bonds to retire these notes. Another set of interests demanded the retention of the greenbacks, supporting their views by arguments varying according to the degree of radicalism of the speakers The more moderate, like Senator John Sherman, of Ohio, who reflected the views of parts of the West, argued that the recuperation of the nation and the rapid increase of business would absorb the existing currency, while gold would cease to go abroad Thus, by the increasing credit of the Government, specie payment would be automatically resumed The most extreme, so far from contracting the currency by retiring the greenbacks, wished to increase this form of money, while diminishing the circulation of the notes of the national banks. The discussion tended to produce a sectional issue with the West against the East, and a social issue with bondholders

and the creditor class in general arrayed against the less well-to-do Congress agreed with Secretary McCulloch, and in the Funding Act of 1866 not only provided for converting short-time securities into long-term bonds, but also for retiring $10,000,000 of greenbacks in six months and thereafter not more than $4,000,000 monthly. But the agricultural depression of 1866 produced a reaction. Loud demands were made that bonds should be paid in greenbacks instead of coin and the national banknotes suppressed. In 1868, on the eve of the presidential campaign, Congress, alarmed by the extent of these popular demands, suspended the process of contraction after $40,000,000 in greenbacks had been retired Ohio was the storm centre of the agitation. The "Ohio idea" that greenbacks should become the accepted currency of the country was championed by George H. Pendleton, of that State, and his friends now brought him forward for the Democratic nomination for President on this issue. In the national convention of that party they succeeded in incorporating into the platform their demands that there should be one currency for the Government and the people, the bondholder and the producer, and that where the obligations of the Government did not expressly provide for payment in coin, they should be paid in lawful money (*i.e.*, greenbacks) of the United States.

But another wing of the Democratic Party desired to make prominent the issue against the reconstruction measures of the Republicans. This wing added to the platform and declaration that these acts were unconstitutional and void, and the demand that the Southern States should be restored to their former rights and given control over their own elective franchise.

Democrats Nominate Seymour.—Although the followers of Pendleton had shaped the financial plank of the platform, they could not nominate their leader. The opposition was at first divided between the various candidates. New York, which feared the effect upon the conservative financial interests of the East if Pendleton were nominated, attempted to break the deadlock by proposing an Ohio man, Chief Justice Chase. But eager as Chase was for the Presidency he had flatly refused to abandon the views which he held in favour of negro suffrage. Ohio was, therefore, able to retaliate by stampeding the convention in favour of Horatio Seymour, of New York As the war governor of his State he had been a consistent critic of the extremes to which the Federal Administration had carried its interpretation of the war power. For vice-president the convention nominated Francis P. Blair, jun., of Missouri.

Grant Elected.—But the popularity of Grant in the North, together with the Republican strength in the States of the South which had been reconstructed under negro suffrage, gave an easy victory to the Republicans in the election of 1868. Seymour carried only Delaware, New Jersey, New York and Oregon, of the North; and Maryland, Kentucky, Georgia and Louisiana of the South. Tennessee, and five of the former Confederate States, upon which negro suffrage had been imposed (North Carolina, South Carolina, Florida, Alabama and Arkansas) voted for Grant. Virginia, Mississippi and Texas had not yet been restored.

Fifteenth Amendment.—This decisive victory and the knowledge that it had been won by the advantage of the negro vote in the restored States led the Republican leaders to ignore their recent platform declaration in regard to negro suffrage. Shortly after Congress assembled propositions were made to place the freedman's right to vote beyond the power of the States to change To do this by constitutional enactment it was necessary to make the provision universal, and Congress, therefore, submitted for ratification the 15th amendment declaring that "the right of citizens of the United States to vote shall not be denied or abridged by the United States or by any state on account of race, color or previous condition of servitude." Congress was given power to enforce the amendment by appropriate legislation. By March 30, 1870, the amendment had been ratified; but it is doubtful whether this could have been accomplished by legislatures chosen on the issue. As it was, the States of Virginia, Mississippi, Texas and Georgia were required to ratify it as a condition of their readmittance to representation in Congress, and the three former States, having been permitted to vote separately on the obnoxious provisions of their Constitutions in regard to the disfranchisement of former Confederates, rejected those clauses, adopted the 15th amendment and were restored in 1870. Georgia, after a new experience of military rule, likewise ratified the amendment, and her representatives were likewise admitted to Congress.

As soon as the 15th amendment was proclaimed in effect, and the military Governments of the South were superseded, the dominant party proceeded to enact measures of enforcement These seemed especially necessary in view of the fact that, partly by intimidation of the coloured vote, Louisiana (1868) and Tennessee (1869) broke away from the Republican column; while in the election of 1870 Tennessee, North Carolina, Georgia, Virginia and Alabama went Democratic The enforcement legislation of 1870 provided penalties for violating the 14th and 15th amendments and re-enacted the Civil Rights Act of 1866. In the years 1871 and 1872 acts were passed providing for effective Federal supervision of Congressional elections, and the "Ku-Klux Acts" (1871 and 1872) still further increased the power of the Federal courts to enforce the amendments and authorized the President to suspend the writ of *habeas corpus* and use military force to suppress public disorders. But these stern measures were accompanied by some efforts to restore harmony, such as the repeal of the "iron-clad oath" for ex-Confederates, in 1871, and the passage of the General Amnesty Act of 1872. The North was becoming restive under the long-continued use of the Federal military arm within State borders in time of peace.

Reconstruction Governments.—In any case the cost of rehabilitating the public works and providing education and the political and judicial institutions which should apply equally to the hitherto non-political class of the blacks, would have been a heavy one But the legislatures, especially of Louisiana, South Carolina, Tennessee, Arkansas and Alabama, plunged into an extravagance made possible by the fact that the legislatures contained but few representatives who paid considerable taxes. In 1872 it was estimated that the public debts of the 11 reconstructed States amounted to nearly $132,000,000, two-thirds of which was composed of guarantees to corporations. Legislative expenses were grotesquely extravagant, the coloured members in some States engaging in a saturnalia of corrupt expenditure. This alienated from the so-called Radical Party the support of Southern whites, because they resented the concessions of the carpet-bag leaders to the negro vote, because they suffered from the burden of taxation, and above all because race friction increased.

By 1872 a coalition had been formed under the name of Conservatives. But the control of electoral machinery in the strongly centralized State executives chosen by negro votes, and coercion by the Federal authority, still upheld Republican rule in various Southern States Virginia and North Carolina were practically bankrupt, the capitals of Louisiana, Arkansas and Alabama, where rival State officers claimed possession, were occupied by Federal troops, and many of the Governments were so corrupt that only the contemporaneous rottenness in New York City and in certain branches of the Federal Government afford a parallel.

It was a time of lax public morals after war, which was ill suited to the difficult experiment of transferring political power to a race recently enslaved Only the strong arm of the Federal authority sufficed to prevent the whites of the South from overthrowing a condition of things which it was impossible under American political ideas permanently to maintain.

Southern Changes.—An important economic reorganization was in progress in the South. White districts were recovering from the war and were becoming the productive cotton areas by the use of fertilizers and by the more intelligent white labour. Cities were rising, and the mines and manufactures of the southern Appalachians were developing. In the black belt, or region of denser negro settlement the blacks became tenant farmers, or workers on shares. The effective and just direction of negro labour was a difficult problem and was aggravated by the political agitation which intensified race friction. It became evident that there was a negro problem as well as a slavery question, and that the North was unable to solve it.

Foreign Relations.—In the meantime important foreign relations had been dealt with by Secretary William H. Seward, under Johnson, and by Secretary Hamilton Fish, under Grant Not only were many treaties of commerce and extradition, including one with China, negotiated by Seward, but he also brought about a solution of more important diplomatic problems. The relations of the United States with France and England had been strained in the course of the war. Not only had Napoleon III been inclined to recognize the Confederacy, but he had also taken advantage of the war to throw into Mexico a French army in support of the Emperor Maximilian The temptation to use force while American military prestige was high appealed even to Gen. Grant; but Seward by firm and cautious diplomatic pressure induced France to withdraw her troops in 1867, and the power of Maximilian collapsed Russia's friendly attitude throughout the war was signalized by her offer to sell Alaska to the United States in 1867. Seward promptly accepted it and the treaty was ratified by the Senate and the purchase money ($7,200,000) was voted by the reluctant House, which saw little in the acquisition to commend it.

"Alabama" Claims.—With England, affairs were even more threatening than with France Confederate cruisers (notably the "Alabama"), built in England and permitted by the negligence of the British Government to go to sea, had nearly swept the American merchant marine from the ocean. Unsettled questions of boundary and the fisheries aggravated the ill feeling, and England's refusal in 1865 to arbitrate made a serious situation Prolonged negotiations followed a change of attitude of England with regard to arbitration, and in 1870 President Grant recommended to Congress that the United States should pay the claims for damages of the Confederate cruisers, and thus assume them against England. However, in 1871, the Treaty of Washington was negotiated under Secretary Fish, by the terms of which England expressed regret for the escape of the cruisers and provided for arbitration of the fisheries, the north-western boundary, and the "Alabama" claims The case of the United States was victorious, the tribunal awarding damages against Great Britain to the amount of $15,500,000 Two months later the German emperor gave to the United States the disputed north-west boundary, including the San Juan island in Puget sound.

In the West Indies also important questions were presented. Seward had negotiated a treaty of purchase of the Danish West Indies, but the Senate refused to ratify it, nor did Grant's attempt to acquire Santo Domingo meet with a different fate at the hands of that body (1870). In Cuba another insurrection was in progress. Secretary Fish "pigeon-holed" a proclamation of President Grant recognizing the Cubans as belligerents, and secured a policy of neutrality which endured even the shock of the "Virginius affair" in 1873, when 50 of the men of the filibustering steamer flying the American flag were shot by the Spanish authorities. It was shown that the vessel had no right to the flag Negotiations for an isthmian canal resulted only in a treaty with Nicaragua in 1868 giving to the United States a right of way across the isthmus and providing for a Government survey of the Panama route.

It was in the field of domestic concerns, in economic and social development, that the most significant tendencies appeared. The old issues were already diminishing in importance before the other aspect of reconstruction which came from the revived expansion of the nation toward the West and the new forms taken by the development of American industrial society.

Finance.—The Republican Party, following the traditions of the Whigs, was especially responsive to the demands of the creditor class, who demanded legislation to conserve their interests. Its victory in 1868 was signalized by the passage in the spring of the following year of an act pledging the faith of the United States to pay in coin or its equivalent all the obligations of the United States, except in cases where the law authorizing the issue had expressly provided otherwise. In 1870 and 1871 refunding acts were passed, providing for the issue of bonds to the total amount of $1,800,000,000, one billion of which was to run for 30 years at 4%. This abandonment of the doctrine of early convertibility was made in order to render the bonds acceptable to capitalists, but in fact they soon went to a premium of over 25%

While the legislature was thus scrupulous of the credit of the nation and responsive to the views of capital, the Supreme Court was engaged in deciding the question of whether the legal tender notes (greenbacks) were constitutional Successive decisions in 1868 determined that they were not legal in certain cases In these decisions the judges had divided, four to three. Within a year the court was changed by the appointment of one new judge to fill a vacancy, and the addition of another in accordance with a law enlarging the court In 1871 the former decision was reversed and the constitutionality of the Legal Tender Acts sustained on loose-construction reasoning. In 1884 the court went to the extent of affirming the right of Congress to pass legal tender acts in time of peace In 1871 and 1872 Secretary George S. Boutwell illustrated the power of the Administration to change the volume of the currency, by issuing in all over $6,000,000 of legal tender notes; and, following the practice of his predecessors, he sold gold from the Treasury to check speculations in that part of the currency.

Economic Changes.—Speculation and the rapid growth of great fortunes were characteristic of the period. The war itself had furnished means for acquiring sudden riches; the reorganization of taxation, currency and banking increased the opportunities; and the opening of new fields of speculative enterprise in the oil fields of Pennsylvania and Ohio and the gold and silver mines of the mountains of the Far West tended in the same direction An enormous development of manufactures resulted from the diminished commerce and increased demand for manufactured goods, the protection afforded by the tariff, the stimulus due to rising prices, and the consumption of the rapidly growing West It was officially reported in 1869 that "within five years more cotton spindles had been put in motion, more iron furnaces erected, more iron smelted, more bars rolled, more steel made, more coal and copper mined, more lumber sawn and hewn, more houses and shops constructed, more manufactories of different kinds started, and more petroleum collected, refined and exported, than during any equal period in the history of the country."

Pacific Railways.—Between the Civil War and 1872, the extension of the nation's activity to the industrial conquest of the great West, as well as the economic reorganization of the East, had a profound effect upon the development of the United States. Between 1862 and 1872 grants were made to the Union Pacific and Central Pacific companies, and to other connecting corporations, for railways from the Missouri to the Pacific, amounting to nearly 33,000,000ac., and in the same period large loans of funds were made by the general Government for this enterprise. Construction advanced rapidly after 1866, and by 1869 an all-rail connection had been established on the line of the Union Pacific and Central Pacific railways between the East and San Francisco Various grants were made in these years to other roads, both trans-continental and Middle Western Between 1850 and 1871 Congress granted about 155,000,000ac. for railway construction, but not all these grants were perfected It is estimated that some $500,000,000 were invested in the construction of Western railways between 1868 and the panic of 1873, and about 30,000m. of railway had been added.

The effects of this extraordinary extension of railway transportation were immediately apparent. In the Far West the railway lines rapidly made possible the extinction of the bison herds. This opened the way for the great extension of the cattle country, following the retreat of the Indians. Upon the plains Indians the effect was revolutionary. Their domain had been penetrated by the railways at the same time that their means of subsistence had been withdrawn. During the Civil War most of these Western tribes had engaged in hostilities against the Federal Government. By the Peace Commission Act of July 20, 1867, commissioners, including Gen. William T. Sherman, were sent to negotiate treaties. As a result the tribes of the Indian Territory were so concentrated as to permit the transfer of other Western tribes to the same region, while the Sioux of the northern plains were given a reservation embracing the western portions of the Dakotas Discontent with these treaties resulted, however, in hostilities following 1867. Between the close of the war and 1880 some $22,000,000

were expended in Indian wars, although the act of 1871 inaugurated the change of policy whereby the Indians were no longer dealt with by treaty, but were regarded as wards of the nation, to be concentrated on reservations and fed at the expense of the nation under the supervision of Indian agents.

Mining.—Part of these Indian difficulties were due to the opening up of new mining areas in the Rocky Mountains, some of them within the Indians' choicest hunting-grounds. At the beginning of the Civil War a preliminary mining boom struck Colorado, the rich Comstock lode was opened in Nevada; Arizona was the scene of mining rushes; the Idaho mines were entered; and the Montana ores were discovered, so that in the period of the Civil War itself the Territories of Nevada, Idaho and Montana had been organized The discovery of gold in the Black Hills in 1874 continued the same movement In 1860 the nation produced $156,000 worth of silver, in 1861 over $2,000,000 and in 1873 nearly $36,000,000. Capital in mines and quarries of the United States was over $65,000,000 in 1860, over $245,000,000 in 1870, and nearly $1,500,000,000 in 1880.

The Middle West.—This revolution in the life of the great plains and the Rocky Mountains, opening the way to agriculture and to cattle raising, and preparing for the exploitation of the precious metals of that great area, was contemporaneous with the important development of the farming regions of the Middle West Even during the Civil War the agricultural development of the northern half of the Mississippi valley had continued This was aided by the demand for food products to supply the armies and was made possible by the extension of railways, the taking up of the prairie lands through the operation of the homestead law of 1862, the marketing of the railway land grants, and the increased use of agricultural machinery in those years. Between 1860 and 1870 the population of the North Central group of States increased over 42%, and in the next decade by 34%, a total addition to the population in those two decades of 8,000,000 Between 1870 and 1880 about 200,000sq.m were added to the farm lands of the United States, an area almost equal in extent to that of France In the same decade the North Central States increased their improved farms from near 78,500,000ac. to over 136,800,000 acres. The production of Indian corn about doubled between 1860 and 1880, and that of wheat and oats more than doubled The addition came chiefly from the Middle West

Railway Scandals.—The pressing need of increased transportation facilities had led, as we have seen, to lavish land grants and to subsidies by nation, States and municipalities to the railways. The railways themselves, tempted by these opportunities, had extended their lines in some cases beyond the immediate needs of the regions. Extravagances in construction and operation, aggravated by "construction rings" of railway officials and by rolling stock companies who received extravagant prices by favouritism, brought about a condition where the roads were no longer able to meet the demands of their stockholders for returns on the investment without imposing rates that the Western farmer deemed extortionate. In the competitive development of these roads and in the struggle of business corporations and localities with each other, the roads also discriminated between persons and places. This condition chiefly accounted for the political unrest which manifested itself in the West in the so-called "Granger" movements of the '70s

"Granger" Movement.—The farmers felt the pressure of the unsettled currency, taxes were very heavy, the protective tariff seemed to them to bear unduly upon the producers of crops which exceeded the home consumption and had to seek the foreign markets. The price of Indian corn, wheat and cotton in the early '70s tended to fall as production rose, so that the gold value of the total crop was not greatly increased during the decade after the war, in spite of increase of production Dissatisfaction with their share in the prosperity of the country, and especially with the charges of middlemen and transportation companies, discontent with the backwardness of rural social conditions, and a desire for larger political influence, all aided in fostering the growth of organizations designed to promote the farmers' interests. The most influential of these organizations was the Patrons of Husbandry, which was founded in 1867 and spread chiefly after 1872 by local clubs or "granges," especially in the West and South.

The height of the movement was reached in the autumn of 1874. It threatened the disruption of the old political parties in most of the Middle Western States By holding the balance of power the Grangers secured legislation in many of these States, fixed maximum railway rates, and provided for regulation through commissions. In the reaction after the panic of 1873 (when nearly a fifth of the railway mileage of the United States had passed into the hands of receivers) many of the "Granger laws" were repealed, the regulation was rendered nominal and the railways more than regained their political power, yet the agitation had established the important principle, sanctioned by decisions of the Supreme Court, that the railways were common carriers subject fully to public regulation so far as it was not confiscatory. The movement for regulation of interstate commerce by congressional legislation was begun at this time under the leadership of congressmen from the Granger States. Later efforts were more wisely considered and more effective; but the rural democracy showed its opposition to the increasing political influence of capital, to special privileges and to the attempts of corporations to avoid public control periodically thereafter

Tweed Ring.—The presidential election of 1872 took place in the midst of this Western upheaval. At the same time in the South the reform Republicans and Democrats were uniting under the name of "Conservatives" against the carpet-bag rule, and control was passing into their hands A reform movement was active against the evident corruption in national and municipal administrations, for Grant's trust in his appointees was grossly violated The Tweed ring was systematically looting New York city, and prior to Tweed's indictment in 1871 it was acquiring large power in State legislation Civil service reformers, men of moderate views with respect to reconstruction, many war Democrats who had adhered to the Union Party, and tariff reformers began to break away

Grant Re-elected.—The Liberal-Republican movement started in Missouri, and a national convention was called to meet at Cincinnati on May 1, 1872. Their platform attacked the corruption of civil service by the Administration, supported the results of the war as embodied in the last three amendments and demanded amnesty and local civil government for the South It opposed further land grants to railways, but denounced repudiation and demanded specie payments in terms which excluded from its support the advocates of inflation of the currency. This effort to combine the opponents of Grant's Administration was wrecked by the nomination of Horace Greeley, a strong protectionist, who did not command the confidence of the masses of the disaffected. Although endorsed by the Democrats, Greeley was defeated by Grant, who ran on the record of the Republican Party, which now dropped the word Union from its name. Greeley died before the electoral count; the Democrats won only the States of Maryland, Kentucky, Missouri, Tennessee, Georgia and Texas, the votes of Louisiana and Arkansas being thrown out

Panic of 1873.—The enormous cost of the war, the excessive railway building, over-trading, and inflated credit and fluctuating currency, the sinking of capital in opening new farming lands and in readjusting manufactures to new conditions brought their results in the panic of 1873, precipitated by the failure (Sept. 18) of Jay Cooke, the financier of the Northern Pacific railway. For over five years the nation underwent a drastic purgation; railway building almost ceased, and so late as 1877 over 18% of the railway mileage of the nation was in the hands of receivers. The iron industry was prostrated, and mercantile failures for four years amounted to $775,000,000. At the close of the period there was a replacement of partnerships and individual businesses by corporations, but in the interval political unrest was in the foreground

Crédit Mobilier.—The charges that congressmen had been bribed by stock in the Crédit Mobilier, a construction company controlled by Union Pacific stockholders, led to a congressional investigation which damaged the reputations of prominent Republicans, including Vice President Schuyler Colfax; but the same Congress which investigated this scandal voted itself retroactive

increases of salary, and this "back-pay grab" created popular indignation. Evidences of fraud and corruption in revenue collection under the "moiety system," and the general demoralization of the civil service continued The demand for relief from the stringency of the crisis of 1873 expressed itself in the so-called Inflation Bill (passed April 1874) providing a maximum of $400,000,000 for greenback issues This was vetoed by Grant, but he later signed a bill accepting as a maximum the existing greenback circulation of $382,000,000. This compromise was satisfactory neither to contractionists nor greenbackers

Republicans Lose Congress.—The "tidal wave" in the congressional elections of 1874 was the result of these conditions It marked a political revolution. The House of Representatives, which exhibited a two-thirds Republican majority in 1872, showed an opposition majority of about 70, and the Senate was soon to be close. Such Republican strongholds as Pennsylvania, Ohio and Massachusetts went over to the Democrats in the State elections, while in the grain-raising States of the Middle West the Grangers were holding the balance of power, and in the South the Republican Radicals remained in force in few States and only by the use of Federal troops. President Grant in his message of Dec. 1874 acknowledged that public opinion was opposed to this use of force, but declared that without it negro suffrage would be worse than a mockery. Thus by the year 1874 the era of triumphant Republicanism and reconstruction was closing The leaders perceiving power about to pass from them rapidly enacted a series of party measures before the meeting of the newly elected Congress Under the leadership of Senator John Sherman an act was passed (Jan 14, 1875) providing for resumption of specie payments on Jan. 1, 1879, gradually contracting greenbacks to $300,000,000 and compensating this by expanding the circulation of the national banks.

In the field of the tariff a similar policy was followed. The act of 1870 had somewhat reduced duties on tea, coffee, sugar and iron; but under Western pressure in 1872 the Republican Congress had consented to a 10% reduction on most classes of goods in order to save the general system of protection On the eve of their relinquishment of full power the Republicans (March 3, 1875) repealed the Tariff Act of 1872, increased the duties on molasses and sugar and increased the revenue tax on tobacco and spirits Thus the tariff was restored to the war basis, before the incoming Democratic House could block the advance. Similarly on March 1 Congress passed a Civil Rights Act, milder than the measure for which Sumner had fought so long, guaranteeing equal rights to the negroes in hotels, public conveyances, and places of amusement and forbidding the exclusion of them from juries. An effort to pass a new force bill levelled against the intimidation of negro voters failed By these measures the Republicans placed the important features of their policy where they could be overturned only by a Democratic capture of Presidency and Senate.

Supreme Court Decisions.—In the midst of these changes the Supreme Court handed down decisions undoing important portions of the reconstruction system by restraining the tendency of the nation to encroach on the sphere of the State; and restricting the scope of the recent constitutional amendments. On April 14, 1873, in the Slaughter House cases, the courts held that the amendments were primarily restrictions upon the States for the protection of the freedom of the coloured man, rather than extensions of the power of the Federal Government under the definition of United States citizenship, and that general fundamental civil rights remained under State protection. In the case of the United States v. Reese, decided March 27, 1876, the court declared parts of the act of 1870 (which provided for the use of Federal force to protect the negro in his right to vote) unconstitutional, on the ground that they did not specify that the denial of suffrage must be on the sole ground of race or colour. A reasonable pre-requisite, such as a poll-tax, for voting was permissible. The South later took advantage of this decision to restrain negro suffrage indirectly. In United States v. Cruikshank (1876) the court held that the amendments to the Constitution left it still the duty of the State, rather than of the United States, to protect its citizens, even when whites had mobbed the negroes. In 1883 the court declared the conspiracy clause of the Ku-Klux Act unconstitutional and restricted the application of the law to acts of a State through its officers and not to private citizens. In the same year it declared the Civil Rights Act of 1875 invalid.

In 1875 President Grant refused the appeal of the "carpet-bagger" Gov Adelbert Ames of Mississippi to be supported by troops, whereupon Ames resigned his office into the hands of the Conservatives The Mississippi plan of general intimidation of negroes to keep them from the polls was followed in Louisiana, South Carolina and Florida which alone remained Republican Thus steadily the radical reconstruction policy and Republican control of the South were being reversed It was made clear that negro suffrage could be enforced upon the South only by military rule which could no longer command Northern sympathy or the sanction of the Federal court. Northern interest increasingly turned to other issues, and especially to discontent over administrative corruption.

Corruption.—The spoils system had triumphed over the advocates of civil service reform to such an extent that Grant abandoned the competitive system in 1875 on the ground that Congress did not support him in the policy Enormous frauds in the collection of the internal revenue by the whisky ring with the connivance of Federal officials were revealed in 1875, and at about the same time, secretary of War William W. Belknap resigned to avoid impeachment for corruption in the conduct of Indian affairs. The enforced resignation in 1876 of secretary of the Treasury Benjamin H Bristow, after he had successfully exposed the whisky ring, and of postmaster-general Marshall Jewell, who had resisted the spoils system in his department, tended to discredit the Administration. Blaine, the leader of the Republicans in the House of Representatives, fell under suspicion on account of his earlier relations with the Little Rock and Fort Smith and Northern Pacific railways, which left it doubtful, in spite of his aggressive defence, whether he had not used his influence as Speaker in previous Congresses to secure pecuniary advantages from land grant railways.

Campaign of 1876.—Thus the campaign of 1876 approached, with the Republicans divided into (1) steadfast supporters of the Grant Administration, (2) a discontented reform wing (which favoured ex-Secretary Bristow), and (3) an intermediate group which followed Blaine. This statesman made a bold stroke to shift the fighting which the Democrats planned to make against the scandals of the Administration, to the old-time war issues. By proposing to exclude Jefferson Davis from amnesty, he goaded Southern congressmen into indiscreet utterances which fanned anew the fires of sectional animosity A compromise candidate was selected in the person of Gov. Rutherford B Hayes, of Ohio, who had vigorously opposed the greenback movement in his State, and whose life and character, though little known to the general public, made him acceptable to the reform leaders of the party. The Democrats, demanding reform, economy, a revenue tariff and the repeal of the resumption clause of the act of 1875, chose the reform governor of New York, Samuel J. Tilden, as their candidate. The Independent National, or Greenback, Party, which was to develop rapidly in the next two years, nominated Peter Cooper, a New York philanthropist, and demanded the repeal of the Resumption Act, and the enactment of a law providing a paper currency.

Hayes Elected.—The election proved to be a very close contest. Tilden, according to the count of both parties, had a plurality of over 250,000 votes, and at first the leading Republican journals conceded his election He had carried New York, Indiana, New Jersey and Connecticut and, by the Democratic count, the solid South But the Republican headquarters claimed the election of Hayes by one electoral vote, based on the belief that the States of South Carolina, Florida and Louisiana had gone Republican. Since these States were in the midst of the transition from negro to white Government, and elections were notorious for fraudulent practices, a serious question was raised, first as to the proper authority to count the electoral vote, and second, how far it was permissible to go behind the returns of the State authorities to ascertain the validity of the canvass of the votes in the

State The political capacity and moderation of the nation were severely tested; but in the end a characteristic American solution was found by the creation of an electoral commission in which five associate justices of the Supreme Court were joined with an equal number of representatives from each of the two houses of Congress The result was that this commission refused to "go behind the returns," and Hayes was declared elected by one vote. To prevent the threatened danger of a filibuster by Democrats of the House of Representatives against the completion of the count until after legal date for the inauguration of the President, Hayes's friends agreed with leading Democrats that he would withdraw the Federal troops from Louisiana.

Thus a new era began under a moderate and reforming Republican President, a close Republican Senate and a Democratic House of Representatives The Southern question was not settled, but other issues of an economic and social nature increasingly forced themselves to the front During the dozen years that followed Hayes's inauguration neither party held complete possession of both the executive and the two houses of Congress. His own moderate character, the conditions of his election and the check imposed during the first two years by a Democratic House of Representatives (and during the second two years by an opposition in both houses) made the period of Hayes's Administration a transition from the era of reconstruction to the era of dominant economic and reform agitation.

When he withdrew the troops which sustained the Republican Governments in Louisiana and South Carolina, those States returned to the rule of the white Democrats. In the Congress elected in 1878 the former slave States chose 101 Democrats to the House of Representatives and only four Republicans. Leading Republicans like Blaine protested vigorously against the policy, declaring that the men who saved the Union should govern it; and on the other hand the Democrats in Congress added "riders" to appropriation bills designed to starve the Administration into complete cessation of the use of troops and Federal deputy marshals at Southern elections. Due to this policy extra sessions had to be summoned in 1877 and 1879 to provide supplies for the Government. Hayes assisted his party by vetoing these coercive attempts of the Democrats and it was not until later that Federal attempts to supervise Southern elections entirely ceased.

Civil Service Reform.—As his early policy toward the South had dissatisfied many of the leaders of his party, his opposition to the spoils system alienated others. In 1877 a Civil Service Reform Association was formed in New York and extended to other States. In June 1877 President Hayes issued an executive order against the participation of Federal officers in political management, and he furnished evidence of his sincerity by removing Alonzo B. Cornell, the naval officer of New York, who was also chairman of both State and national Republican committees, and Chester A. Arthur, collector of the port of New York. As both were friends of Senator Roscoe Conkling of that State, the leader of the Grant men, this was a bold challenge. The "Stalwarts" answered it by securing the nomination of Cornell as governor of New York and Arthur as vice-president of the United States.

Finances.—The monetary question rose to primary importance at this time. Hayes himself had campaigned in Ohio successfully against the greenback movement, and he chose as his secretary of the Treasury, John Sherman, whose long service as chairman of the finance committee had made him familiar with conditions and influential with moderate men. The *per capita* circulation of the nation had fallen from $20.57 in 1865 to $15 58 in 1877 and was still declining. The remarkable increase in the production of silver, as the new mining regions were opened, was accompanied by a fall in its ratio to gold from 15 to one in 1860 to 17 to one in 1877. Congress had, in 1873, passed an act dropping the standard silver dollar from the list of coins; but though the significance of this omission of a coin not widely circulated passed almost unnoticed at the moment, the demonetization of silver was afterward stigmatized as a conspiracy, "the crime of 1873." As the date (Jan. 1, 1879) for the redemption of the greenbacks in specie approached, demands were renewed for the replacement of national bank-notes by greenbacks, for the postponement, or abandonment of resumption, for the free coinage of silver, and for the use of silver as well as gold in payment of bonds redeemable in "coin." Sectional grouping of debtor against creditor regions, rather than party alignment, showed itself in the votes, for each party had its "soft money" as well as "hard money" followers.

A monetary commission, appointed in 1876, reported in 1877, but without agreement or real influence upon the country. The president took strong ground against free coinage and against the payment of bonds in silver; but the House of Representatives passed the measure, known as the Bland bill, for the free coinage of silver, by a vote of 163 to 34. In the Senate this was amended and as it finally passed both houses it was known as the Bland-Allison Act after the two leaders, the Democratic representative from Missouri and the Republican senator from Iowa. This compromise was carried over the veto of President Hayes and became a law Feb. 28, 1878. In the vote of Feb. 15, all but one of the senators from New England, New York and New Jersey opposed it, while the States west of the Alleghenies furnished only four opposing votes. The law restored the legal tender character of the silver dollar and authorized the secretary of the Treasury to buy silver bullion at the market price, to an amount of not less than $2,000,000 nor more than $4,000,000 per month, and to coin the bullion into silver dollars.

Hardly had the Bland-Allison compromise been effected on the silver issue when an act was passed (May 31, 1878) forbidding the further retirement of greenbacks, which remained at $346,681,000. Substantially the same sectional alignment was followed in the vote on this bill as in the silver votes. Not satisfied with this legislation, nearly 1,000,000 voters cast their ballots for Greenback Party candidates at the congressional elections in the autumn of 1878. The preparations of Secretary Sherman had been so carefully made, and the turning tide of trade brought coin so freely to the United States, that before the date of resumption of specie payments a gold reserve had been accumulated to the amount of $133,000,000 in excess of matured liabilities and the greenbacks rose to par before the date of redemption.

Election of 1880.—In the campaign of 1880, Hayes and Tilden both declined to stand for renomination. Thus the issue of the "fraud of 1876," which the Democratic platform called the paramount issue, was subordinated. Nor was it possible for the Republicans to force the tariff question into a commanding position, for although the Democratic platform declared for a tariff for revenue only, a considerable wing of that party led by Samuel J Randall, of Pennsylvania, favoured protection. Gen. Winfield S. Hancock, a distinguished soldier in the Civil War, whose nomination for the Presidency by the Democrats was designed to allay Northern distrust, refused to make the tariff a national issue. The recent adjustment of the monetary question and return of prosperity relegated the discussion of the currency also to a subordinate place.

The Republicans, after a heated convention in which the followers of Grant, Blaine and Sherman, fought each other to a deadlock, selected Gen. James A. Garfield of Ohio, who was political manager for Sherman in the convention. This was a blow to the Grant, or "Stalwart" wing, which was, however, partly placated by the nomination of Arthur for the vice-presidency. Garfield's popular plurality was only a little over 9,000 out of a total vote of over 9,000,000; but his electoral vote was 214 to Hancock's 155. The area of the former slave States marked the boundaries between the Republican and the Democratic States, except that Hancock also carried New Jersey, Nevada and California. The Republicans won the elections for the House of Representatives which would meet in 1881, and the Senate was at first nearly evenly divided, two independents holding the balance. In the ensuing four years party lines were badly broken, factions made bitter war upon each other, and the independent reformers or "Mugwumps" grew in numbers. The selection of Blaine as secretary of State committed Garfield to the anti-Grant wing, and the breach was widened by his appointment of the collector of the port of New York against the protests of Roscoe Conkling and Thomas C. Platt, the "Stalwart" senators from New York. They resigned, then sought re-election in order to vindicate the right of senatorial recommendation; but were defeated.

Garfield Assassinated.—In the midst of this excitement the President was assassinated by a disappointed office-seeker of unsound mind. Vice-President Arthur, who succeeded Garfield in Sept. 1881, by his tact and moderation won the admiration of former opponents; but the bad crops in 1881 and the dissatisfaction with boss rule among independent voters caused a Democratic victory in the congressional campaign of 1882.

Legislative Acts.—Garfield's assassination had given new impetus to the movement against the spoils system, a National Civil Service Reform League had been organized in 1881, President Arthur presented the question in his message of December of that year, and in 1882 George H. Pendleton, a Democratic senator from Ohio, urged the subject upon the attention of Congress. Stimulated by the elections of 1882 Congress passed an act (Jan. 16, 1883) authorizing the President to appoint a commission to classify certain of the Federal employees, and providing for appointment and promotion within this classified list by competitive examination. Congressional recommendations for these offices were not to be received, and political assessments for campaign purposes were forbidden This was an effective beginning in the purification of the civil service; but the evil of assessment of employees was succeeded by the evil of soliciting campaign contributions from corporations interested in legislation. The extension of the competitive list proceeded gradually through succeeding Administrations. The Edmunds Anti-Polygamy Act (1882) was levelled at the Mormons and the Chinese Exclusion Act was passed at the demand of labour, after a long agitation in 1882, the way having been prepared by the Treaty of Peking in 1880. Bills to this effect had been vetoed by Hayes and Arthur as violative of international agreement, but the desire of the politicians to win the California vote, and the compromise by which the exclusion was limited to ten years finally carried the measure, and the Supreme Court (1889) held it constitutional

Surplus Revenues.—From 1879 to 1890 the Treasury showed a surplus of revenue over expenditure. This furnishes the explanation of much of the legislation of that period. It led to extravagant appropriations, such as the Arrears of Pensions Act of 1879, and the River and Harbor Act of 1882 providing for the expenditure of more than $18,000,000 which was passed over the veto of Arthur. Appropriation bills were merely constructed in various committees of Congress under a system of bargaining between interests and sections with primary reference to the political fortunes of the congressmen.

The surplus also strengthened the demand for a reduction of the tariff. A tariff commission, composed of men friendly to protection, appointed in 1882, proposed an average reduction of 20 to 25%. Nevertheless, in the act as passed in 1883 duties were increased in general on those protected articles which continued to be imported in large volume, especially on certain woollen goods and about two-thirds of the imported cotton goods, and on iron ore and some steel products, while they were lowered on finer grades of wool and cheaper grades of woollen and cotton fabrics, etc. It was unsatisfactory to large portions of both parties and did not materially lower the revenue; but the act of 1883 made extensive reductions in internal taxes As the Senate had just fallen into the hands of the Republicans, and the House would not become Democratic until the new Congress met, this protective law gave the Republicans the advantage of position. Moreover, the Democrats were themselves divided, 19 Representatives voting with the Republicans on the act of 1883. In the next Congress (1884), when the leaders made an attempt to rally the Democrats to show their position by passing a bill for a horizontal reduction of 20% in general, 41 Democrats voted against the bill and prevented its passage through the House.

Election of 1884.—Thus the campaign of 1884 found both parties still lacking unity of policy although it seemed possible that the tariff might become the touchstone of the contest. The Republicans challenged the independents by nominating Blaine, whose record was objectionable to many reformers, and who had been chiefly identified with the reconstruction politics The Democrats, taking advantage of the situation, nominated Grover Cleveland of New York. He had won approval by his reform administration as mayor of Buffalo and as governor of New York during the past two years, when he had shown an independence of party "bosses" and had convinced the public of his sincerity and strength of character. He represented conceptions and interests which had grown up since the war, and which appealed to a new generation of voters. The platform emphasized the idea that "new issues are born of time and progress," and made the leading question that of reform and change in Administration, lest the continued rule of one party should corrupt the government. On the question of tariff the Democrats took a conservative attitude, emphasizing their desire to promote healthy growth, rather than to injure any domestic industries, and recognizing that capital had been invested and manufactures developed in reliance upon the protective system. Subject to these limitations, they demanded correction of abuses The Greenbackers nominated Gen. Benjamin F Butler of Massachusetts, recently chosen governor of that State on the Democratic ticket, but he polled only 175,000 votes John P St. John, the candidate of those who would prohibit the liquor traffic, secured 150,000 votes, an unprecedented gain

Cleveland President.—The campaign abounded in bitter personalities, and the popular vote was close, Cleveland's plurality being only 23,000. The great State of New York, with electoral votes enough to have turned the scale, was carried by the Democrats by only a few more than 1,000 votes out of a total of over 1,000,000 Cleveland's electoral majority was 37. The election was nevertheless recognized as making an epoch. For the first time since victory came to Lincoln and the Republicans on the eve of the Civil War, nearly a quarter of a century earlier, the country had entrusted power to the Democrats, although over two-thirds of their electoral vote came from the former slave States New York, Connecticut, New Jersey and Indiana constituted their Northern territory Perhaps the most significant thing about the result was the evidence that in the North political and sectional habits and prejudices were giving way among a sufficient number of independent voters, responsive to strong personal leadership on reform issues, to turn the political scale. The transition from war issues which began in 1872, and became marked in 1876, was completed by the election of Cleveland in 1884

During the first half of his term President Cleveland had the opposition of a strongly Republican Senate. In the second half the Senate remained Republican by a majority of two, and the House continued Democratic His civil service policy naturally met severe criticism not only from his party foes, but also from the independent supporters who looked to him to establish the service on a strictly non-partisan basis. The outcome of the first two years of his Administration was that, of the entire body of Federal office-holders, two-thirds were changed and the obnoxious Tenure of Office Act was repealed, thus leaving the President the right of removal without presenting his reasons. Nevertheless there was a gain, for the criticism by the Republicans placed them on record against the former spoils system; Cleveland somewhat checked the political activity of officeholders; and before leaving the Presidency he transferred the railway mail service to the classified list requiring competitive examination.

The transition of executive power for the time to the Democratic Party, however much it impressed the imaginations of the public, as the end of an era, was not so significant as the national growth and expansion in the decade between 1880 and 1890 whereby forces were set loose which determined the characteristics of the succeeding period. Between these years the nation grew from about 50,000,000 to over 62,000,000. The Middle West, or North Central group of States, gained nearly 5,000,000 and the Western division over 1,250,000 West of the Alleghenies altogether more than 8,000,000 souls had been added, while the old Eastern States gained but 4,000,000. In 1890 the North Central division alone had achieved a population nearly 5,000,000 greater than that of the North Atlantic, while the trans-Allegheny region surpassed the whole East by about 10,000,000, and the numbers of its representatives in House and Senate placed the political destiny of the nation in its hands.

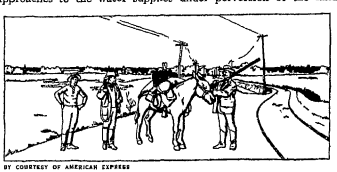
The West.—One of the most important reasons for the wholesale taking up of Western resources in these and the following years was the burst of railway building subsequent to the interruption of the panic of 1873. The eager pioneers pushed into western Kansas and Nebraska as they had into the northern Ohio valley a half-century before. Nebraska grew from a population of 123,000 in 1870 to nearly 500,000 in 1880 and to over 1,000,000 in 1890 From about 333,300 in 1870, Kansas rose to almost 1,000,000 in 1880, and to nearly 1,500,000 in 1890. The railway had "boomed" the Golden West and a cycle of abundant rains seemed to justify the belief that the "Great American Desert" was a myth Thus settlers borrowed money to secure farms beyond the region of safe annual rainfall under the agricultural methods of traditional pioneering Swift disappointment overtook them after 1886, when droughts and grasshoppers ruined the crops and turned back the tide of Middle Western colonists until the western parts of these States were almost depopulated, Kansas alone losing one-seventh of its population; nor did prosperity return for a decade.

As the column of settlement along the Ohio valley had extended its flanks into the old North-west between the Ohio and the Great Lakes, and into the old South-west of the lower Mississippi after the war of 1812, so the later pioneers by railway trains began to take possession of the remoter and vaster North-west and South-west The "granger roads," centring in Chicago, thrust their lines out to develop wheat farms in interior Iowa, Minnesota and the Dakotas, where the virgin soil of the prairie farms brought returns that transferred the wheat belt to this new land of promise, and by competition forced the older wheat areas to develop varied agriculture. The introduction into the Minneapolis mills of the recently invented steel-roller system of making flour not only built up a great flour industry there but created a demand for the hard wheat suited to the North-western prairies. The pine forests of Michigan, Wisconsin and Minnesota were exploited in the same era

A more impressive movement was in progress as additional trans-continental railways were extended from the frontier to the Pacific. In 1870 for 1,000m. west of Duluth, at the head of Lake Superior, along the line of the projected Northern Pacific railway there were no cities or little towns. Relying upon its land grant and upon the undeveloped resources of the vast tributary region, the railway, after halting for a few years subsequent to the panic of 1873 at Bismarck on the Missouri rushed its construction to Seattle and was opened in 1883 The Great Northern, a product of the vision and sound judgment of James J Hill, started from St Paul without a land grant and reached Puget sound in 1893 Thus a new industrial zone had been brought into existence Colorado had become a State in 1876; in 1889 North Dakota, South Dakota, Washington and Montana were admitted as States and the next year Idaho and Wyoming were added The Western political forces, especially the friends of silver, were thus given the balance of power in the Senate.

As a new North-west was opened by the completion of the Canadian Pacific (1883), the Northern Pacific (1883) and the Great Northern (1893), so the new South-west was entered by the completion of the Southern Pacific from New Orleans across Texas, New Mexico, Arizona and southern California to San Francisco by 1883. In 1883 also the lines which became the Atchison, Topeka and Santa Fe, extending from the lower Missouri valley, with St. Louis and Kansas City as important terminals, through south-eastern Colorado, northern Arizona and New Mexico, reached the same goal. The Denver and Rio Grande opened new mining areas between Denver and Ogden.

Not only additional mines were reached by these lines, but a great cattle country, recently the habitat of the bison and the Indian, was opened All the large cities commanding the approaches to this country developed packing industries, but Chicago especially profited South-eastern Texas was the original home of these cattle ranches, but the driving of herds to supply the miners of the Rocky Mountains revealed the fact that the whole bison country was capable of supporting range cattle, and the practice grew of driving the stock to the feeding ground of the north and returning. The height of the movement along the cattle trail, which in its largest extent ran through the public lands of the great plains from Texas to the Dakotas and Montana, was reached in 1884. In that period cattlemen fought over the possession of the range, controlled vast tracts by seizing the approaches to the water supplies under perversion of the land laws, fenced in the public domain, either defiantly or by leases from land grant roads, and called out proclamations of Presidents from Hayes to Cleveland. The steady advance of the farmer, and protective measures against the spread of the cattle disease known as Texas fever, gradually prevented the continuance of the trail, and ultimately broke down the system of great ranches. About 1870 shipment of live-stock from Chicago had become significant, and within a decade the refrigerator car revolutionized the packing industry by making possible the shipment of dressed beef not only to the markets of the Eastern United States but even to Europe. The value of slaughtering and packing industries in the United States increased from less than $30,000,000 in 1870, to $564,000,000 in 1890.



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"ON THE NORTH LINE." THE LAND RUSH TO OKLAHOMA IN 1889
Since 1834 the land comprising the present state of Oklahoma had been in the possession of Indian tribes. In 1889 the Federal government purchased a title to a large tract and a proclamation was issued that at noon on April 22nd, this land would be opened to homestead settlement. More than 20,000 people were on the border at the appointed hour

Another important revolution in American economic life was effected by the opening of new iron mines, the growth of the steel and coal industry and the rise of an extraordinary internal commerce along the whole length of the Great Lakes. By 1890 the output of pig-iron in the United States surpassed that of Great Britain, having doubled since 1880. The full meaning of the revolution is seen in the fact that by 1907 the United States produced more pig-iron and steel than Great Britain, Germany and France combined. As a result of the growth of the wheat, lumber and iron-ore production of the North-west, the traffic along the 1,000m of the Great Lakes grew (chiefly after 1890) by leaps, and changed from wooden sailing-vessels to steel ships driven by steam. The traffic through the Sault Ste. Marie canal came greatly to exceed that through the Suez canal.

The New South.—The South shared in these industrial transformations Not only did white labour produce an increasing proportion of the cotton crop, but cheap white labour came from the uplands to cotton mills situated at the water-powers. This, with the abundant supply of power material, enabled the South to develop cotton manufacture between 1880 and 1890 on a scale that threatened New England's dominance The southern Appalachians began to yield their treasures of coal and iron; northern Alabama became one of the great centres of the iron industry and the South produced nearly 400,000 tons of pig-iron in 1880 and 2,500,000 20 years later By 1890 the production of coal, iron-ore and pig-iron in this section was as great as that of the United States in 1870. The value of the products of manufacture in the South rose from $338,000,000 in 1880 to $1,184,000,000 in 1900. The exploitation of the long leaf pine forests also attracted Northern capital Fruit and truck gardening grew rapidly, and the South began to exhibit traits of industrial development familiar in the North and West. The negro problem continued to hold the South as a whole to the Democratic party.

Industrial Changes.—The opportunities opened to capital by these forces of growth in the West and South, as well as the

general influence of an age of machine production, led to transformations in the East which brought new difficulties for political solution. The East began to exhibit characteristics of other long-settled countries where increasing density of population and highly developed industry are accompanied by labour troubles To capital the opening resources of the West, and the general national prosperity after 1879, offered such inducements that large scale production by corporations became the order of the day. The forces which had exhibited themselves in increased manufacture and railway development between the Civil War and the panic of 1873 now found expression in a general concentration of industries into fewer plants with vastly greater capital and output, in the combination of partnerships into corporations, and of corporations into agreements and trusts to avoid competition and to secure the needed capital and economies for dealing with the new problems of industrial magnitude. Western farming competition led to the actual abandonment of much inferior land in New England and to agricultural disadvantages in the Middle States. As agriculture became less attractive and as industrial demands grew, the urban population of the East increased at the expense of the rural. The numbers of cities of the United States with more than 8,000 people nearly doubled between 1880 and 1890; by 1900, the urban population constituted a third of the total; this phenomenon was especially marked in the North Atlantic division, where, by 1900, over half the population was in cities of more than 8,000 inhabitants

In similar fashion concentration of industry in large establishments was in progress In 1880 nearly 2,000 mills were engaged in the woollen industry; in 1890 not many more than 1,300 Even more marked was the change in iron and steel, where large-scale production and concentration of mills began to revolutionize this fundamental industry, and other lines of production showed the same tendency. The anthracite mines of Pennsylvania fell into the possession of seven coal-carrying railways which became closely allied in interest. In most of the important industries the tendency of large organizations to subject or drive out the small undertakings became significant. Already the railways to avoid "cut-throat competition" had begun to consolidate, to form rate agreements and to "pool" their earnings.

Interstate Commerce Act.—The Cullom bill as enacted into the interstate commerce law of Feb. 4, 1887, was framed to prevent unjust discriminations by the railroads between persons, places and commodities, the tendency of which was to foster monopoly. The law forbade discriminations and pooling, made a higher charge for a short haul than for a long haul over the same road illegal, required publicity of rates, and provided for a commission to investigate and fine offenders. But the decisions of the commission were reviewable by the Federal courts and the offender could be coerced, if he refused to obey the commission, only by judicial proceedings. The commission was empowered to provide uniform accounting and to exact annual reports. The principle settled by the law was an important one, and marked the growing reliance of the former individualistic nation upon Federal regulation. But the difficulties by no means disappeared; the Federal judiciary refusing to accept the findings of the commission on questions of fact, retried the cases; and the Supreme Court overruled the commission on fundamental questions, and narrowed the scope of the act by interpretation.

Social Unrest.—Labour exhibited the tendency to combination shown by capital. The Knights of Labor, founded in 1869, on the basis of "the individual masses" instead of the trades unions, and professing the principle that "the injury of one is the concern of all," grew from a membership of about 100,000 in 1885 to 730,000 in 1886. The number of strikes in 1886 was over twice as many as in any previous year. In one of the strikes on the Gould railway system 6,000m. of railway were held up. In New York, Henry George, author of books proposing the single tax on land, ran for mayor of the city and received 68,000 out of 219,000 votes. At the same time socialistic doctrines spread, even among Western farmers But sympathetic strikes, anarchistic outbreaks, and drastic plans for social change did not appeal to the people as a whole. The Knights of Labor began to split. and the unions, organized as the American Federation of Labor, began to take their place with a less radical membership President Cleveland broke with precedents in 1886 by sending in the first message on labour, in which he advocated, without success, a labour commission to settle controversies A national bureau of labour to collect statistics had been established in 1884; State legislation increasingly provided for arbitration of labour disputes, and regulation of factories and child labour

Early in 1885 a law had been enacted forbidding the importation of labour under contract, and in 1888 the Chinese Exclusion Act was continued. Immigration was exceptionally large in the decade from 1880 to 1890, amounting to about 5,250,000 as compared with 2,800,000 for the previous decade But a large number of these new-comers settled on the newly opened lands of the Middle West By 1890 the persons of German parentage in the Middle West numbered over 4,000,000. Minnesota held 373,000 persons of Scandinavian parentage. The Irish constituted the largest element among the English-speaking immigrants The population of foreign parentage amounted to one-third of the whole population of the United States in 1890.

In the midst of this national development and turmoil President Cleveland struggled to unite his party on a definite issue. The silver question continued to divide each party, the continued fall of silver leading to renewed agitation for free coinage. The surplus led to extravagant appropriation bills, such as special pension bills, which Cleveland vetoed altogether, thereby incurring criticism by veterans of the Civil War, and river and harbour improvement measures, particularly the act of 1886, to which the President gave reluctant assent, and the bill of 1887, to which he gave a "pocket veto" by refusing his signature. But the retention of the surplus in the Treasury would create a monetary stringency, its deposit in banks aroused opposition, and its use to buy bonds was unpopular with the Democrats.

The Tariff.—Cleveland boldly met the issue and gave purpose to his party by his annual message of Dec. 1887, which he entirely devoted to an exposition of the situation arising from the surplus, and to a demand for a revision of the tariff in order to reduce revenue. He did not profess free trade doctrines: "It is a condition which confronts us, not a theory," he declared. The election of 1886 had reduced the Democratic majority in the House, but the President was able to induce his party to pass the Mills bill (1888) through that body as a concrete presentation of policy The bill put many important raw materials (including wool) on the free list, substituted *ad valorem* for specific duties to a large extent, and generally reduced the protective duties. It was believed that the measure would remit over $50,500,000 of duties, nearly $20,000,000 of which would result from additions to the free list. The Republican Senate also found party unity on the tariff issue and its committee on finance, under the leadership of Senator Nelson W. Aldrich of Rhode Island, drafted a counter proposal. They would reduce revenue by repealing the taxes on tobacco, and the taxes on spirits used in the arts and for mechanical purposes, and by revising the tariff so as to check imports of articles produced at home.

Harrison Elected.—On the tariff issue the two parties contested the election of 1888, the Republicans denouncing the Mills bill and the Democrats supporting it. Blaine having withdrawn from the contest, and John Sherman having secured but little more than half the votes necessary to nominate, the Republicans picked from a multitude of candidates Gen. Benjamin Harrison of Indiana, grandson of President William Henry Harrison, to run against Mr. Cleveland. The popular vote was exceedingly close, but Harrison had an electoral majority of 65, having carried all of the States except the solid South, Connecticut and New Jersey The increasing use of money to influence the election, and particularly the association of great business interests with such political "bosses" as Matthew S. Quay of Pennsylvania and Thomas C. Platt of New York, were features of the campaign The congressional elections ensured to the Republicans the undisputed control of all branches of the Government when the 51st Congress should convene, and it was generally agreed that the party had a mandate to sustain the protective tariff.

THE UNITED STATES AND ITS POSSESSIONS WITH THEIR POPULATIONS, AREAS AND DATES OF ACQUISITION

	Population 1950 Census	Population 1940 Census	1940 Land Area sq. mi	Date of Acquisition
Continental U S.	150,697,361	131,669,275	2,977,128	
Alaska	128,643	72,524	571,065	1867
American Samoa	18,937	12,908	76	1900
Guam	59,498	22,290	203	1899
Hawaii	499,794	423,330	6,441	1898
Panama Canal Zone	52,822	51,827	362	1904
Puerto Rico	2,210,703	1,869,255	3,423	1899
Virgin Islands	26,665	24,889	132	1917
Military and Naval, etc , abroad	481,545	118,933	....	. ..
Total	154,177,087*	150,265,534‖	3,673,660‖	

THE STATES OF THE UNION, THEIR POPULATIONS, AREAS, DATES OF ADMISSION, POPULAR NAMES, CAPITALS, STATE FLOWERS AND BIRDS

State	Electoral Vote	Population, 1950 Census	1950 Land Area sq mi	Date of Admission†	Popular Names‡	Capitals	Flower	Bird
na	11	3,061,743	51,078	1819	Cotton State	Montgomery	Goldenrod	Yellowhammer
a	4	749,587	113,575	1912	Apache State	Phoenix	Saguaro Cactus	Cactus Wren
as	8	1,909,511	52,075	1836	Wonder State	Little Rock	Apple Blossom	Mockingbird
nia	32	10,586,223	156,740	1850	Golden State	Sacramento	Golden Poppy	Calif. Valley Quail
do	6	1,325,089	103,922	1876	Centennial State	Denver	Rocky Mt. Columbine	Lark Bunting
ticut	8	2,007,280	4,899	1776	Nutmeg State	Hartford	Mountain Laurel	Robin
are	3	318,085	1,978	1776	Diamond State	Dover	Peach Blossom	Blue Hen Chicken
t of Columbia		802,178	61	.	None	None	None	None
	10	2,771,305	54,262	1845	Peninsula State	Tallahassee	Orange Blossom	Mockingbird
a	12	3,444,578	58,483	1776	Empire State of the South	Atlanta	Cherokee Rose	Brown Thrasher¶
	4	588,637	82,769	1890	Gem State	Boise	Syringa	Mountain Bluebird
	27	8,712,176	55,935	1818	Prairie State	Springfield	Native Violet	Cardinal
a	13	3,934,224	36,205	1816	Hoosier State	Indianapolis	Zinnia	Cardinal
	10	2,621,073	56,045	1846	Hawkeye State	Des Moines	Wild Rose	Eastern Goldfinch
	8	1,905,299	82,108	1861	Sunflower State	Topeka	Native Sunflower	Western Meadowlark
ky	10	2,944,806	39,864	1792	Blue Grass State	Frankfort	Goldenrod	Cardinal
na	10	2,683,516	45,162	1812	Pelican State	Baton Rouge	Magnolia	East Brown Pelican¶
	5	913,774	31,040	1820	Pine Tree State	Augusta	Pine Cone, Tassel	Chickadee
nd	9	2,343,001	9,881	1776	Old Line State	Annapolis	Black-Eyed Susan	Baltimore Oriole
husetts	16	4,690,514	7,867	1776	Bay State	Boston	Mayflower	Chickadee
an	20	6,371,766	57,022	1837	Wolverine State	Lansing	Apple Blossom	Robin
sota	11	2,982,483	80,009	1858	North Star State	St. Paul	Moccasin Flower	American Goldfinch¶
ippi	8	2,178,914	47,248	1817	Magnolia State	Jackson	Magnolia	Mockingbird
ri	13	3,954,653	69,226	1821	Show Me State	Jefferson City	Hawthorn	Bluebird
na	4	591,024	145,878	1889	Treasure State	Helena	Bitterroot	Meadowlark
ka	6	1,325,510	76,663	1867	Cornhusker State	Lincoln	Goldenrod	Western Meadowlark
a	3	160,083	109,789	1864	Sagebrush State	Carson City	Aspen (Tree)¶	Mountain Bluebird¶
ampshire	4	533,242	9,017	1776	Granite State	Concord	Purple Lilac	Purple Finch¶
rsey	16	4,835,329	7,522	1776	Garden State	Trenton	Violet	Eastern Goldfinch
lexico	4	681,187	121,511	1912	Sunshine State	Santa Fe	Yucca Flower	Road Runner¶
ork	45	14,830,192	47,944	1776	Empire State	Albany	Rose	None
Carolina	14	4,061,929	49,097	1776	Tar Heel State	Raleigh	Dogwood	None
Dakota	4	619,636	70,057	1889	Flickertail State	Bismarck	Wild Prairie Rose	Western Meadowlark
	25	7,946,627	41,000	1803	Buckeye State	Columbus	Scarlet Carnation	Cardinal
ma	8	2,233,351	69,031	1907	Sooner State	Oklahoma City	Mistletoe	Bobwhite¶
	6	1,521,341	96,315	1859	Beaver State	Salem	Oregon Grape	Western Meadowlark
lvania	32	10,498,012	45,045	1776	Keystone State	Harrisburg	Mountain Laurel	Ruffed Grouse
Island	4	791,896	1,057	1776	Little Rhody	Providence	Violet	None
Carolina	8	2,117,027	30,395	1776	Palmetto State	Columbia	Yellow Jasmine	Carolina Wren
Dakota	4	652,740	76,536	1889	Sunshine State	Pierre	Pasqueflower	Ring-necked Pheasant
see	11	3,291,718	41,797	1796	Volunteer State	Nashville	Iris	Mockingbird
	24	7,711,194	263,513	1845	Lone Star State	Austin	Bluebonnet	Mockingbird
	4	688,862	82,346	1896	Deseret	Salt Lake City	Sego Lily	Seagull¶
nt	3	377,747	9,278	1791	Green Mountain State	Montpelier	Red Clover	Hermit Thrush
a	12	3,318,680	39,803	1776	Old Dominion	Richmond	Dogwood	None
gton	9	2,378,963	66,786	1889	Evergreen State	Olympia	Western Rhododendron	Willow Goldfinch¶
irginia	8	2,005,552	24,080	1863	Panhandle State	Charleston	Big Rhododendron	Tufted Titmouse¶
sin	12	3,434,575	54,705	1848	Badger State	Madison	Wood Violet	Robin
ng	3	290,529	97,506	1890	Equality State	Cheyenne	Indian Paint Brush	Meadowlark
	531							

*Total includes 1,119 on minor Pacific islands

†The date given for the original 13 states is that of the Declaration of Independence The date for each of the other 35 states is that of the year when they ceased to be territories and became states. The dates when the original 13 states ratified the constitution are: 1787—Delaware, Pennsylvania, New Jersey, 1788—Connecticut, Georgia, Maryland, Massachusetts, New Hampshire, New York, South Carolina, Virginia, 1789—North Carolina; 1790—Rhode Island

‡Most of the states have more than one popular name. The name given here is that most commonly used.

‖Includes Philippine Islands

¶Unofficial



THE GREAT SEALS OF THE UNITED STATES AND OF THE INDIVIDUAL STATES

The design for the Great Seal of the United States of America was adopted June 20, 1782. The reverse side was originally designed, but was never cut

Lacking a large majority in either house the Republicans were exposed not only to the danger of free silver defections in the Senate, but also to "filibustering" by the Democratic minority in the House as the means of blocking the victorious party's programme. These obstructive tactics were made possible chiefly by the use of privileged motions and roll calls to delay business, and the refusal to respond on the roll call for a vote, thus preventing a quorum. Speaker Thomas B. Reed of Maine, a virile and keen-witted leader, greatly strengthened the power of the Speaker, as well as expediting the business of the House, by ruling that the Constitution required a present, not a voting, quorum; and in spite of disorderly protests he "counted a quorum" of those actually present. By securing rules sanctioning this action and empowering the Speaker to refuse to entertain dilatory motions, that officer became the effective agent for carrying on the business of the party majority. As his power through the committee on rules, which he appointed, grew, he came, in the course of time, also to dominate the action of the House, refusing to recognize members except for motions which he approved. This efficiency of action was secured at a loss to the House as a representative and debating body, responsive to minority proposals.

Sherman Anti-Trust Act.—But the discipline of party caucus and House rules enabled the Republican leaders to put through with rapidity a number of important laws. One of these was the measure known as the Sherman Anti-Trust Act of July 2, 1890, which declared combinations affecting commerce between the several States, or with foreign nations, illegal and punishable by fine or imprisonment or both. This act, the full power of which was not exhibited until later, was a response to the growing unrest of the nation as other corporations emulated the success of the Standard Oil Trust (formed in 1882). The members of a trust combined in an organization managed by boards of trustees whose certificates the former owners accepted instead of their shares of stock in the component companies. Competition was thus eliminated within the combination and the greatly increased capital and economies enabled it not only to deal with the increasing magnitude of business operation, but also to master the smaller concerns which opposed it. State legislation had proved unable to check the process, partly because the trust was an interstate affair By putting into operation its power to regulate interstate commerce, Congress responded to the popular demand for Federal restraint of these great combinations which threatened the old American ideals of individualism and freedom of competition. The trusts, although embarrassed, soon showed their ability to find other devices to maintain their unified control. Nor was the act used, in this period, to prevent the railways from agreements and combinations which in large measure neutralized the anti-pooling clause of the Interstate Commerce Act of 1887

Silver Purchases.—Another important law was the so-called Sherman Silver Purchase Act of July 14, 1890. By 1889 the ratio of silver to gold had fallen to one to 22. In the 12 years of the Bland-Allison Act of 1878 over 378,000,000 silver dollars had been coined from bullion purchased at the market price This bullion value was falling: it was $.89 in 1877 and $.72 in 1889. The production of gold in the United States in 1878 was about 2,500,000 fine ounces, and of silver about 35,000,000; in 1890 the gold production was 1,588,000 and the silver 54,500,000. The Silver Purchase Act authorized the secretary of the Treasury to purchase each month 4,500,000 oz. of silver at its market price and to pay for it in treasury notes redeemable at his discretion, in silver or gold.

McKinley Tariff.—The customs duties upon which the fighting of the campaign of 1888 had turned was promptly taken up, and in the McKinley Tariff Act of Oct. 1, 1890 the Republicans embodied their conceptions of protection to American industry. Some of the main features of this law were: the addition of agricultural products to the protected articles; the extension of the free list, particularly the inclusion therein of raw sugar, which had been bringing in a revenue of $50,000,000 annually; the granting of compensating bounties to sugar planters to an amount of about $10,000,000 a year; and the raising of duties to the prohibitory point on many articles of general consumption which could be produced at home Blaine, then secretary of State, had just been active in promoting closer relations with South America wherein he hoped for an extension of American trade and he severely criticized the bill as it passed the House, because the free list opened wide the doors of American trade, particularly to sugar-producing countries, without first exacting compensating advantages for our products in those markets. To meet this criticism a provision was finally added authorizing the President to impose discriminating duties where it was necessary to obtain the advantages of reciprocity.

This tariff, which passed on the eve of the congressional elections of 1890, was immediately followed by such increases in prices and the cost of living that it was potent in bringing about the political revolution, or "land slide," which swept the Republicans from power in the House of Representatives. The Republicans returned but 88 members as compared with nearly twice that number in the Congress which passed the McKinley bill. Looked at broadly, the movement was a rural uprising, strongest in the South and Middle West, the old Granger areas, against forces which seemed to them to threaten their ideals of American democracy. But the movement was recruited by the silver-mining states and discontented labour interests.

Farm products had not proportionately shared the general increase in prosperity. This convinced large portions of the agricultural West that the currency system had too narrow a basis in gold, which was appreciating in value. Much of the Middle Western agricultural development had been made on borrowed Eastern capital, and it seemed to the farmer that the principal of his mortgage was in effect increasing with the rise in the price of gold, at the same time that his crops brought a smaller net profit. He did not give due attention to the effect of greatly increased production, as the new wheat lands were opened on such a grand scale; but he was keenly sensitive to increased freight rates and to the influence of Eastern capitalists, banks, bondholders, trusts and railways upon Federal and State legislatures and judiciary. After the evidence of the power of this tide of Western discontent in the elections of 1890, those portions of it which were ripest for revolt combined in 1892 as the People's Party or Populists, soon to prove an important political factor.

The Republicans meanwhile had been actively reducing the surplus. In 1892 the excess of revenue over expenditures was $10,000,000; in 1893 only $2,000,000. This was effected not only by the Tariff Act but by such measures as the Dependent Pension Act of 1890 (resulting in a list of pensioners of the Civil War which cost the nation $68,000,000 by 1893, over half of these pensioners having been added during Harrison's Administration); the rapid construction of the new Navy, raising the United States from 12th to fifth in the list of naval powers; the repayment of the direct war tax to the States (1891) to the amount of $51,000,000; and other appropriations such as those provided by river and harbour bills. The Democrats stigmatized this Congress as a "billion dollar Congress" from its expenditures, to which Speaker Reed replied that the United States was a billion dollar nation. In fact the Democrats when they regained power were not able greatly to diminish the cost of government

Homestead Strike.—The Democratic House in the 52nd Congress repressed obstructive Republican tactics by methods like those adopted by Speaker Reed, and contented itself with passing a series of bills through that body proposing reductions of the tariff in special schedules, including free wool and a reduction of the duty on woollens, free raw material for the cotton planters of the South, free binding twine for the farmers of the North and a reduced duty on tin plate for the fruit raisers. Of course these bills failed in the Republican Senate. A bloody strike on the eve of the election of 1892 in the great steel works at Homestead, Pa., where armed guards engaged by the company fired upon the mob which sought higher wages, was not without its adverse effect upon public sentiment in regard to the Republican tariff for the protection of labour.

During the campaign of 1892 the Democrats rejected a conservative tariff plank, denounced the McKinley tariff in violent language, and denied the constitutional power to impose tariff

duties except for the purpose of revenue only. But Cleveland, who was renominated in spite of vigorous opposition from leading politicians of his own State, toned down the platform utterances on the tariff in his letter of acceptance In their declarations upon the currency the Democrats furnished a common standing ground for the different factions by attacking the Silver Purchase Act of 1890 as a cowardly makeshift.

Cleveland Re-elected.—The People's Party, in its national convention at Omaha (July 1892), drew a gloomy picture of Government corrupted in all of its branches, business prostrated, farms covered with mortgages, labour oppressed, lands concentrating in the hands of capitalists. Demanding the restoration of government to the "plain people," they proposed an expansion of its powers, to afford an adequate volume of currency and to check the tendency to "breed tramps and millionaires" Among their positive proposals were the free and unlimited coinage of silver at the legal ratio of 16 to one, the expansion of a national currency issued directly to the people, the establishment of postal savings banks; Government ownership of the railways, telegraph and telephone; restoration to the Government of the lands held by railways and other corporations in excess of their needs; and a graduated income tax Combining with the Democratic Party in various States beyond the Mississippi, and with Republicans in some of the Southern States, they won large masses of voters in the West, and exerted an influence upon public opinion in that section beyond what was indicated in the returns, although Gen James B. Weaver of Iowa, their candidate for the Presidency, received over 1,000,000 popular votes and 22 votes in the electoral college The Republicans renominated President Harrison, though he lacked an enthusiastic personal following. They supported the McKinley Tariff Act in spite of the wave of opposition shown in the elections of 1890. But, fearing party divisions, they, like the Democrats, made an ambiguous declaration on the currency. The result of the election of 1892 was to return the Democrats under Cleveland to power by a plurality of over 380,000 and an electoral plurality of 132. Congress in both branches was to be Democratic in 1893, and the way was open for the first time in a generation for that party to carry out a policy unchecked by any legislative or executive branch of Government.

Panic of 1893.—But before Cleveland was fairly started in his second Administration the disastrous panic of 1893 swept the nation, nor did prosperity return during the four years that followed. The panic is not, directly at least, to be traced to the silver purchases, but was the result of various causes, including the agricultural depression, farm mortgages, reckless railway financing and unsound banking in the United States. The panic began in the spring with the failure of the Reading railway and the collapse of the National Cordage Company, one of the numerous examples of reckless trust financiering into which large banks had also been drawn. Clearing-house certificates were resorted to by the New York banks in June, followed in August by partial suspension of specie payments. Currency remained at a premium for 8 month; deposits in national banks shrank enormously; national bank loans contracted more than 14·7%; failures were common; 22,000m. of railways were under receiverships, and construction almost ceased.

The panic of 1893 was in many ways a turning-point in American history. It focused attention upon monetary questions, prostrated the silver-mining States, embittered the already discontented farming regions of the West, produced an industrial chaos out of which the stronger economic interests emerged with increased power by the absorption of embarrassed companies, and was accompanied by renewed labour troubles. Most noteworthy of these was the Pullman Car Company strike near Chicago in 1894, which led to sympathetic strikes by the American Railway Union, extending over 27 States and Territories from Cincinnati to San Francisco. Mobs of the worst classes of Chicago burned and looted cars. The refusal of Gov. John P. Altgeld of Illinois to call out the militia, and interference with the United States mails, led President Cleveland to order Federal troops to the scene, on the constitutional ground that they were necessary to prevent interference with interstate commerce and the postal service and to enforce the processes of the Federal courts. The courts issued a sweeping injunction requiring that the members of the American Railway Union or other persons desist from interference with the business of the railways concerned. The president of the striking organization, Eugene V. Debs, was imprisoned for contempt of court and conspiracy.

Silver Issue.—The most immediate political effect of the panic was upon the silver issue Soon after the outbreak of the financial crisis, the gold reserve, which protected the greenbacks and the Treasury notes issued under the Silver Purchase Act, shrank ominously, while foreigners returned their American securities instead of sending gold. To sell bonds in order to replenish the gold reserve, and to repeal the Silver Purchase Act without substituting free coinage, would aggravate Western discontent and turn away the promise of recruits to the Democratic Party from the Populists of the prairie and silver-mining States; to carry out the Democratic platform by a tariff for revenue only while mills were shutting down would be hazardous in the East The fruits of victory were turning to ashes; but Cleveland summoned a special session of Congress for August, while the panic was acute, and asked his party to repeal the Silver Purchase Act without accompanying the repeal with provisions for silver Not until the last of Oct. 1893 was repeal carried, by a vote in which the friends of repeal in the House were about equally divided between Democrats and Republicans, and nearly two-thirds of its opponents Democrats.

By this time the surplus had disappeared and the gold reserve was drawn upon for ordinary expenses. Early in 1894 the Administration, failing to secure legislation from Congress to authorize the sale of gold bonds on favourable terms to protect the reserve, sold under the Resumption Act of 1875 $50,000,000 5% bonds, redeemable in ten years Part of this very gold, however, was withdrawn from the reserve by the presentation of legal tender notes for redemption, and the "endless chain" continued this operation to the verge of extinguishing the reserve, so that another loan of $50,000,000 in 1894 was followed in 1895 by a dramatic meeting between Cleveland and some of his cabinet with the Wall street banker, J. Pierpont Morgan, who agreed on behalf of his syndicate to sell the Government $65,166,000 of gold for $69,315,000 of bonds, equivalent to 4% bonds for 30 years at a price of 104. In return the syndicate agreed to use its influence to protect the withdrawals of gold from the Treasury. These securities were over-subscribed when offered to the public at 112½. President Cleveland had protected the Treasury and sustained the parity of gold and silver, but at the cost of disrupting his party Again, in the beginning of 1896, the Treasury was forced to sell bonds, but this time it dealt directly with the public and easily placed $100,000,000 in bonds at about 111, affording a rate of interest about equal to 3·45%.

Tariff Reform.—Before the political harvest of the monetary issue was reaped, the Democrats had also found party ties too weak to bear the strain of an effective redemption of the party pledges on the tariff. The Wilson bill prepared as the administrative measure was reported late in 1893, while the panic was still exerting a baneful influence. Its leading features were the substitution of *ad valorem* for specific duties in general, the extension of the free list to include such materials of manufacture as iron ore, wool, coal, sugar and lumber, and the reduction of many prohibitory rates The loss in revenue was partly provided for by an income tax, significant of the new forces affecting American society, and an increase in the duty on distilled liquors. Although the bill passed the House by an overwhelming majority, it met the opposition in the Senate of the representatives, Democratic as well as Republican, of those States whose interests were adversely affected. Led by Senators Arthur P. Gorman, of Maryland; Calvin S. Brice, of Ohio; and David B. Hill, of New York, the bill was transformed by an alliance between Democratic and Republican senators, on the plea that it would otherwise result in a deficit of $100,000,000 Coal, iron ore and sugar were withdrawn from the free raw materials and specific duties replaced *ad valorem* in many cases, while many other individual schedules

were amended in the direction of protection. The House, given the alternative of allowing the McKinley Act to remain or to accept the Senate's bill, yielded, and the Wilson-Gorman Tariff Act became a law without the President's signature, Aug 27, 1894 Even the income tax was soon (1895) held by the Supreme Court to be unconstitutional.

Venezuela Message.—Toward the close of his administration Cleveland's brusqué message on the Venezuelan boundary question aroused such excitement and so rallied the general public (though not the more conservative) that the war spirit, shown soon afterwards against Spain, might have been a potent factor in the election of 1896 had not England exhibited exceptional moderation and self-restraint in her attitude The silver question, therefore, became the important issue The Republicans nominated McKinley and declared for the gold standard in opposition to free coinage, losing thereby an influential following in the silver-mining and prairie states, but gaining the support of multitudes of business men among the Democrats in the East and Middle West

William J. Bryan.—The Democratic convention marked a revolution in the party. The old school leaders were deposed by decisive majorities, and a radical platform was constructed which made "the free and unlimited coinage of both silver and gold at the present legal ratio of 16 to one, without waiting for the aid or consent of any other nation," the paramount issue. Objecting also to the decision against the income tax, and to "government by injunction as a new and highly dangerous form of oppression," they incurred the charge of hostility to the Federal judiciary. William J. Bryan made a brilliant speech in behalf of free coinage, and so voiced the passion and thought of the captivated convention that he was nominated by it for the Presidency over the veteran free-silver leader, Richard P. Bland of Missouri. The Cleveland men, or "gold Democrats," broke with their party after it became committed to free silver, and holding a convention of their own, nominated Gen John McA Palmer, of Illinois, for the Presidency on a platform which extolled Cleveland, attacked free coinage and favoured the gold standard. Its main influence was to permit many Cleveland men to vote against Bryan without renouncing the name of Democrats. On the other hand the Populist convention also nominated Bryan on a platform more radical than that of the Democrats.

The contest was marked by great excitement as Bryan travelled across the country addressing great audiences. The endangered business interests found an efficient manager in Marcus A Hanna of Ohio, McKinley's adviser, and expended large sums in a campaign of education. In the event, the older States of the Middle West, holding the balance between the manufacturing and capitalistic East and the prairie and mining States of the West, gave their decision against free silver. But class appeals and class voting were a marked feature of the campaign, the regions of agricultural depression and farm mortgages favouring Bryan, and those of urban life favouring McKinley. Labour was not convinced that its interests lay in expanding the currency, and Mr. Hanna had conducted McKinley's campaign successfully on the plea that he was the advance agent of prosperity under the gold standard and a restoration of confidence. McKinley carried all the Northern States east of the Missouri, and North Dakota, Oregon and California of the Farther West, as well as Maryland, Delaware, West Virginia and Kentucky. His plurality over Bryan in the popular vote was more than 600,000, and his electoral majority 95 All the departments of Government were transferred by the election to the Republicans.

Dingley Tariff.—Having secured power, the Administration called a special session of Congress, and enacted the Dingley protective tariff (July 24, 1897), under which the deficit in the Treasury was turned into a surplus. The act raised duties to their highest point, and as the protective schedules included some important articles produced by trusts which had a practical monopoly, such as sugar and petroleum, this was seized upon by the Democrats to stigmatize the tariff as the "mother of trusts." Many articles which had been placed on the free list in the Tariff Act of 1894, including lumber and wool were made dutiable.

Gold Standard.—The Republicans also wrote their triumph into the Gold Standard Act of March 4, 1900, which ensured the maintenance of this standard by reserving $150,000,000 of gold coin and bullion to redeem the United States notes and the Treasury notes of 1890, and by authorizing the sale of bonds when necessary to maintain the reserve National banks were authorized in the smaller towns (3,000 or less) with a capital of $25,000, half of that formerly required, and increased circulation was further provided for by permitting the national banks to issue notes on United States bonds up to their par value.

Economic Changes.—The economic policy of the Republicans was facilitated by the prosperity which set in about 1898. The downfall of silver-mining turned the prospectors to seek new goldfields, and they found them, especially in Alaska; and contemporaneously the chemists discovered cheaper and more efficient methods of extracting the gold from low-grade ores Within five years after the crisis of 1893 the gold production of the United States nearly doubled. The United States coined $437,500,000 in gold in the five-year period 1897–1902, while the average for five-year periods since 1873 had been only $224,000,000. Thus gold instead of silver began to inundate the market, and to diminish the demand for expansion of the currency. Agriculture, prostrated in the years immediately preceding and following the panic of 1893, turned to the scientific study of its problems, developed dry farming, rotation and variety of crops, introduced forage crops like alfalfa, fed its Indian corn to cattle and hogs, and thus converted it into a profitable and condensed form for shipment. Range cattle were brought to the corn belt and fattened, while packing industries moved closer to these western centres of supply. Dairy-farming replaced the unprofitable attempts of older sections of the Middle West and the East to competé with the wheat-fields of the Farther West. Truck and fruit farming increased in the South, and the canning industry added utility to the fruits and vegetables of the West. Following the trend of combination the farmers formed growers' associations and studied the demand of the market to guide their sales. The mortgaged farms were gradually freed from debt. The wheat crop increased from less than 400,000,000bu. valued at $213,000,000 in 1893 to 675,000,000bu. valued at $392,000,000 in 1898. Prosperity and contentement replaced agitation in the West, and the Republican Party gained the advantage of these changed conditions.

In the South also there was greater contentment as the new industries of iron, textiles and forestry grew, and as the cotton crops increased. Unrest was diminished by the new State Constitutions, which after 1890 disqualified negro voters by educational and tax requirements so contrived as not to disfranchise the poor whites.

In the decade which followed the crisis of 1893 a new industrial structure was made out of the chaos of the panic. "High financing" was undertaken on a scale hitherto unknown. Combinations absorbed their weaker rivals; Standard Oil especially gained large interests in New York banks and in the iron mines and transportation lines about the Great Lakes, while it extended its power over new fields of oil in the South-west. In general, a small group of powerful financial interests acquired holdings in other lines of business, and by absorptions and "community of interest" exerted great influence upon the whole business world. The group of financiers, headed by J. Pierpont Morgan, came to dominate various Southern transportation lines and the anthracite coal roads and mines, and extended their influence to the Northern Pacific railway, while a new genius in railway financing, Edward H Harriman, began an avowed plan of controlling the entire railway system of the nation. Backed by an important banking syndicate he rescued the Union Pacific from bankruptcy, and with its profits as a working basis he started in to acquire connecting and competing lines. Labour also shared in the general prosperity after 1898 Relative real wages increased, even allowing for the higher cost of living, and the length of the working day in general decreased except in special industries.

General Prosperity.—By 1900 the continental United States had a population of 76,000,000; an aggregate real and personal wealth of $88,500,000,000; a per capita public debt of $14.52, and per capita money circulation of $26.94 against $21.41 in 1896. In 1901 bank clearings amounted to nearly $115,000,000,000 against

$45,000,000,000 in 1894 Imports of merchandise had fallen in this period, while exports rose from about $847,000,000 in 1893 to $1,394,000,000 in 1900 Of these exports foodstuffs and food animals, crude and partly manufactured, aggregated nearly 40% of the total. The production of pig iron, which was about 7,000,000 long tons in 1893, was nearly twice that in 1900 This economic prosperity and these far-reaching processes of social change by which the remaining natural resources of the nation were rapidly appropriated, went on contemporaneously with the extension of the activity of the nation overseas. The first rough conquest of the wilderness accomplished, the long period of internal colonization drawing to a close, the United States turned to consider its position as a world power.

To understand this position it is necessary to return to an earlier period and briefly survey the foreign relations since the close of the reconstruction era The most significant and persistent influence came from the growing interest of the United States in the Pacific, as its population and economic power extended to that ocean. The problem of an overflow of Chinese migration to the Pacific coast, and the jeopardizing of the American standard of labour by this flood, had been settled by various treaties and laws since 1880. The question of the relation of the United States to an interoceanic canal was not so easily settled In 1878 Colombia granted a concession to a French company, promoted by Ferdinand de Lesseps, the engineer of the Suez canal, to dig a tide-level canal through the Isthmus of Panama. President Hayes voiced the antagonism of the United States to this project of European capital in his message of 1880 in which he declared that such a canal should be under the control of this nation, and that it would be "virtually a part of the coast-line of the United States." Although an American company was organized to construct a canal under a concession from Nicaragua in 1884, no real progress was made, and the French company, defeated by engineering and sanitary difficulties, failed at the close of 1888.

Pan-American Congress.—Meantime, for a few months, Blaine, as secretary of State under President Garfield, began a vigorous foreign policy with especial reference to the Pacific. He attempted to get the consent of England to abrogate the Clayton-Bulwer Treaty of 1850, which contemplated the construction of an isthmian canal by private enterprise under joint control and neutralization of the United States and Great Britain, together with such other Powers as should join them. In South America he actively pressed the influence of the United States to settle the war between Chile and Peru Again, in the years from 1889 to 1892, Blaine held the portfolio of State, and attempted to increase the influence of his country in Spanish America by the Pan-American congress of 1890, which proposed a great international railway system and bank, commercial reciprocity and arbitration, without immediate results Indeed, the bad feeling aroused by his earlier policy toward Chile found expression in 1891 in a mob at Valparaiso, when some of the men from the United States ship "Baltimore" on shore leave were killed and wounded. An apology averted the war which President Harrison threatened Blaine also asserted, against Canada particularly, the right of the United States to the seals of the Bering Sea; but in 1893 arbitrators decided against the claim.

Foreign Affairs.—As the Navy grew and American policy increasingly turned to the Pacific, the need of coaling stations and positions advantageous to its sea power was appreciated. By a tripartite treaty in 1889 the Samoan islands were placed under the joint control of the United States, England and Germany, and, a decade later, they were divided among these powers, Tutuila and the harbour of Pago-Pago falling to the United States. The Hawaiian islands, which had been brought under the influence of civilization by American missionaries, were connected by commercial ties with the United States. Upon the attempt of the ruler to overturn the constitution, the American party, aided by the moral support of the United States, which landed marines, revolted, set up a republic, and asked annexation to the Union. A treaty, negotiated under President Harrison to this end, was withdrawn by President Cleveland, after investigation, on the ground that the part of the United States in the revolution was improper. He attempted, without success, to restore the original state of affairs, and on July 7, 1898, the islands were annexed

President Cleveland's conservatism in this and other matters of foreign policy had not prepared the people for the sudden exhibition of firmness in foreign policy with which he startled the nation in his message of Dec. 1895 upon the question of the boundary of Venezuela That nation and England had a long-standing dispute over the line which separated British Guiana from Venezuela. Great Britain declined to arbitrate, at the suggestion of the United States, and gave an interpretation to the Monroe Doctrine which the Administration declined to accept. President Cleveland thereupon brusquely announced to Congress his belief that Great Britain's *attitude* was in effect an attempt to control Venezuela, and proposed that a commission on the part of the United States should report upon the disputed boundary, and support Venezuela in the possession of what should be ascertained to be her rightful territory. Secretary of State Richard Olney declared: "To-day the United States is practically sovereign on this continent, and its fiat is law upon the subjects to which it confines its interposition." Great Britain tactfully accepted arbitration, however, and in the end (1899) was awarded most of the territory regarding which she had been unwilling to arbitrate.

Spanish-American War.—The growing activity of the United States in foreign relations next manifested itself against Spain. Cuba in its commanding position with reference to the Gulf of Mexico and the approaches to the proposed isthmian canal, as well as in its commercial relations, and its menace as a breeding spot for yellow fever, had long been regarded by the United States as an important factor in her foreign policy. Between 1868 and 1878 a harsh war had been in progress between the island and the mother country, and American intervention was imminent. But Spain promised reforms and peace followed; again in 1895 revolt broke out, accompanied by severe repressive measures, involving grave commercial injury to the United States

By the Treaty of Paris, signed Dec. 10, 1898, Spain lost the remaining fragments of her ancient American empire. She relinquished Cuba, which the United States continued temporarily to occupy without holding the sovereignty pending the orderly establishment of an independent Government for the island. Porto Rico, Guam and the Philippines were ceded outright to the United States, which agreed to pay $20,000,000 to Spain, and to satisfy the claims of its citizens against that power. By the treaty Congress was to determine the civil rights and political status of the native inhabitants of the ceded territory.

As a result of the Spanish-American War, the United States found itself in a position of increased importance and prestige among the nations of the world. Especially in the Pacific, it was immediately involved in the diplomatic situation created by the efforts of European States to divide China into spheres of influence or of actual possession. The interests of the United States in the trade with China, as well as her new position in the Philippines, inclined her to oppose this policy, and secretary of State John Hay showed himself one of the great American diplomats in his treatment of this difficult problem. In order to preserve Chinese entity and the "open door" for trade, he drew replies from the nations concerned, the result of which was to compel them to avow and moderate their intentions.

The acquisition of Porto Rico and the acceptance of responsibilities in Cuba gave new importance to the isthmian canal and increased the relative weight of the United States in regard to its control. The popular excitement with which the voyage of the "Oregon" was followed, as it took its way 14,000m around South America to participate in the destruction of the Spanish fleet in the battle of Santiago, showed the American people the need of such communication between the Atlantic and Pacific coasts.

The Philippines.—But the immediate political issues were concerned with problems of the relation of the newly won lands to the United States Government. Bryan had persuaded his party to join in ratifying the Treaty of Paris, expecting to determine the status of the islands later. But attention soon turned to the insurrection which broke out (Feb. 4, 1899) in the Philippines under Aguinaldo, after it became probable that the Administra-

tion intended to retain these islands, not under a weak protectorate, but as a possession to be ruled and "assimilated." It was not until the spring of 1902 that this insurrection was completely put down, and in the interval the question of the destiny of the islands and the harshness of the measures of repression aroused political debate The Democrats and many Republicans charged the Administration with a policy of imperialism.

Porto Rico.—The same issue was involved, in its constitutional and economic aspects, in the treatment of Porto Rico and Cuba. While the insurrection contmued in the Philippines the government there was legally a military one, although exercised in part through civil officers and commissions. But in the case of Porto Rico the question was whether the "Constitution follows the flag," that is, whether it extended of its own force without an act of Congress to acquired territory, and covered the inhabitants with all the rights of citizens of the United States, as an integral part of the American people.

The Foraker Act of 1900 imposed a special tariff for two years upon Porto Rico, the proceeds to go to that island's own Treasury. The act further asserted the principle that the inhabitants of the new possessions were not incorporated into the United States or entitled to all the privileges of citizens of the United States under the Constitution, by declaring that statutory acts of the United States locally inapplicable should not be in force in Porto Rico. The Supreme Court sustained this act in 1901, holding that Porto Rico was not so strictly a part of the United States that separate customs tariffs could not be imposed upon the territory. The Foraker Act also provided a government for the island. In Cuba the United States remained in authority until May 20, 1902. Details of the arrangements whereby the United States secured the substantial advantages of a protectorate without destroying the independence of Cuba, will be found by the reader in the article on CUBA.

Re-election of McKinley.—Meantime, in the election of 1900, the Democrats renominated Bryan on a platform which opposed the Republican Administration's acts in relation to the newly acquired territory and declared that "imperialism" was the paramount issue The platform reaffirmed its silver doctrine of the previous campaign and denounced the tariff as a breeder of trusts. The Republicans renominated McKinley and endorsed his Administration. McKinley received an electoral majority of 137 and a popular plurality of 849,790. Before his second term was fairly begun he was shot by an anarchist while attending the Pan-American exposition at Buffalo, and died on Sept. 14, 1901. His wisdom in choosing able cabinet officers, his sympathetic tact in dealing with men and with sections, as well as the victories of the Spanish-American War, had brought him popularity even among his political opponents. But McKinley, like Cleveland, lacked the imagination to perceive and the desire to voice the aspirations and demands that had been gathering force for many years for legislation and executive action that should deal with the problem of effective regulation of the economic forces that were transforming American society. This gave his opportunity to Theodore Roosevelt, who as vice president now succeeded to office.

Roosevelt President.—It was in foreign relations, which Secretary Hay continued to conduct, that continuity with McKinley's Administration was most evident. But even here a bolder spirit, a readiness to break new paths and to take short cuts was shown by the new President Venezuela had long delayed the payment of claims of citizens of various nations. In 1901, the President, having been informed by Germany of its intention to collect the claims of its citizens by force, but without acquisition of territory, announced that the United States would not guarantee any State against punishment if it misconducted itself, provided that the punishment did not take the form of acquisition of territory. As a result, a blockade of Venezuela was undertaken by the joint action of Germany, England and Italy at the close of 1902. The diplomatic intervention of the United States early the next year resulted in Venezuela's agreement to pay the claims in part and to set aside a portion of her customs receipts to this end. But since the blockading powers demanded preferential treatment, the United States secured a reference of the question to The Hague court, which decided that this demand was justified. Santo Domingo offered a similar problem, having a debt incurred by revolutionary governments, beyond its power to pay, and being threatened with forcible intervention by European States. President Roosevelt, in 1904, declared that in case of wrongdoing or impotency requiring intervention in the western hemisphere the United States might be forced "to the exercise of an international police power." In 1905 Santo Domingo and the United States signed a protocol under which the United States Government was empowered to take possession of the custom-house, conduct the finances and settle the domestic and foreign debts of Santo Domingo. In spite of the refusal of the Senate to assent to this protocol, President Roosevelt put the arrangement unofficially into effect, until, in 1907, the Senate consented to a treaty authorizing it with some modifications.

In the Far East the Boxer insurrection in China had been followed by the combined military expedition of the powers to the relief of Peking (in which the United States shared), and the exaction of a huge indemnity, of which the United States relinquished nearly half of its share, as in excess of the actual losses The United States protested against Russian demands upon China, and actively participated in the negotiations which resulted in Russia's agreement to evacuate Manchuria. The delays of that power and her policy toward China having led Japan to declare war, Secretary Hay's diplomacy was influential in limiting the zone of hostilities, and the good offices of President Roosevelt brought about the conference between the two powers at Portsmouth, N H., which terminated hostilities in 1905. The dispute over the boundary between Alaska and Canada was narrowed by diplomatic discussion, and the remaining questions, involving the control of important ports at the head of the great inlets which offered access to the gold-fields, were settled by arbitration in 1903 favourably to the American contentions

The isthmian canal also received a settlement in this Administration by a process which was thoroughly characteristic of the resolution of President Roosevelt. *See* PANAMA CANAL.

The Philippines.—In the Philppines early in 1901 municipal and provincial governments were provided for, and the President had been for a brief time granted full power to govern the archipelago. He appointed Judge Taft civil governor, and limited the power of the military governor to regions where insurrection continued. On July 1, 1902, congressional authority was substituted for that of the President, but Taft remained governor The provisions of the Constitution guaranteeing life, liberty and property were in general extended specifically to the dependency, and a legislative assembly was promised, the lower house elective, and the upper house to consist of the Philippine commission. By negotiations with Rome Gov. Taft secured for the Philippines the "friars' lands" which had been a source of friction. On Oct. 16, 1907, the first Philippine assembly was convened in the presence of Taft, then secretary of war.

The tariff question complicated American relations with both the Philippines and Cuba. Beet sugar and tobacco interests feared the competition of these products, and opposed freedom of trade between the United States and the new territories. The Philippine tariff of 1902 made a reduction of only 25% from the Dingley tariff in the case of the products of those islands, instead of the 75% urged by Taft; but the duties were to go to the Philippines In the case of Cuba a more heated controversy arose over the tariff—Roosevelt strongly urged a substantial reduction in justice to Cuba at several regular and special sessions of Congress; but not until the close of 1903 was a treaty in operation which, under the principle of reciprocity, admitted some products of the United States to Cuba at reduced rates, and allowed Cuban products a reduction of 20% from the Dingley tariff.

The Trusts.—The dominant historical tendencies of the beginning of the 20th century in the United States, however, were characterized by huge combinations of capital and labour, the rapid passing of natural resources into private possession, and the exploitation of these resources on the principle of individualism by aggregations of capital which prevented effective competition by ordinary individuals. Pioneer conceptions of individual in-

dustrial achievement free from governmental restraint were adopted by huge monopolies, and the result was a demand for social control of these dangerous forces.

After the Sherman Anti-Trust Act of 1890 the combinations found in the favourable laws of States like New Jersey opportunity to incorporate under the device of the "holding company," which was supposed to be within the law. A "promotion mania" set in in 1901 The steel industry, after a threatened war between the Standard Oil and Carnegie groups, was united by Pierpont Morgan into the United States Steel Corporation with stocks and bonds aggregating $7,400,000,000. This was only one of the many combinations embracing public utilities of all kinds. Where open consolidation was not effected, secret agreements, as in the case of the meat packers, effectively regulated the market In the field of railway transportation, Harriman used the bonds of the Union Pacific to acquire the Southern Pacific with the Central Pacific, and by 1906 he was dictator of one-third of the total mileage of the United States. Meanwhile the Great Northern and the Northern Pacific had been brought into friendly working arrangements under James J. Hill, and tried to secure the Burlington railway A fierce contest followed between the Hill, Morgan and Harriman forces, resulting in a compromise by which the Northern Securities Company, a holding company for the joint interests of the contestants, was created. It was admitted by the counsel for this company that the machinery provided in this organization would permit the consolidation of all the railways of the country in the hands of three or four individuals. By using notes of one railway company, based on its treasury securities, one could acquire a controlling interest in others; and by watering the capital stock, recover the cost of the undertaking, while the public paid the added rates to supply dividends on the watered stock.

Following a similar tendency the great Wall street banking-houses were dominated by the large financial groups in the interest of speculative undertakings, the directors of banks loaning to themselves, as directors of industrial combinations, the funds which flowed into New York from all the banks of the interior. By a similar process the great insurance and trust companies of New York became feeders to the same operations. Thus a community of control over the fundamental economic interests of the nation was lodged in a few hands

Such was the situation in domestic affairs which confronted Roosevelt when he became President. In his first message he foreshadowed his determination to grapple with these problems. In 1903 he instructed the attorney-general to bring suit to dissolve the Northern Securities Company as a combination in restraint of trade, and in 1904 the Supreme Court held the merger illegal. But the effect was to increase the tendency to change from incomplete combination of financial interests to consolidated corporations owning the property, and to lead the Government, on the other hand, to seek to regulate these vast business interests by legislation. The Elkins law, passed in 1903, increased the power of the interstate commerce commission to prosecute offenders, especially those who violated the anti-rebating clauses. In the same year the creation of the Federal bureau of corporations provided for increased publicity in the affairs of these organizations.

Combinations of Labour.—Labour was combining in its turn. Not only did local unions in most of the trades increase in number and power, but workers in separate industries over large areas were combined for collective bargaining and a national organization, the American Federation of Labor, had a membership by 1905 of approximately 2,000,000. Labour legislation by the States increased under these influences, and political leaders became increasingly aware of the power of the labour vote, while employers began to form counter organizations to check the growth of the movement. In 1902 Pennsylvania members of the United Mine Workers of America struck. Inasmuch as their employers were the owners of the anthracite coal monopoly under the control of an allied group of coal-carrying railways, the contest was one of far-reaching importance, and soon brought about a coal famine felt throughout the nation. So threatening was the situation that President Roosevelt called a conference of the contestants, and induced them to submit their difficulties to an arbitration commission which, by its report, in the spring of 1903, awarded to the miners shorter hours and an increase of wages.

Steadily the United States enlarged its economic functions In 1903 Congress created a department of Commerce and Labor and made the secretary a member of the cabinet. The reports of this department gave publicity to investigations of the perplexing industrial conditions. The department of Agriculture enlarged its staff and its activity, investigating different plants and animals, ascertaining means of checking insect pests, advising upon the suitability of soils to crops, seeking new and better seeds, and circulating general information. The contemporaneous development of agricultural education in the various Western and Southern States whose agricultural colleges had been subsidized by land grants and appropriations by the Federal Government, and the experimental farms conducted by railways, all worked to the same end. The nation began also to awake to the need of protecting its remaining forests, which were rapidly falling into the hands of corporations by perversion of homestead and other land laws. President Cleveland had withdrawn large forest tracts, and in 1898 Gifford Pinchot was made head of a division of forestry in the department of Agriculture In 1901 the work was organized under a separate bureau, and four years later the national forests were placed under his management.

Reclamation.—The increasing demand for lands for agriculture led also, under Roosevelt, to the real beginning of national irrigation actively in the vast arid area of the Far West. The reclamation service was created by the act of June 17, 1902, which set aside the proceeds of the sale of public lands in 13 States and three Territories as a fund for irrigation works. The Government itself reserved timber and coal tracts, water powers and other requisites for construction, and sold the irrigated lands to actual settlers in small farms, while retaining title to the reservoirs and the works. The income from the reclamation fund between 1901 and 1910 aggregated over $60,000,000. By the use of suitable crops and dry farming agricultural occupation was extended into formerly desert lands.

Election of 1904.—In the election of 1904 the popularity of President Roosevelt, after his strenuous activity in challenging some of the strongest tendencies in American life, was put to the test. His political management exhibited the fact that he was trained in the school of the New York politician as well as in the reformer's camp, and he was easily nominated by the Republicans on a platform which endorsed his Administration, and made no promise of tariff changes The Democrats turned to the Conservative wing, omitted any reference to silver or the income tax, and nominated Judge Alton B. Parker, of New York. The issue of imperialism had been largely eliminated by the current of events and the anti-trust issue was professed by both parties In the outcome Roosevelt won by the unprecedented popular plurality of over 2,500,000, and an electoral majority of 196.

The State elections of the same period showed that a wave of reform and of revolt against former political forces was rising. In five States which Roosevelt carried by his popularity the machine Republican candidates for governor were defeated by reforming Democratic candidates, and in cities like Chicago and Philadelphia the issues of reform and radicalism won unexpected though temporary success. Roosevelt had "stolen the thunder" of the parties of social unrest, including the old populistic areas of the Middle West and the labour element of the cities, and also retained control of the Republican party machinery.

Roosevelt's Second Administration.—In his second Administration President Roosevelt pressed his policies so hard and with such increasing radicalism that he lost control of the regular organization in Congress before the end of his term. In the House Speaker Joseph G. Cannon, of Illinois, exhibited the full power of his office in concentrating party policies in the hands of the few regular leaders, while in the Senate a directing group of New England men who had served for a long time, chiefly senators Nelson W. Aldrich and Eugene Hale, showed a similar mastery. Against this control a significant revolt, illustrative of revived discontent in the Middle West, was made by the Republican senator Robert M. La Follette, of Wisconsin, who had won his fight in that State

against the faction friendly to the railways, and had secured primary elections, railway rate regulation on the basis of expert valuation of the physical property of the railways, and a system of taxation which rested more heavily upon public utilities In pressing similar policies upon Congress he became isolated from the party leaders, but forced them to go on record by roll calls.

In New York a legislative investigation of the insurance companies disclosed such connections with the high financing of Wall street as to create widespread distrust and to lead to reform legislation. The attorney who conducted the investigation, Charles Evans Hughes, had shown such ability that he was chosen governor of New York in 1906. His administration was marked by independence of the party machine and a progressive policy. Foreign relations were conducted during the second administration of Roosevelt by Secretary Elihu Root from 1905. He fostered friendly relations with the other American nations, allaying their concern lest ambitious designs of their larger neighbour might endanger their independence. In Cuba a signal illustration of the good faith of the United States was exhibited when an insurrection in the summer of 1906 left the republic substantially without a government. Taft, then secretary of War, was sent, under the treaty provisions for intervention, to organize a provisional Government. During his few days' service as governor-general he set in motion the machinery for restoring order. But Roosevelt had plainly stated that if the insurrectionary habit became confirmed in Cuba she could not expect to retain continued independence.

Japanese Immigration.—Attention was again fixed upon the Pacific coast, not only by the earthquake and conflagration which in 1906 destroyed the business parts and much of the residence section of San Francisco, but also by municipal regulations there against the presence of Japanese in the public schools. The incident seemed to threaten grave consequences, which were averted by the popularity of Roosevelt both in California and in Japan. In the Immigration Act of Feb 20, 1907, the problem of exclusion of Japanese labour, which underlay the difficulty, was partly solved by preventing the entrance to the continental United States by way of neighbouring countries of persons holding passports issued by a foreign Government for going to other countries or dependencies of the United States.

As a demonstration of the naval power of the United States in Pacific waters, the President sent the American fleet on a cruise around the world, in the course of which they were received in a friendly spirit by Japan. The Navy was increased to keep pace with the growth of that of other nations, both in numbers and size of vessels, in this period, but not to the extent demanded by the Administration. Already a more efficient organization of both Army and Navy had been effected. While the nation prepared for war, it also engaged prominently in the successive international peace congresses between 1899 and 1907, aiming consistently to increase the use of arbitration.

Railway Regulation.—The tendencies of the Government to deal with social improvement were exemplified by the laws of 1906 providing for pure food and meat inspection. The Railway Rate Regulation Act of 1906 strengthened previous interstate acts by including pipe lines (except for gas and water) under the jurisdiction of the interstate commerce commission, and extending the meaning of "common carrier" to include express and sleeping-car companies. Published rate schedules were required, not to be changed without 30 days' notice, and more stringent provisions were made to prevent rebating. The act provided for review by the Federal courts, and did not permit the commission to investigate an increase of rates until the rates went into operation, nor did it provide for a valuation of the railways as a basis of rate-making which the commission had desired. Later acts partly met the demands of railway employees by increasing the liability of common carriers and by providing for shorter hours.

Panic of 1907.—Although Roosevelt had made concessions to the railways in the formation of the act of 1906, his utterances showed a tendency alarming to the large business interests and the holders of corporation securities generally The unsettled business conditions were reflected in the stock market, and began to produce a reaction against the activity of Government in this direction The panic of 1907 started with the downfall of an attempted combination of a chain of banks, copper interests and other enterprises, and was followed by the collapse of the Knickerbocker Trust Company in New York (Oct. 21, 1907). The country was generally prosperous, though much of the banking funds was tied up in New York city at this juncture. Clearing-house certificates were resorted to; by Nov. 1 partial suspension was general throughout the nation; and banking facilities were more completely interrupted than at any time since the Civil War The Government greatly increased its deposits, and offered Panama 2% bonds to the amount of $50,000,000, and 3% certificates for $100,000,000, with the object of providing the national banks a basis for additional note issues But these were taken only to a small amount, as they proved useful for their moral effect chiefly. An enormous addition to the money supply was made in the course of the panic, both by governmental activity, gold imports and national bank-notes. The crisis was brought to a close before the end of 1907 by the vigour of the Government and the activity of the large financial interests under the lead of J P. Morgan, who finally entered the field to stop the decline, at the same time that his associates in the Steel Trust acquired possession of their last remaining rival of importance, the Tennessee Coal and Iron Co.

The reaction after the panic, and the loss of influence resulting from his announcement that he would not permit his renomination for the campaign of 1908, left Roosevelt unable to exercise the compelling power which he had displayed in previous years. Congress under the control of the Conservatives refused him legislation which he asked, but before he left the Presidency he raised a new issue to national importance in his calling of a congress of State governors and experts to consider the need of the conservation of natural resources. This congress met in May 1908 and endorsed the proposal for vigorous attention by State and nation to the question

Election of 1908.—In the campaign of 1908 he succeeded, against the opposition of both the extreme Conservative and the Radical wings, in procuring the nomination of Secretary Taft by the Republicans on a platform endorsing the Roosevelt policies, promising a revision of the tariff at a special session, on the basis of such protection as would equal the difference between the cost of production at home and abroad, together with a reasonable profit to American industries, and providing for maximum and minimum rates to be used in furthering American commerce and preventing discriminations by other nations. A postal bank was promised, a more effective regulation of the railways, and a modification of the Sherman Anti-Trust Act. The Democrats again selected William J. Bryan as their candidate; demanded the enforcement of criminal law against "trust magnates" and such additional legislation as would prevent private monopoly; opposed the use of injunctions in cases where they would issue if no industrial dispute was involved; impugned the Republicans' good faith in tariff revision, promising for themselves a substantial reduction of duties; favoured an income tax and a guarantee fund by national banks to pay depositors of insolvent banks, or a postal savings bank, if the guaranteed bank could not be secured; demanded election of United States senators by direct vote of the people, legislation to prevent contributions by corporations to campaign funds, and a more efficient regulation of railways.

Taft President.—The Republicans won a sweeping victory, Taft's popular plurality reaching about 1,270,000 and his electoral majority 159. But it had been won by some ambiguity of utterance with respect to tariff and railway regulation. The result was made manifest early in the new Administration, when party contentions over the direction of revision of the tariff, the thoroughness of the regulation of railways and corporations, and the question of where the postal bank fund should be placed, resulted in a movement of "insurgency" among the Republicans of the Middle West. The insurgents termed themselves "Progressive Republicans," and did not hesitate to join forces with the Democrats in order to shape legislation to their wishes. Progressives and Democrats united in overturning the control of Speaker J. G. Cannon in the House of Representatives by modifying the rules,

and a group of senators, chiefly from the middlewestern states, destroyed the control of the regular leaders in the upper house President Taft's influence over the revolting wing was further weakened by the charges made against his secretary of the interior, Richard A. Ballinger, on behalf of Gifford Pinchot, the chief forester, who accused the administration of obstructing Roosevelt's "conservation" policy.

Pinchot was indeed removed from office, but the "conservation" issue was raised to primary importance by the return of Roosevelt from his African trip. His influence was revealed even while he was enjoying the hospitality of European countries. On his return, there was a widely extended desire to know his judgment of the administration's policy; but he maintained silence until the close of the summer of 1910, when in a series of public utterances in the west he ranged himself, on the whole, with the progressive wing and announced a "new nationalism" which should enlarge the power of the federal government and drive the "special interests" out of politics. The "insurgents" achieved remarkable victories in the middle west, California, New Hampshire and New York in the fall conventions and primary elections, retiring various leaders of the regular wing of the Republicans Senators Aldrich and Hale, former regular leaders in the senate, had already announced their purpose to resign. The result of the autumn elections was a pronounced victory for the Democratic party.

Social Questions.—At the close of the first decade of the 20th century the United States was actively engaged in settling its social and economic questions, with a tendency toward radicalism in its dealings with the great industrial forces of the nation. The "sweatshops" and slums of the great cities were filled with new material for U S. society to assimilate To the sisterhood of States had been added Oklahoma (1907), and in 1910 congress empowered New Mexico and Arizona to form constitutions preparatory to statehood, thus extinguishing the last territories, except the insular dependencies and Alaska. Already the food supply showed signs of not keeping pace with the growth of population, while the supply of gold flowed in with undiminished volume. High prices became a factor in the political situation. Between 1890 and 1900, in the continental United States, farms were added in area equal to that of France and Italy combined. Even the addition of improved farm land in that decade surpassed the whole area of France or of the German empire in Europe But intensive cultivation and agricultural returns hardly kept pace with the growth in population or the extension of farms (F. J. T.)

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FROM 1910 TO ENTRY INTO WORLD WAR I

The Nation in 1910.—The total population of the continental United States in 1910 was 92,000,000. Of these, only 50,000,000 were native whites of native parentage; 13,000,000 were foreign-born, and 19,000,000 others were of foreign-born or mixed parentage The Negroes and Indians together numbered about 10,000,000. Everybody in the United States except the American Indian was an immigrant from some other country or a descendant of an immigrant. The main race groups were: (1) the descendants of the colonists, who were mainly Anglo-Saxons, with some Germans and Scotch-Irish and small elements of other races; (2) descendants of the Europeans who came over in great numbers from 1820 to 1870; (3) the large number of later immigrants and their children.

In the opening years of the 20th century the country was not yet aroused to the problems arising from this mixture of unassimilated races Few voices were raised against admitting not only western Europeans, whose languages and customs were much like those of the United States, but men and women from east and southeast Europe and from western Asia. The only bar to immigration based on race was the prohibition, after 1888, of Chinese immigration and the practical exclusion of Japanese labourers by a "gentlemen's agreement" with the Japanese government (1907) The undigested load was becoming heavy.

Defects in Government.—The units of U.S society were held together by a strong, if complicated, democratic government, well fitted to rule a diverse population. The political forms were familiar to every schoolboy: (1) a group (in 1910) of 46 states, each with its own government rigidly confined by the traditional principle of "checks and balances" into three departments, legislative, executive, judicial; (2) a widely distributed franchise almost equivalent to universal suffrage for adult males; (3) a belief that the courts were the highest authority, not only as to questions of personal rights and duties, but as to the validity of the laws and acts of the other two departments; (4) local government of city and town, township and county. Thus combination of governments was expensive and not highly skilled, but was supported by the conviction of a large part of the population that it was the "best government on earth."

In the organization and conditions of business there could be traced some startling contradictions between the word liberty and the fact Nominally all kinds of business not prohibited by law were open to all comers in free and honourable competition. In reality, by 1908, a considerable number of both employers and employees were engaged in a combat outside the laws, constant and conscienceless. It was hard for individuals and firms to compete with corporations, and hard for small corporations to compete with large ones The railways were among the most conspicuous of the large corporations, and they, too, tended to combine into larger and more powerful units The states could not deal adequately with these powerful bodies because most of the railways and many of the other corporations operated from state to state, and could not be controlled at either end by anything short of federal power.

Political organizations were on nearly the same basis as business companies. they also grew bigger and more powerful and gathered into fewer groups Nominally, parties are simply associations of voters for common ends. Actually, they are armies acting under commanding leaders who in many cases hold no offices The evils of this "invisible government," as Elihu Root called it, were apparent. The political philosophy of Americans was based on the belief that mankind was steadily growing better Hence a tendency to rely upon laws and political devices for correcting the ills of popular government What was most needed was the leadership of bold and farseeing men.

Finances and the Tariff (1908–13).—Every growing unit in the country was harassed by questions of taxation and expenditure The U S. government also sought new resources, and found them in the income tax. This was made possible on July 13, 1909, by the 16th amendment to the constitution, which came into effect on Feb. 25, 1913. Another new resource of the federal government was a tax upon corporations levied on net income (Aug. 5, 1909) The important question of reorganizing the national banking system, so as to furnish a strong national institution, was debated from 1908 to 1912, and was the subject of an elaborate report by a national monetary commission; but no action was taken at that time The net federal debt was $1,000,000,000, or only about $11 per head of the population.

A financial resource over which congress had sole authority was the tariff. Under strong pressure from members of the party to carry out the promises of the Republican convention of 1908, President Taft, a few days after his inauguration, summoned congress to meet in special session, for a revision of the tariff. As usual there was a long controversy, which resulted (Aug. 5, 1909) in the Payne-Aldrich tariff. The act created a permanent court of customs appeals, with power to determine finally all questions as to the value of imports, together with a tariff board, expected to make investigations and recommend specific measures which congress might adopt As to rates, the act was not very different from its predecessor, except for a decided increase of duties on cotton and silk manufactures There was a loud outcry that the revision intended by the party platform was a revision downward and not upward Nevertheless President Taft signed the bill, and in a speech at Winona, Minn , Sept. 17, 1909, surprised the country by declaring that it was the "best tariff bill that the Republican party has ever passed."

Political Reform (1908–13).—When Roosevelt left the presidency in 1909 the position of president was at the highest point of authority that it had ever known. Most presidents had found their principal legislative influence in the veto; Roosevelt had followed the McKinley method of emphasizing his wishes in personal discussion with members of congress. He did more: he revived the Jacksonian method of announcing a legislative plan, and if congressmen hung back, of appealing over their heads to the country at large A similar policy was adopted by President Taft, who had many of the qualities of leadership. He was large, happy, genial, fond of his many friends, a cheerful, balanced man. He had served as first civil governor of the Philippines and

as secretary of war in the cabinet of Roosevelt, who practically designated him as his successor Nevertheless, as an avowed inheritor of Roosevelt's policies, he drew upon himself the opposition of Roosevelt's enemies while it soon became apparent that he was not relying upon Roosevelt's friends

At this time the "primary" method of selecting candidates was spreading rapidly through the union. Candidates for each party were selected by the ballots of the people, thus undermining the convention system From nominations for local officers the new method had spread, by 1911, to state officers in numerous states; and after 1910 it began to be applied to the choice of delegates to the national party conventions. An unforeseen effect was that the official ballots were made upon the basis of party nominations, with an opportunity for independent voting. The primary thus became a part of the system of public elections, and therefore the party system was engrafted on public law, as a part of the government

The distrust of conventions and controlled elections extended to the numerous and powerful bosses in city and state legislatures. Three new devices were set at work to curb them and to interest the electors in public measures The first of these, the referendum (*q.v.*), was by 1909 spreading rapidly through the western states, as a means of checking legislative action contrary to public sentiment. The referendum system furnished a mechanism, usually imbedded in state constitutions, by which on the demand of a sufficient number of voters, a statute could be held back from effect until submitted to a vote of the electors What was to be done if the legislature refused to enact a statute demanded by the people? The initiative (*q.v.*) was invoked, by which a designated number of voters could unite on a measure, which must then be submitted to the electors for their suffrages

A third branch of this system of appeal to the people was the recall (*q.v.*), under which a public officer already chosen by popular vote (and in a few cases those who were appointed in some other way) could be subjected to an election; and, should the majority decide against him, be thereby removed from office In 1911–12 the question came up in connection with the proposed constitution of the new state of Arizona, which included a provision for the recall of judges. Because of this provision President Taft vetoed the act of admission. The state withdrew the clause, was duly admitted in 1912, and thereupon proceeded to reinsert the recall

A still wider application of the principle of the responsibility of functionaries to the voters was the recall of judicial decisions, which was advocated by Roosevelt in 1912, but proved to be more than the country desired.

United States senators, till then chosen by state legislatures, were next made subject to popular choice. Urged by public sentiment, congress submitted (June 12, 1912) the 17th amendment, which was duly ratified and added to the constitution (May 31, 1913). Under this, all elections to the senate were to be made by direct popular vote Another evidence of a rising feeling of responsibility in congress was a statute (Aug. 7, 1911) requiring candidates for the house and senate to submit statements of the money raised and expended in their behalf and limiting the amount which they themselves might spend. One purpose of both these measures was to make it difficult for men to purchase their way into the senate. On July 13, 1912, Sen. W. Lorimer of Illinois was practically expelled from the U.S. senate for buying votes in the legislature.

Another slow reform was in the ballot system. Most cities, towns and states were loaded down with long lists of the officers to be chosen. The result was an agitation for the reform commonly known as the short ballot, by reducing the number of elective officers and increasing the officers to be appointed by the few elective officials. Working difficulties were found in many of these reforms. It was hard to keep the public keyed up to the necessary pitch of thought and attention at every election; but it was evident that the American people intended to free themselves from the shackles of "invisible government."

Social Questions (1908–12).—The spirit of discontent extended to many questions outside of politics. Throughout the Taft administration there was an increasing pressure for equal suffrage —that is, woman suffrage—which, introduced in the territory of Wyoming in 1869, had gradually spread among the far-western states, and then begun working its way eastward Again, both state and national governments were compelled to deal with the question of alcoholic beverages From the earliest times there had been restriction on liquor selling and liquor sellers By 1909 in almost all states there was some form of general legal restriction —prohibition, local option, high licence or a state dispensary system. The question became national, because the liquor trade transported its wares from one state to another; and that brought it within the interstate commerce clause of the constitution and the Interstate Commerce act Eventually by the original Package act of 1890, congress adopted the policy of prohibiting shipments of liquor into prohibition states. Pure food laws in force before 1909 were supplemented by the Drug Label act of 1912, which greatly aided in preventing the adulteration of drugs.

Many questions arose out of immigration. The laws in 1909 forbade the entry of labourers under a contract to work in the United States, of convicts, diseased persons and the insane, but the execution of the laws was slack. The first statute looking toward decided control of immigration was that of Feb. 1907, which increased the grounds of exclusion, and at the same time provided a plan to help the immigrants in finding work. It also created an immigration commission, which in 1910 made a report in 41 volumes, strongly recommending the sifting of immigrants by testing their ability to read and write some language. Meanwhile, in the decade 1901–10 the number of immigrants rose to an average of 1,000,000 a year. Later, however, the record showed that from 300,000 to 500,000 annually returned to their old homes, the actual rate of increase of population by immigration was no more than about ½% annually.

Labour Questions.—No legal obstacle stood in the way of the right to organize, first, by local trade unions, then by nation-wide unions for single trades, and finally by national unions combining many trades To this was slowly added by the unions the principle of the "right to labour," which meant both that it was the duty of the community to see that the worker had a job and that at least the skilled workers had a kind of title in their employment, so that it became contrary to good morals for a "scab" to take the place of a striker.

The legal position of labour unions in these controversies was brought out by suits of national importance against unions In the test case of *Gompers v. Buck's Stove and Range Co.*, the charge was that the federation, by posting the company in its publications as "unfair to labour," was boycotting, and thus infringing legal rights Samuel Gompers, president of the American Federation of Labor, was convicted for contempt of court on the ground that he had refused to obey a court order to abandon the boycott. In 1908 a suit was decided with a verdict of $74,000 damages against a union of the hatters of Danbury, Conn , who had attempted to boycott the products of a local hat manufacturer.

Another phase of the labour situation was the spread of employers' liability laws through various states, and the passing of an act of congress (April 22, 1908) for the protection of the employees of interstate railways. In June 1912 congress added to its previous enactment of an eight-hour maximum regular day for public employees, by providing that all contract work for the federal government must also be on the eight-hour basis. As most labourers were voters they brought powerful influences to bear on state legislatures and on congress in favour of labour. On the other hand, the courts, particularly those of the states, were slow to recognize the changes in industrial conditions.

In addition, the courts began to use a system of labour injunctions: workmen, labour unions and their members were ordered to abstain from committing acts which if committed would presumably violate a law and would thus lead to a prosecution, in which the question of guilt could be settled by a jury. Instead; the courts by injunction would decide on the responsibility and affix a penalty not specifically laid down in any statute.

Trusts and Transportation 1887–1912.—During the 20 years ending with 1910 it became clear that the most difficult question

before the United States government was the regulation of the vast aggregates of capital, commonly called trusts (*q.v.*), which combined into corporations, aimed at the control of particular lines of business, and also of the railways. The efforts of congress to adjust the question were registered in two lines of restrictive statutes, headed by the Interstate Commerce act of 1887 and the Sherman Anti-Trust act of 1890. Upon these was built a structure of decisions by the United States supreme court. To carry out and partly to avoid these decisions, the Mann-Elkins act of June 18, 1910, widely extended the Interstate Commerce acts by including telephones, telegraphs, express and sleeping-car companies, and setting up a commerce court which was to render decisions on transportation questions Federal control of railways on the whole worked well The commission was a striking example of disregard of the principle of separation of powers, inasmuch as it was a rule-making body, an executive body and a court which interpreted its own rules, subject as to some questions of appeal to the federal courts.

The great problem of the trusts was much farther from a solution than that of the railways, because the large corporations were linked together through the holding and manipulation of stocks by capitalists and banks, and through the so-called "interlocking of interests" The only effective way of dealing with large corporations whose activities extended from state to state was to bring suit against them for monopolizing or conspiring to monopolize in their lines of trade. It was considered a triumph when (May 9, 1911) the United States supreme court rendered decisions against two of the most powerful trusts—the Standard Oil company and the American Tobacco company. The court held that the antitrust legislation must be interpreted by the "standard of reason"—namely, that a combination was not unlawful or against the public interest unless it actually caused a restraint of trade and commerce among the federal states or with foreign nations. Having thus set up a "rule of reason" which congress had refused to enact, and having created an example of judicial legislation, the court proceeded in both the pending cases to hold that the companies were guilty of attempts to monopolize their lines of trade. As to penalties, the court contented itself with ordering the offenders to disintegrate. The general danger of vast aggregations of capital was ignored.

Foreign Affairs.—The fields of the diplomacy of the United States for many years had been American and Pacific, and in a much smaller degree European. In the second Hague conference of 1907 the United States delegates urged international arbitration; and in accordance with the general principles put forth at that conference, Elihu Root as secretary of state secured 25 arbitration treaties with as many countries (1908). The United States and Great Britain arranged (Jan 27, 1909) to refer to The Hague tribunal their long-standing dispute on the Newfoundland fisheries. The result was a decision acceptable to both sides (Sept. 7, 1910). In 1911 the Republican majority under President Taft's leadership initiated a policy of commercial reciprocity with Canada An agreement was made with the Canadian government by which each side should by legislation reduce or abolish duties on certain raw products and manufactures. With great difficulty the necessary bill was pushed through congress (July 1911); but two months later the Canadian electors refused to support the reciprocity agreement, and the plan broke down.

Latin America.—Notwithstanding the position of the United States as the responsible holder of the Philippine Islands, and hence an Asiatic power, the tradition of isolation continued to be a strong force in the public mind. Nevertheless no formidable public protest was made to a policy of special U.S. intervention in Mexico, the Caribbean and the Isthmus region. The arrangements of 1902 made Cuba practically a dependency, subject in the last resort to decisions from the White House. President Taft continued the occupation of the Dominican Republic; consent of the senate under a treaty to that effect having been obtained by Roosevelt in 1907. In 1911 Taft secured a convention by which Nicaragua gave exclusive canal privileges to the United States.

The Panama canal was now approaching completion and the little republic of Panamá, which it bisected, though nominally an independent state, was in fact under U S control. An act of congress (Aug 24, 1912) laid tolls on shipping, from which U.S. ships engaged in coastwise trade were to be relieved The British government lodged a protest on the ground that by its treaty with the United States the canal was to be opened on equal terms to the ships of "all nations"; President Taft, however, stood by the act, and the question was passed on to the next administration

Still more serious were the relations with Mexico, where, in 1910, a revolution headed by Francisco Madero assailed the government of Porfirio Díaz and drove him after a few months out of the country. Mexico was thrown into confusion, and President Taft found it necessary to place troops on the border In 1912 he proclaimed an embargo on the export of arms or military supplies to Mexico Meanwhile the concessions and property of Americans in Mexico were threatened or destroyed. The Americans who had interests in Mexico began a steady pressure for intervention by the United States.

Pacific Relations 1908–12.—Across the Pacific, clouds rose on the diplomatic horizon The commercial treaties with Japan allowed a reciprocal freedom of residence and trade to the nationals of the two countries. The immigration of Japanese was very distasteful to the people of California, who undertook to restrict Japanese children to separate schools Behind this difficulty was the rising power of the Japanese and their national spirit, greatly enhanced by their victory over the Russians in 1905. In 1908 Roosevelt sent round the world a powerful naval fleet, which visited Japan and was received with elaborate courtesy by a welcoming Japanese squadron exactly equal in number, ship for ship. In the Root-Takahira reciprocal note of Dec. 1, 1908 (which was never submitted to the senate), the United States practically admitted Japan's special interest in Asiatic affairs The question of Japanese immigration was settled for the time being by a renewal of the commercial treaty (July 24, 1911). It continued the previous "gentlemen's agreement," according to which, though claiming a right of immigration into the United States, the Japanese government pledged itself not to issue passports to labourers.

Politics 1909–12.—In the action of congress on many of the important issues above discussed no party lines were drawn, though such measures as the tariff and new taxes were distinctly Republican. On the tariff, some members from middle western states, particularly Minnesota, voted against the Payne-Aldrich measure of 1909. Another disturbance was caused by resentment against the speaker of the house, Joseph Cannon of Illinois, who through the union of various powers virtually had a veto on any measure or proceeding which he did not like. Cannon kept too tight a hand; hence (March 19, 1910) a group of Republican "insurgents" joined hands with the Democrats to reduce his prerogatives till Cannon became simply a partisan moderator.

A new issue upon which both parties were divided was covered by the general term "conservation" Although most of the arable land had passed out of its possession, the federal government was still the possessor of great tracts of forest, of mineral lands and of water power. Congress in 1902 provided for a system of irrigation, the cost to be advanced by the government and repaid in instalments by the users of the water. President Roosevelt became interested in stopping the waste of timber and minerals, in preserving part of the gifts of nature for future generations and in retaining public ownership of the utilities of the country, particularly the forests and streams. In 1910 new statutes provided for a fresh classification of land and for the reservation of coal by the government.

Roosevelt and Wilson.—By 1910 it became clear that the Republican party was weakening, and that President Taft's popularity and influence were lessening. The state and congressional elections of 1910 were unfavourable to the Republicans. The insurgents, who soon came to be called Progressives, gained most of the Republican districts in the west, and the Democrats gained about 50 seats in congress. This result transferred to the Democrats the control of the house, while in the senate they secured 41 of the 92 members.

A group of dissatisfied Republicans gathered about Sen. Robert

La Follette of Wisconsin as a leader and presumptive candidate for president Meanwhile state legislatures were passing primary laws which included the election of delegates to national nominating conventions This made it easier to break through the old-line organizations, as La Follette had done in his own state Taft's friends and supporters naturally expected that the president would be renominated

All these calculations were disturbed by the greatest personality in the country, Theodore Roosevelt. A few weeks after leaving the White House (1909) he started on an expedition to Central Africa, and was, on his way back, received in Europe as the former president of the most important of republics and as a commanding personage. He returned to the United States (June 18, 1910) to find political conditions little to his liking Most of his friends had disappeared from the administration, his policies seemed to him to have been slighted Taft did not satisfy the former president, and the two drifted apart. On Aug 31, 1910, at Osawatomie, Kan , Roosevelt set forth a program which he called "the New Nationalism," favouring publicity of the accounts and proceedings of trusts, a tariff commission, a graduated income tax, an adequate army and navy, conservation, protection of labour and the direct primary with the recall of elective officers For the time being Roosevelt made no direct movement toward standing for the presidency Meanwhile several of the western states, particularly California under the guidance of Gov Hiram Johnson, accepted a radical program of political and social reform A formal breach with Taft and the open candidature of Roosevelt seemed inevitable The crisis came when (Feb 12, 1912) President Taft in a speech alluded to the Progressives (evidently having Roosevelt in mind) as "Extremists—not Progressives; they are political emotionaries, or neurotics" This was taken as a challenge, and a few days later Roosevelt openly declared himself a candidate

The Election of 1912.—As the convention held in Chicago approached, the lines of battle were developed. Behind Taft were William Barnes of New York, Boies Penrose of Pennsylvania, Winthrop Murray Crane of Massachusetts and other "standpat" leaders Among those in favour of Roosevelt were James R. Garfield of Ohio, Gifford Pinchot of Pennsylvania and a strong body of Republican governors. Roosevelt himself went to Chicago, and threw his immense energy and enthusiasm into the campaign The convention was a scene of unusual excitement

The critical decision was made in the preliminary meetings of the national committee, which was strongly "standpat"; for that committee had to decide upon the right of claimants to be inscribed in the preliminary roll of delegates. Every contest except one was settled in favour of the Taft claimants. The shifting of 30 delegates from one side to the other would have brought about a stampede to Roosevelt, but they were not to be had. Roosevelt advised his delegates to take no further part in the proceedings. At the final roll call, June 22, there were 561 votes for Taft, 58 scattering and 107 for Roosevelt, besides 344 Roosevelt men not voting. In the last issue, therefore, Taft had a majority of 50 votes out of 1,070. In the minds of Roosevelt and most of his followers the nomination was a violation of the principles of popular government. Roosevelt openly advised a bolt. This was duly accomplished by a formal Progressive convention. It met in Chicago in August and nominated Roosevelt for president and Hiram Johnson for vice-president.

Meanwhile the Democratic convention met at Baltimore with William J. Bryan in a position to dictate the choice. The apparently sure candidate was Champ Clark of Missouri, speaker of the house of representatives. But under the rules of the Democratic convention requiring a two-thirds majority, he was finally defeated by Woodrow Wilson, governor of New Jersey The platforms of the two old parties were of the usual type. The Republicans declared for protective duties. The Democrats stood by their platform of a tariff for revenue only, additional regulation of the railways and presidential preference primaries. The Progressive platform was a general program of political reform and "an enlarged measure of social and industrial justice."

Woodrow Wilson's Victory.—Not platforms, however, but men, appealed to the voters All three candidates took the field. From the first it was clear that the real fight was between Roosevelt and Wilson The Progressives were well organized, and their convention and campaign included many women The final question was whether Roosevelt could draw to himself a sufficient number of Democrats to reduce the Democratic vote below the winning point. The result in November showed that the Democrats in the main stood by their party candidates The total popular Democratic vote, 6,293,454, was only about 115,000 less than in 1908. The total Taft and Roosevelt vote combined was almost exactly the same as that of the Republicans in 1900 Roosevelt polled 4,119,538 popular votes to 3,484,980 for Taft; but he carried only 6 states, with 88 electoral votes, against 2 states with 8 votes for Taft and 40 states with 435 votes for Wilson

Woodrow Wilson.—On March 4, 1913, Wilson was inaugurated as president. Born in Staunton, Va , in 1856, of Scotch Presbyterian ancestry, he graduated from Princeton in 1879, essayed the practice of law, then was a professor in several colleges. From 1902 to 1910 he was president of Princeton university He was an easy and attractive speaker and had a remarkable literary style. (*See* WILSON, THOMAS WOODROW) As governor of New Jersey during 1911 and 1912 he had opportunity to show his skill as a party leader and his interest in reform In 1912 he was taken up by Bryan, who saw in him an exponent of the political principles for which Bryan had stood and a president who could meet the Progressives on their own ground

In making up his cabinet it was only reasonable that Bryan should enter it. He was made secretary of state, an office for which he had little adaptation. To a new cabinet office recently created by congress, the secretaryship of the department of labour, Wilson appointed W. B. Wilson, a strict labour organization man. Lindley M Garrison, secretary of war, and Franklin K Lane, secretary of the interior, were strong men Albert S. Burleson, postmaster general, and Josephus Daniels, secretary of the navy, had insufficient training for their duties David F Houston of Missouri was made secretary of agriculture, William G. McAdoo, secretary of the treasury, and James C. McReynolds, attorney general. Most of the members of the cabinet were men who could be trusted to follow the president's lead. One remarkable statesman not included in this list was Col E M House of Texas, who for six years was the president's most trusted counsellor and political friend without holding any political office In the minor civil service Wilson carried out his principles by enlarging the classified list of posts which could be entered only by competitive examinations.

A genial man, who could be a delightful companion, full of experience and of Scotch Presbyterian humour, President Wilson had a powerful mind, an amazing skill of expression and an intense belief in the power of ideals to arouse and inspire a people. He thought he had no need of conferences, of feeling the public pulse, of mixing with members of congress and party leaders, of personally greeting the average voter.

Finance and Tariff, 1913.—The election of 1912 carried with it a safe Democratic majority in the senate and a two-to-one majority in the house. On April 8, 1913, the president created a surprise by appearing in person to address the two houses of congress jointly at the opening of a special session, instead of sending a written message. This practice he followed throughout his administration, with great effect. He felt himself not only chief magistrate of the nation, but head of the Democratic party, and practically the premier of the government from which ought to proceed plans for important legislation.

A special session was called particularly to frame a tariff act. Rep. Oscar Underwood (Ala.), chairman of the committee of ways and means, gave to the new measure his name and experience. The purpose of the statute was to enlarge the free list of raw materials, foodstuffs and some manufacturers, to make a moderate reduction of the protective duties and to correct some of the things which made the Payne-Aldrich act unpopular. Included in the statute was an income tax, at last made possible by the adoption of the 16th amendment (Feb 25, 1913), which was expected to supply any revenue which might be lost by the reduc-

tion of duties A tariff commission was created to make researches into the workings of the act and to find out what was the actual difference between the cost of labour in the United States and in other countries (Oct 3, 1913).

The powerful influence of the president was again exerted to secure a systematic banking system, with the result that (Dec. 23, 1913) the Owen-Glass Federal Reserve Bank act was added to the statutes. The principle was to create a national institution, which was to be divided into 12 regional banks, in each of which was a body of directors, besides the central organization in Washington, D.C. In these 12 subdivisions clustered such banks, whether national or state-chartered, as chose to accept. The new institution was also to issue a new form of paper money The system from the start was recognized as a large national asset. At the same time a Rural Credits act was passed (July 17, 1916), which created a special group of banks to lend money to farmers on the security of their farms

Transportation, 1914–16.—Under a statute of March 1, 1913, the Interstate Commerce commission was authorized to enter on an elaborate valuation of the railway property throughout the country as the basis of a judgment as to what was a reasonable profit. The Panama canal was now approaching completion This was the first great agency of transportation owned and managed by the United States government. President Wilson used to the utmost his personal influence for a bill to repeal discrimination in favour of U S.-owned vessels, of which the British government had complained; it became an act, June 15, 1914. On Aug. 15 the first steamer passed through the canal from sea to sea and in a few months the canal was paying its own way A new question of transportation was arising through the rapid development of motor vehicles. At first a plaything, then a luxury, by 1908 they were spreading throughout the land The attention of the whole country was called to the absolute necessity of good roads In 1916 congress passed an act appropriating approximately $85,000,000 to be paid in about five years to such states as would contribute equal sums for good roads From this beginning the movement spread rapidly throughout the whole country.

The Trusts, 1914.—A few hours before the end of President Taft's term a congressional committee reported against the "great and rapidly growing concentration of the money control and credit in the hands of a few men" In June 1914, in a suit involving the International Harvester company, the United States supreme court upheld state antitrust laws.

Yet the trusts still flourished; and huge corporations, such as the U S. Steel corporation, paid dividends on thousands of millions in stocks and bonds. President Wilson urged successfully a radical amendment of the Sherman act (Oct. 15, 1914) against discriminating freight agreements, interlocking directorates and holding corporations.

Another branch of the same attack on the money power was the Federal Trade commission, created Sept. 26, 1914, which was an attempt to find means of dealing with corporations engaged in interstate commerce other than banks and common carriers.

In the same direction went the blue-sky laws passed in this period by many states, to break up the practice of floating the stock of companies which had no property more substantial than the atmosphere.

Labour, 1913–17.—The example of capital, in rolling itself into masses too great to be controlled by ordinary means, was followed by labour. The American Federation of Labor was a loosely woven council of representatives from the great trade organizations. It did not undertake to call strikes, though it was likely to support them, and it had great effect in bringing about combined and simultaneous demands for the various items in the labour program. The leaders fixed upon an eight-hour day as the basic working time. The next item was the minimum wage, which made its way slowly and was not altogether acceptable to labour. Another demand was that U.S. citizens should have preference over aliens in employment. Labour in general was unfriendly to child labour and was, therefore, interested in a federal statute of Sept. 1, 1916, to prevent the transport of products made by child labour under specified conditions.

As the labour unions gained in numbers and strength they used their energies in favour of the closed shop, a system under which union men refused to work in any establishment where men not members of the union were also employed. From this idea rapidly developed the system of sympathetic strikes, in which members of one union back up another union by refusing to handle, use or transport products of nonunion labour. Hence boycotts, and perhaps ruin for employers who had no difficulty or quarrel with their own workmen Never in the prior history of the U.S had there been so many and so violent strikes as from 1913 to 1917. The I W.W. organized long and tumultuous strikes among the silk weavers of Paterson, N J , and the textile workers of Lawrence, Mass In the trying years of 1916–17 violent strikes were directed not only against nonstriking workmen, but against the public peace In July 1917, at Bisbee, Ariz., the tables were turned. A kind of vigilance committee seized and carried out of town, with orders not to return, about 1,200 striking miners and their friends No jury would convict those responsible for this illegal action The most serious of all these labour struggles was the threatened strike in 1916 of the large and very powerful unions of railway employees President Wilson intervened and practically compelled congress to pass (Sept. 3, 1916) the Adamson act by which a basic eight-hour day was secured with pro rata for overtime. The supreme court upheld this statute, which went to the farthest verge thus far of the federal government's authority over labour matters

Social Movements, 1913–17.—These struggles between the railways and the courts, between the trusts and congress, between labour and state governments, between strikers and the president of the United States, are part of U.S. history because they were vital to the welfare of the country. The farmers everywhere were aroused, for they looked on railways as hostile to their interests, by overcharging for carrying their products; and they resented the trusts, which they believed raised prices The antiliquor forces steadily developed strength They urged out-and-out prohibition and secured it in more than half the states. At the end of 1917 war prohibition was enacted by the federal government and also prohibition in the District of Columbia On Dec. 19, 1917, a two-thirds majority was secured in congress for a prohibition constitutional amendment—the 18th amendment—which was at once submitted to the states. Woman suffrage also advanced steadily. Congress submitted a woman suffrage amendment in 1919 Thus changes that had been 50 years on the way finally were brought about by the force of public opinion. A change was also visible in the attitude of the country toward immigration which congress was determined to reduce by an intelligence qualification. A new bill (Feb. 5, 1917) was passed over Wilson's veto Besides a literacy test it raised the head tax to $8 and excluded oriental labourers coming from certain geographical areas, which did not include Japan but did apply to Hindus and Malays.

Educational Progress.—The several years following 1909 were marked by a new sense of the possibility of general education, and the need for a more direct, searching and practical type of education The country was accustomed to a system of graded public schools, offering the "common school education," and leading up to a few endowed and private schools, and to thousands of public high schools, which were expected to prepare the small proportion of young men and women who went on to institutions of higher education. Secondary education was subdivided into literary, commercial and industrial schools. The institutions of higher learning set up new professional departments, including the intensive study of education and separate schools of science, engineering, agriculture and other specialties. Private enterprise created a great number of so-called business colleges, and a few very efficient trade schools.

Nevertheless there was general complaint that the schools did not relate themselves to the life of the community. A National Society for the Promotion of Industrial Education became the focus of a movement to organize what now became generally known throughout the country as vocational education. A na-

tional commission was appointed by President Wilson, in 1914, to consider the whole subject. The resulting Smith-Hughes act (Feb 23, 1917) created a federal board for vocational education which framed an elaborate plan for instruction in the four vocational fields of agriculture, commerce, industry and homemaking

The act promised to appropriate federal funds to be paid to such states as would match these funds dollar for dollar

Private enterprise accompanied this movement by building up advanced engineering and trade schools of a high type, such as the Carnegie institute at Pittsburgh; by improving the private commercial schools and by establishing advanced schools of business training in colleges. Some of the great manufacturers, especially of automobiles, set up schools within their own works

When the United States plunged into World War I in 1917, the government established a variety of vocational schools to train men for the numerous specialties of military service It made use of the shops and other vocational facilities of the existing schools and colleges Great sums were raised by special drives among the alumni and friends of the endowed institutions, and the state universities were allotted hitherto unheard-of grants The strictly vocational schools were admitted into fellowship with the other institutions.

Wilson's Foreign Policy.—Woodrow Wilson was naturally a man of peace, and so emphatically was Secretary Bryan They set themselves to aid the cause of general peace by arbitration treaties Secretary Bryan prepared a definite project for treaties by which the nations concerned should, in case of difficulties, pledge themselves to submit their grievances and claims to a special examining commission and to abstain from war or preparations for war until the commission should have had time to report. The presumption was that a sensible nation would submit to the judgment of an impartial tribunal There was little difficulty in concluding more than 30 treaties upon this basis in the course of a year, but none was put into effect The truth was that the American people, as a whole little accustomed to international questions, had no definite foreign policy.

Philippines and Caribbeans.—The government of the Philippine Islands was altered by setting up the first Filipino assembly in 1907. In response to the pleading of President Taft, congress in 1909 grudgingly included them within the customs boundary of the United States Under President Wilson, Gov. Gen. Cameron Forbes was withdrawn and Burton Harrison was appointed his successor, to carry out a policy of liberalization and preparation for independence. The Filipinos were allowed to hold a majority of the seats in the commission, which became a kind of administrative upper house. Filipinos were substituted for Americans in many of the civil offices The people were thus given a definite opportunity to govern themselves. The Jones bill, enacted Aug. 29, 1916, greatly enlarged the power of the popular part of the government, and the commission ceased to exist. The act promised that the Filipinos should be given their independence when their ability to govern themselves should be demonstrated.

At the other end of the American sphere of influence, Cuba, while nominally independent, remained a protectorate of the United States. On March 2, 1917, the Puerto Ricans were for the first time made American citizens and received a popular government of two elected houses. President Wilson continued the administration of the Dominican republic which dated back to Roosevelt. He also took military control of Haiti in 1914, and followed it by a controlling treaty which was ratified by the senate (Feb. 28, 1916) He carried even farther Taft's policy in Nicaragua by a treaty (ratified Feb. 18, 1916) which converted that country into a virtual protectorate. Another area came under control of the United States by a treaty for the annexation of the Danish West Indies proclaimed in 1917. These islands were duly organized under the title Virgin Islands of the United States. Little opposition was made to this creation of a virtual empire, including dependent provinces.

Latin America and the Orient, 1913–17.—The peaceful policy of the United States toward its neighbours was severely tested by disturbances in Mexico In 1913, Francisco Madero, president of that republic, was murdered, presumably by order of V Huerta, an insurgent officer, who thereupon declared himself the head of the state The almost invariable policy of the United States had been to recognize any *de facto* head of a Latin-American government without inquiring into the source of his title But on this occasion President Wilson adopted what he called a policy of "watchful waiting" He steadily refused to recognize Huerta, against rival revolutionists. In April 1914 a trifling dispute arose at Tampico as to a salute of the U S flag and Wilson, apparently yielding to strong public sentiment, ordered the navy to attack and capture Veracruz, of which the United States remained in possession for several months The real object was to discredit Huerta, who was compelled to flee the country. When in 1916 the brigand Francisco Villa raided Columbus, N M., the president ordered a military expedition under Gen. John J. Pershing to advance into the interior of Mexico It remained about eight months, without capturing Villa or accomplishing any other definite result The three friendly nations of South America—Argentina, Brazil and Chile, commonly known as the "ABC powers"—offered a kind of mediation At their suggestion V. Carranza was recognized as president by the United States Disorder continued, and in May 1920 Carranza was overthrown and killed by the troops of A. Obregon For a time thereafter Mexico emerged from the state of revolution.

This long controversy was highly disturbing to the desired close relations with Lain America in general. In spite of four Pan-American congresses and several scientific congresses, in spite of visits of Roosevelt and of Root and Philander Chase Knox as secretaries of state to South America, there could be no harmony if the United States were to continue "administering" small and defenseless Latin-American nations and waging undeclared wars with Mexico. Nevertheless, President Wilson in a speech at Mobile, Ala., (Oct. 27, 1913) declared that the United States had no designs on the territory or independence of its Latin-American neighbours. Colombia, too, had a grievance arising out of the loss of the isthmus when the Panama canal zone was annexed in 1904. A treaty negotiated by Bryan to pay to Colombia $25,000,000 as a kind of reparation was ratified by the Republican administration in 1921

In regard to the far east, Wilson had little opportunity to develop a policy He began by disavowing the plans made under the advice of President Taft for a loan by U.S. bankers to China. He argued with the people of California because they insisted on passing a statute restricting alien ownership of lands by Japanese residents World War I soon united the United States and Japan in a common cause, and on Nov. 2, 1917, the Lansing-Ishii note, on the same plan as the Root-Takahira note of 1908, set forth that the United States recognized Japan's "special interests in China."

Neutrality.—The United States in 1914 expected to remain indefinitely at peace, as was shown by lack of anything that could be considered national military preparation in the terms of modern warfare. When on Aug. 4, 1914, President Wilson issued a proclamation of neutrality as between the two groups of European nations just engaging in a gigantic struggle, the authorized military establishment was about 107,000 men, of whom about 87,000 were enrolled The United States had not one military aeroplane of approved type; had only four modern heavy field guns and no transport for them; had not a trench bomb or a mine thrower; nor considerable supplies of any weapons or equipment except 800,000 excellent rifles; nor any officers experienced in the kind of warfare used in late wars; nor any instruction camps for officers or men. The navy included a fleet of battleships recently built, but weak in small and swift vessels and particularly in submarines. The militia proved to be of little service, though Secretary Bryan publicly declared that the nation needed no preparation, for it "could raise a million men between sunrise and sunset."

Neither the foreign policy nor the diplomatic organization of the United States was fitted for such a crisis The traditional Monroe Doctrine was expected to keep the nation out of dan-

gerous controversies with the other American states The counterpart principle of isolation forbade the United States to take any part in European crises or wars As a neutral it stood by the principle of "freedom of the seas," by which was meant in particular the right to carry on commerce with all belligerents in case of war, subject to the limitations of the then acknowledged international law as to contraband and blockade Soon after the beginning of World War I relief was organized on a large scale for the Belgian people, most of whose country was overrun and held by the Germans. This system soon included French refugees, the unhappy peoples of Serbia and Asia Minor and other combatant or noncombatant sufferers, besides the sick and wounded of the contending armies.

Difficulties with the Belligerents, 1914–17.—The United States was compelled at once to take into account the relation between the war and U S industries, commerce and finance Heavy loans were placed in the United States by Great Britain, France and Russia As fast as the money was borrowed it was spent in the United States for the purchase of food, clothing, animals and especially munitions President Wilson issued a proclamation (Aug 18, 1914) advising that the people remain neutral "not only in act but in word and in thought." Such neutrality was impossible In the first weeks of the war, German commerce was driven from the seas. The command of the sea by the Allies very nearly cut off trade of any kind between the United States and Germany and Austria, while commerce continued in ever-increasing volume with England and France. This disparity led to protests on the part of the German government, and also to lawless acts perpetrated or directed by agents dispatched by the German government for the purpose of paralyzing the munition factories. Violent antipathies were caused by the German methods of carrying on war, and particularly the treatment of the occupied areas of Belgium and France. The American population included hundreds of thousands of citizens of the belligerent countries, many of whom attempted to return to their homes in order to serve in the army. The road for such recruits was blocked for the Germans and their allies, but open to the Allies. For the first time in half a century the United States found within its own borders a sharp division on questions of foreign policy.

On the other hand, the war trade brought immense profits The favourable balance of trade rose from $690,000,000 in 1913 to $1,770,000,000 in 1915 and $3,000,000,000 in 1916. This prodigious debit was balanced by about $3,000,000,000 sent to the United States in securities and gold, besides $2,000,000,000 in foreign war bonds. Under these circumstances genuine neutrality was out of the question. A decided preponderance of sympathy developed toward the western Allies, who were profitable customers, were in close and almost undisturbed intercourse with the United States and were considered to be fighting against a ruthless, arrogant and dangerous autocracy.

International Controversies, 1914–17.—The internal tension of the United States was tightened by the insistence of Germany on the right to use new weapons, tactics and practices of war, without the traditional limitations of international law, without mercy to noncombatants, on the basis of "a law of necessity." No able-bodied German man or woman was really a noncombatant; the Germans insisted that they must regard all civilian enemies as combatants. There was no way to stop them without using similar new methods of warfare.

Great Britain, which in the London Maritime conference of 1908–09 had shown some disposition to enlarge the privileges of neutral commerce, now seized U.S. ships and shipments, and arbitrarily extended the list of contraband, until (Dec. 26, 1914) a dispatch signed by Secretary Bryan, but expressing the conclusions of President Wilson, made a protest In the course of 1915 the British government began to apply the U.S. principle of "continuous voyage" as applied by the United States during the Civil War to cover shipments to neutral ports in cases where those shipments were likely ultimately to reach Germany; and also where they might replace products of the neutral countries that could thus be spared for Germany; or if the neutral countries declined to make a hard and fast agreement not to reship.

In 1916 the British were practically blockading neutral European ports and capturing vessels, U.S. and other, wherever they liked The Central Powers set up a new war practice of using submarines as commerce destroyers. The U S government protested. A crisis came through the sinking by a submarine of the British passenger liner "Lusitania" (May 7, 1915), with the loss of 139 American lives. That sinking seemed a deliberate act of the Germans to test the temper of the United States Apparently they were greatly surprised when the people of the United States rose in resentment. President Wilson, who had earlier insisted on "strict accountability," insisted on a sharp protest Bryan thought milder measures sufficient, and on that issue resigned the secretaryship of state (June 8, 1915), being succeeded by Robert M. Lansing The correspondence went on until October when Germany at last informed the U.S. government that merchant ships would not be sunk without warning and an opportunity to save noncombatant lives Meanwhile, throughout 1915 and 1916, systematic violations of the neutrality laws of the United States by Germans and Austrians caused the dismissal of the Austrian ambassador to the United States and of the two most obnoxious members of the German ambassador's staff.

"Preparedness."—By the end of 1915 it became clear that with or without their own desire, the people of the United States might find themselves involved in the war President Wilson desired peace. A day or two after the sinking of the "Lusitania" he spoke of there being such a thing as "a nation that was too proud to fight." In his message of Dec. 1915 he urged national defense and the protection of American shipping. Long before this time World War I had brought about a violent change in the economic conditions of the country. The great demand for foodstuffs raised the price of grain and other farm products. The high cost of living became a political issue. The munition factories offered unheard-of wages and drew hundreds of thousands into improvised towns. The war caused a great change in immigration. Hundreds of thousands of men left the United States for Europe, while the net immigration fell from 1,200,000 in 1914 to 300,000 in 1916.

The Election of 1916.—In the midst of this turmoil and confusion of business came the preliminaries of the presidential election of 1916. President Wilson carefully abstained from taking sides between the Allies and the Central Powers; but the aggressive submarine policy of Germany provoked a much sharper tone than did the aggressions by the English. He felt the need of caution, particularly because a growing group of men, among them Roosevelt, were coming to the conclusion that eventually the United States would have to join in the war.

The Republican nominating convention met in Chicago, June 7. A strong effort was made by friends of Roosevelt to capture the Republican convention, but the standpat Republicans had control of the party machinery. The Progressives—who in Nov. 1914 had cast 1,800,000 votes for congressional and state candidates—also met in convention in Chicago. Their purpose was to compel the Republicans to nominate Roosevelt as the only means of healing the breach. That effort failed· the Republicans nominated Justice Charles E. Hughes of the supreme court, who had been a reform governor of New York state. The days of the Progressive party seemed numbered.

In the Democratic convention (June 14) there was practically no opposition to Wilson and his running mate T. R. Marshall. The platform in many respects was similar to that of the Republicans. Both favoured woman suffrage, the conservation of national resources and national enforcement of child-labour laws; both reaffirmed the Monroe Doctrine, But the Democrats upheld tariff for revenue only; they endorsed the promise of ultimate independence to the Filipinos; they commended the establishment of a federal trade commission; and they approved a merchant marine owned and operated by the federal government. In the campaign Roosevelt publicly supported Hughes, though it was well-known that he felt no enthusiasm for him. The only slogan that caught the public ear was favourable to Wilson: "He kept us out of war." Wilson received about 9,000,000 popular

votes against 8,500,000 for Hughes, and was chosen by a close vote in the electoral college

ENTRY INTO WORLD WAR I

President Wilson stood in a strong position in the United States and in the world He had been re-elected. His policy was approved He felt that he had the nation politically united behind him. He hoped that the one great neutral nation might bring about peace On Dec 18, 1916, he sent a communication to the warring powers suggesting that they come to an understanding of each other's demands. On Jan 22, 1917, in an address to the senate on foreign affairs, the president described the replies he had received to the identic note of Dec 18.

The Central Powers united in a reply which stated merely that they were ready to meet their antagonists in conference to discuss terms of peace The Entente Powers have replied much more definitely, and have stated, in general terms indeed, but with sufficient definiteness to imply details, the arrangements, guarantees and acts of reparation which they deem to be indispensable conditions of a satisfactory settlement

He went on to speak of an "organized common peace," and of a "peace without victory"; he outlined the principle of self-determination, declaring that "Governments derive all their just powers from the consent of the governed," and that "no right anywhere exists to hand people about from potentate to potentate as if they were property." The German answer was a brief note communicated by Ambassador Count von Bernstorff to Secretary Lansing (Jan. 31, 1917), withdrawing the pledge given in Oct 1915 and renewed in May 1916 that merchant ships would not be sunk without preliminary warning and announcing that the Germans would shortly resume unrestricted submarine warfare. High military authority in Germany believed that Americans would never sacrifice the large profits of export trade and incur the huge expenses of war merely for the sake of a question of neutral maritime rights.

Immediate steps were taken to make the U.S. navy ready for war. For a time the president dallied with a plan of arming merchant ships One result of the controversy was the adoption by the senate (March 8) of a mild and cumbrous method of cutting short debate by closure. During Feb. and March 1917 a few U.S. vessels were torpedoed by German submarines. On March 1 the government published an intercepted German dispatch to the Mexican government asking it to join in the war, promising it the "former Mexican provinces," long incorporated in the United States The participation of the United States in the war was now inevitable A formal declaration of a state of war was signed by the president (April 6) after a house vote of 373 to 50 and a senate vote of 82 to 6, which stated that war had already been begun by Germany. Relations with Austria and Turkey were at once broken off, but the declaration of war with Austria was delayed until Dec. 7 and no declaration was ever made against Turkey or Bulgaria.

The breach with Germany was a spontaneous national action representing a national belief that the United States could no longer live in peace with such a nation as Germany had become. As President Wilson put it the war was to make the world "safe for democracy." Moreover, there was widespread sympathy with the three western powers, France, Belgium and Great Britain, which were closest to the United States in their political principles and system of government. Wrath was aroused by the German treatment of the people of Belgium and other conquered countries In some minds there existed a genuine and well-grounded fear of a future attack upon the United States by Germany if the resistance of the Allies should be destroyed. Amid all the motives for the war, the one thing was that the American people recognized Germany as an enemy, and the enemies of Germany as natural friends and partners in the great enterprise of subduing "the Hun."

War Measures.—Passionate national spirit, patriotism and urgent reasons for war were all useless unless the United States could enrol, train, equip, convey and continuously supply an immense army. The U.S. navy, though the vessels were good and the crews skilled and well commanded, was in no position to give direct aid in the process of destroying the German army What was most needed was to raise and convey to the fighting front a large force of U S. troops.

Soon after the declaration of war by the United States, missions from the various Allied countries were sent to America. The British mission, headed by Arthur (later Lord) Balfour, British foreign secretary, reached Halifax April 20 and proceeded to Washington The French mission, headed by René Viviani, the former premier, and including Marshal Joseph Joffre, landed April 24. Other missions came from Italy, Belgium, Russia, Rumania and Japan. The United States was able at once to help the western Allies in their pressing financial difficulties. Taxes were low and little felt, money abounded Under acts of congress beginning Oct. 17, 1917, the Allies received essential credits, which amounted eventually to $9,500,000,000.

These enormous payments were made possible by the Liberty Loans. In June 1917, 4,000,000 people joined in offering $3,000,000,000 to the government; and at the end of World War I the interest-bearing debt had increased from $972,469,290 on Dec. 31, 1916, to $25,234,496,174, on June 30, 1919 These loans were supplemented by the War Revenue act (Oct 17, 1917) and later statutes, which laid a variety of new taxes, increased the income tax heavily and combined with it an excess-profits tax to bring into the treasury unreasonable profits likely to be made in the war industries

All traditional limitations on raising an army were discarded On May 18 the Selective Service act was passed which provided for the enlistment of 1,000,000 men by "selective draft." When called up, the men had to be clothed, housed, fed and drilled Thousands of officers were necessary, and training camps, both for men and officers, were established on a vast scale In May 1917 a few U.S. destroyers reached England On June 9 General Pershing, who had been selected as commander in chief, arrived in England. On June 26 a small detachment of United States troops reached Europe New branches of military service were established, among them the chemical warfare service which provided materials for lethal gases and for gas masks and other means of resisting the enemy attacks Congress, on July 24, appropriated $640,000,000 for aviation By August about 700,000 men were enrolled in the army and 230,000 in the navy

Control of Industry and Transportation.—The establishment of huge war industries put a great strain on the industry and transportation of the United States On Aug 10, 1917, a Food Control act gave the president powers never before conferred with regard to food and fuel Herbert C Hoover of California, who had distinguished himself in the management of the Red Cross in Europe, was made food administrator with large powers. Before World War I ended he had established "meatless" and "wheatless" days; the price of grain was fixed; eventually the farmers were assured $2.20 a bushel for their wheat crops H. A. Garfield, fuel administrator, carried through drastic measures for stimulating the production of fuel, regulating shipments and distributing supplies. On March 21, 1918, the Federal Control act placed the management of all the railways in the country in the hands of the government during World War I, and for a period after its close W. G. McAdoo, secretary of the treasury, was made director-general of the railways; later Walker D. Hines, an experienced railway man, succeeded him. One of the most serious needs of the times was a merchant fleet adequate to carry across the Atlantic the army and its supplies. The government undertook the great task of improvising such a fleet, and vast construction was authorized in both steel and wood.

War Activities at Home.—At once after the declaration of war the American people through official and unofficial channels gave support by civilian service and money contribution. Among the multifarious public agencies was a committee on public information, of which George Creel, journalist, was chairman, which kept up a lively system of publicity aided by the National Board for Historical Service. A censorship board censored all communications—mail, cable, radio—passing between the United States and foreign countries As early as Aug. 29, 1916, the Council of National Defense was created by act of congress Under it were

created numerous special organizations The Council of National Defense appointed a women's committee to co-ordinate the patriotic work of the women throughout the country The advisory commission of the Council of National Defense created a committee on transportation and communication A railroad war board undertook to secure unity of operation among all the railways, to subordinate private interests and to eliminate competition Important coastwise steamship lines were added to this system In 1918 the government assumed control of telegraph, telephone, marine cable systems and radios Many scientists were engaged in research throughout the country under the National Research council Commerce also was regulated.

By the Espionage act of June 15, 1917, the president was empowered to control exports, and he created a bureau of export licences and a trade board A list was prepared of firms throughout the world with whom Americans should not trade The government formally took charge of all foreign trade Feb. 15, 1918, and seized all German ships interned in United States ports.

Samuel Gompers, president of the American Federation of Labor, co-operated in organizing a committee on labour, and a mediation commission was appointed The National War Labor board (April 9, 1918) acted throughout the country as a kind of "supreme court" to settle labour disputes. For the recruiting of essential labour and directing it into necessary industries a U S. employment service was created.

Several private war agencies were established. Chief among these were the American National Red Cross, which was to be found wherever there was fighting, sickness, suffering or starvation, the Y M C A ; Y W.C.A ; Knights of Columbus (Catholic); Salvation Army; Jewish Welfare board; American Library association; and War Camp Community Service.

Enemies in the United States.—While the people of the United States were practically a unit in favour of a vigorous prosecution of World War I, a few, chiefly foreign-born or sons of foreign-born, were opposed to the war or more often to the nations in concert with which the United States was fighting Ever since 1914 the country had been irritated and aroused by a series of illegal, violent and often murderous acts which were traced to German and Austrian agents. Such were determined efforts to blow up the international bridge at Vanceboro, Me., and the locks of the Welland canal, Ont. Bopp, German consul general at San Francisco, Calif , was convicted and imprisoned for aiding German vessels in the Pacific in defiance of neutrality laws. Franz von Rintelen (after the war specially rewarded by the German government) was sent to the federal prison at Atlanta, Ga , for aiding in placing bombs on outgoing vessels with intent to destroy them.

The Navy.—Beginning with patrol work on the American coast as soon as war was declared, the activities of the United States navy extended to co-operation with the British and French in the hunting down of submarines and the protection of convoys and in the laying of the North sea mine barrage, extending from the Orkneys to Norway The U S navy had some part in blockading the Austrian coast of the Adriatic, and it participated in maintaining that Allied command of the sea which in the end was fatal to Germany. By a remarkable convoy system more than 2,000,000 troops were carried safely 3,000 mi. overseas to France. In this work the utmost secrecy was necessary. In June 1917 a few cruisers and transports were provided and the first troops sent across At intervals vessels assembled and sailed on definite routes under the protection of destroyers According to the report of the secretary of the navy (1920), 911,047, or nearly half of the U S. troops, were carried on United States navy transports; the rest chiefly by the British. Not one eastbound U S. transport was torpedoed by the German submarines; and only three ships were sunk on their return voyage. Three small fighting ships were destroyed by the enemy.

During the campaign of 1918 efforts were made to extend the possible field of enlistment by the passage of the Man Power act of Aug. 27. All men between 18 and 45 were required to register with a view to service if needed, and 11,000,000 were registered. By a statute of Oct. 6, 1917, provision was made for a system of military and naval insurance available for all men in the service (A. B. H ; X)

The American Expeditionary Force.—When Gen. John J. Pershing, commander in chief of the American expeditionary force, departed for Europe on May 28, 1917, America's military defensive forces comprised a regular army of approximately 80,000 and a national guard of less than 150,000. While the regular army was well officered and trained as regimental units, the national guard was not adequately organized nor sufficiently trained Industry was not prepared for its part and no authority for raising national armies had been enacted. Consequently, the nation found itself faced with the problems involved in providing manpower and organizing, financing, equipping and transporting overseas an enormous army and organizing a theatre of operations—all before Germany could strike decisively on the western front With her small unprepared forces as a nucleus, the United States called into army service 4,000,000 men, sent overseas 2,086,000 in 19 months, averaging in the summer of 1918 about 10,000 men per day. The first contingent comprised the regular army 1st division and some special troops which landed in France at the end of June 1917. The peak of the troop shipment was reached in the summer of 1918, when more than 300,000 men landed in one month. More than 50% of the U S. forces were carried in Allied ships In addition about 7,500,000 tons of supplies were shipped from America to France, practically all in U.S ships. The tasks involved in these problems were both intricate and gigantic.

Upon America's entry into World War I, German hopes of final victory cannot be said to have been extravagant The Allies were embarrassed financially and through lack of supplies Losses had been tremendous and resources in manpower were so low that there was little prospect of materially increasing their armed strength even in the face of the probable concentration on the western front of practically the whole German military strength in the spring of 1918. A review of the conditions then existing made so apparent the early necessity for a supreme effort that General Pershing cabled Washington on July 6, 1917: "Plans should contemplate sending over at least 1,000,000 men by next May " Upon completion of his study on July 11, 1917, he reported· "Plans for the future should be based . . . on at least 3,000,000 men." By the middle of Oct. 1917, General Pershing had completed his basic plans for the operation of the U.S. army in Europe These included the training of the combat army, the organization of supply in Europe, a priority for shipment from the U.S. of troops and supplies, and a project for the army's strategical and tactical employment.

The U S. mission was offensive. The plans were based on striking where a definite military decision could be gained. While the Allied armies had endeavoured to maintain the offensive, the British, in order to guard the channel ports, were committed to operations in Flanders and the French to the front protecting Paris. Both lacked troops to operate elsewhere on a large scale A deep advance east of Metz, or the capture of the Briey region, by threatening the invasion of rich German territory in the Moselle valley and the Saar basin; and curtailing her supply of coal or iron, would have a decisive effect in forcing a withdrawal of German troops from northern France The military and economic situation of the enemy and the Allies indicated Lorraine as the field promising most fruitful results and in Sept. 1917 it was selected by General Pershing as the area for the decisive operations of the U.S. army. These plans contemplated a reduction of the St. Mihiel salient followed by a decisive blow based either on Verdun or on Nancy. The organization of the immense U.S. supply service accorded with this strategical conception. The complexity of trench life had enormously increased the tonnage of supplies required by troops. Not only was it a question of providing food but enormous quantities of munitions and material. Upon the railroads of France fell the burden of meeting the heavy demands of the 3,500,000 Allied combatants. If the U.S. army was to have an independent and flexible system it could not use the lines behind the British-Belgium front nor those in the rear of the French front covering Paris, for these were needed for the

British and French forces respectively The problem confronting the American expeditionary forces was then to superimpose its rail communications on those of France where there would be the least possible disturbance to the existing arteries of supply These controlling factors led to the organization of base ports along the southwest coast of France and the utilization of French railways passing mainly south of Paris

For all practical purposes the American expeditionary forces were based on the American continent. Three thousand miles of ocean to cross with a growing submarine menace, an uncertain quantity of ship tonnage available and a land line of communications in France 400 mi. long, presented almost insurmountable difficulties. The system developed in France included U.S construction of 83 new ship berths, about 1,500 mi. of new railway with shops and roundhouses, 4,000 km of telegraph and telephone lines with the operation of a 215,500-km. system; 1,500 locomotives and 20,000 freight cars brought over and U.S. engineers repaired 2,000 French locomotives and 58,000 French freight cars Daily tonnage at ports increased from 17,000 in July to 45,000 in Nov. 1918. Commanded by Maj. Gen James G. Harbord, this great supply system engaged more than 650,000 personnel by Nov. 11, 1918.

The problems indicated were complicated by those necessarily involved in the association of the U S commander with Allied governments and commanders. The outstanding problems related to the persistent Allied proposals for the amalgamation of the Americans in the British and French ranks. This General Pershing consistently and successfully opposed; he favoured unity of U.S. command; adherence to the American doctrine of open warfare training and the primary value of the rifle and bayonet.

In meeting the crises caused by the German offensives in the spring and summer of 1918, U.S. troops (combat and service) were frequently employed with decisive results under Allied command. The 1st division's successful Cantigny operation near Montdidier, in May, demonstrated American fighting qualities. The 2nd and 3rd divisions in June blocked the German advance on Paris by holding the line about Château Thierry. The 3rd and 42nd divisions held a vital part of the line against the German attack of July 15. The successful Allied counteroffensive of July 18 was based on the decisive blow delivered south of Soissons by the 1st and 2nd U.S. divisions with the 1st French Moroccan division between them. Thus the U S arms were in time to assist in crushing the last offensive of the enemy and to commit him entirely to the defensive.

After these divisions cut the main German communications in the Marne salient, the 3rd, 4th, 26th, 28th, 32nd, 42nd and 77th U.S divisions joined the French in driving the enemy out of the salient and across the Vesle river. At the same time some divisions were holding sectors in the Vosges and others were training as reserves behind the British and even participating in British operations. About 20,000 aviation specialists were working in England and more than 11,000 motor mechanics were helping the French in addition to several thousand engineers, medical, hospital and other specialists.

The successful counteroffensive of July 18 against the Marne salient showed that the emergency which justified the dispersion of U.S. divisions had passed. By July 24 Marshal Ferdinand Foch accepted General Pershing's proposal for the organization and operation of an independent U.S. combat army and the execution of the U.S. plan of the previous September. Accordingly, early in the morning of Sept. 12 the U.S. 1st army, 550,000 strong, supported by 110,000 French troops, attacked the St. Mihiel salient and within a few hours had attained its objectives. Following out a prearranged plan the Americans were immediately transferred to the Meuse-Argonne zone where they began operations on Sept. 26. In the fighting which followed the Americans (24 U.S. and 7 French divisions) drove the Germans from their strongly fortified positions and captured the heights commanding Sedan; only the Armistice saved the 5th German army from complete destruction. The Germans had employed one-fourth of their divisional strength (62 divisions) to meet the attack. (For full particulars of these two battles *see* ST. MIHIEL· MEUSE-ARGONNE OPERATION.)

During these purely American battles, other U.S. troops and services continued to operate under Allied command, such as the troops of two divisions who assisted the British to break the Hindenburg line at Le Cateau in Sept 30–Oct. 1; the two divisions with the 4th French army capturing Mont Blanc and advancing toward the Aisne in early October; two divisions with the 6th French army in Flanders in late October and early November driving the enemy across the Escaut and the Scheldt rivers. In addition, a regiment of infantry with auxiliaries assisted the Italians on the Piave in the fall of 1918 and another regiment and auxiliaries joined the Allies in the Russian Archangel expedition of 1918–19.

Thirteen major operations in which Americans participated:

Operations	Approximate number of Americans engaged
West front—campaign of 1917.	
Cambrai, Nov. 20–Dec 4	Detachments
West front—campaign of 1918:	
German offensives, Mar. 21–July 18:	
Somme, Mar 21–Apr. 6	2,200
Lys, Apr 9–27	500
Aisne, May 27–June 5	27,500
Noyon-Montdidier, June 9–15	27,000
Champagne-Marne, July 15–18.	85,000
Allied offensives, July 18–Nov. 11:	
Aisne-Marne, July 18–Aug. 6	270,000
Somme, Aug 8–Nov. 11	54,000
Oise-Aisne, Aug 18–Nov. 11	85,000
Ypres-Lys, Aug 19–Nov 11	108,000
St Mihiel, Sept. 12–16	550,000
Meuse-Argonne—Sept. 20–Nov. 11	1,200,000
Italian front—campaign of 1918:	
Vittorio-Veneto, Oct. 24–Nov. 4	1,200

The Armistice.—The campaign of 1918 was the final effort of the Germans. No one can say that the U.S. army in the field was the chief element that ensured victory; but there is not a doubt that the triumphant success in raising and transporting incessantly troops, provisions and supplies was to the German mind convincing and disheartening evidence that the government and the people of the United States, with all their power and potentiality, would stand by the Allies indefinitely. On Nov. 11, 1918, by the Armistice in which the U S. armies shared, the Germans admitted their defeat and at once began to evacuate the occupied regions and also portions of their own national territory.

In accordance with the terms of the Armistice, the Allies were to occupy all German territory west of the Rhine. The zone assigned the U.S. command was the bridgehead of Coblenz and the district of Trèves. This territory was occupied by the U S army with its reserves held between the Moselle-Meuse rivers and the Luxembourg frontier. The advance toward German territory began on Nov. 17, 1918, and passing through Luxembourg crossed the German line on Dec. 1.

Shortly after the signing of the Armistice, the U.S. commander formulated plans for the early return of the U.S. forces to America. Rearrangement of base port and rail facilities, securing additional ships and the demands of the Allies for considerable U.S. forces to remain in France, necessarily presented important considerations. Beginning, however, in December, a continuous flow of returning troops was maintained and by May 19, 1919, all combat divisions, except five still in the army of occupation, were scheduled to sail by July. The remaining troops, less a permanent force of one regiment of infantry and certain auxiliaries, were released in Aug. 1919. (J. P.)

AFTER WORLD WAR I—TO 1926

Rehabilitation, 1919.—The task of *post bellum* economic adjustment was long and costly. At the end of the war the federal government by means of war statutes was attempting to control the distribution of food, was in fact limiting and rationing manufactured goods and was continuing to direct mining of

coal and its shipment. The government was directing the operation of railways, and the telegraph and telephone services. It had taken over the property of aliens through an alien property custodian. For foreign commerce there was still the Shipping board, the Emergency Fleet corporation, the War Trade board and the War Finance board. Two million U S. soldiers were overseas and wanted to come home as soon as possible The United States had spent on the war about $35,500,000,000, including $9,500,000,000 lent to the Allies. Expenditures after peace came continued on a scale far beyond any previous experience of the country.

In the course of six months after the Armistice, about two-thirds of the troops were brought back, leaving behind them enormous stores, large parts of which were sold at heavy discounts to European governments. On June 1, 1920, the only U S. troops left in Europe were an army of occupation in western Germany.

The Election of 1918.—The Armistice had come a few days after the state and congressional elections of the autumn of 1918 Despite the deep political and sectional divisions in both the Republican and Democratic parties that had preceded the declaration of war in 1917, the nation had been a unit in waging war. Partisan politics did not enter into the organization of the armed forces. Little attention was paid to politics in the civilian administration of the war. Yet the administration of the president was subject to constant attack by prominent Republicans and by Republican members of congress, and in Jan. 1918 the Republican national committee began a campaign to capture control of congress in the autumn elections.

A few days before the elections, President Wilson issued a circular letter urging the voters to return a Democratic majority to the senate and the house. The result of the election, however, made the new house decidedly Republican and the senate Republican by two votes. It was apparent, therefore, that the administration in making the necessary adjustments after the war had to take into account the preponderant opposition in both houses of congress.

Throughout 1918 the influence of Theodore Roosevelt in the Republican organization was manifestly growing It became clear that he would wield great influence in the Republican convention of 1920 and might be chosen as candidate of the party, despite his defection in 1912. But he died suddenly on Jan. 6, 1919

The Peace Conference.—In Dec 1918 President Wilson decided that he would attend the forthcoming peace conference in person, and designated as peace commissioners Secretary of State Lansing, Col. Edward M. House of Texas (his most intimate friend and political adviser), Gen Tasker Bliss of the army and Harry White, formerly minister to France. Wilson was one of the representatives of the four great powers—Great Britain, France, Italy and the United States—who prepared the articles of the treaty of peace.

A part of the treaty was the covenant of the League of Nations, a crystallization of long-debated suggestions for a world confederation of states President Wilson was deeply interested in the foundation of such a league as was envisioned in the covenant, and was willing to agree to a suggestion of the French for a treaty of mutual protection in order to gain the support of the French for the proposed covenant.

U.S. Action on the Treaty, 1919.—It had been apparent during the course of the negotiation of the treaty that in the U S. congress and electorate there would be vigorous debate on the covenant of the League and, indeed, upon the question of U.S. membership in such a league. President Wilson returned home for a short stay (Feb. 24–March 4), defending the general terms of the treaty and the covenant. On June 28, 1919, he and his four commissioners signed for the United States the formal treaty of Versailles, including the covenant of the League, which was so interwoven into the text of the treaty that it was impossible to ratify one without the other. The treaty had many powerful supporters among all parties, particularly former President Taft, the League of Free Nations association and the League to Enforce Peace. The senate was divided into strongly opposed groups. Most of the Democrats, under the lead of Sen. Gilbert Hitchcock (Neb.), followed the president in favouring the treaty with the covenant as it stood. A group of Republicans, headed by Sen. Henry Cabot Lodge of Massachusetts, favoured "amendments" to the treaty and "reservations" to the League. Another group desired reservations that would practically destroy both. A small group, including Sen William Borah of Idaho and Sen. Hiram Johnson of California, were against both the treaty and the covenant in any form or with any reservations.

The contest ostensibly centred about article x of the covenant, under which the members of the League undertook "to respect and preserve as against external aggression the territorial integrity and existing political independence of all members of the League." The implacable group expressed fear lest the United States be drawn into foreign wars and insisted that "no American soldiers or sailors must be sent to fight in other lands at the bidding of the League of Nations." The president, on the other hand, regarded article x as the heart of the whole treaty. He declined at the critical moment to accept either amendments or reservations, except certain minor alterations After strenuous debate and by a test vote, Nov. 19, 1919, the senate refused to ratify the peace treaty with reservations—the vote being 53 to 38 in favour, but not the necessary two-thirds. In the regular session upon resubmission, the vote was 49 to 35, again not the necessary two-thirds Thus after five months' discussion the treaty was rejected, and the United States was left in the situation of remaining technically at war with Germany and Austria though all hostilities had ceased a year before.

President Wilson, believing that he could arouse public sentiment to force senate ratification, had undertaken a tour of the country in September. He was greeted by great audiences, but the response of the country was not convincing Not only did senate opponents speak before great audiences in rebuttal, but it was apparent in public discussion that many elements in the population were pledged to U.S. "isolation" from Europe.

The president's tour was abruptly ended when he collapsed, in Colorado, and a paralytic stroke in October removed him for months from active participation in work of the government.

On March 4, 1921, Wilson accompanied President-elect Warren G. Harding to the capitol as the last act of his official life. Wilson had been president for eight years, during six of which he was the undisputed leader of his party. He was responsible for important revenue, banking and labour laws. He had a great hold on millions of citizens. For a time in Paris he was the foremost man in the world, and he succeeded in inducing foreign statesmen to accept the League of Nations At the height of his career he lost the prestige gained as war president of the whole country, was no longer fully accepted by his party and ceased to be the one man who could appeal from congress to the people. He lived in Washington in retirement, physically unable to take part in public affairs, and died Feb. 3, 1924.

Presidential Election of 1920.—The peace revealed underlying elements of dissatisfaction The soldiers received in many states a money bonus and an organized lobby demanded a bonus from congress The general public complained bitterly against the rising cost of living A multitude saw their incomes and expectations reduced by the fall in the purchasing power of the dollar As the presidential election opened, the Democratic party was paralyzed by internal dissensions over the peace treaty and by lack of leadership of the president; it had no accepted policy in foreign relations or reconstruction and no commanding figure to put forward for the presidency.

The Republicans were rent by personal rivalries. Gen. Leonard Wood, Gov. Frank Lowden of Illinois and Sen. Hiram Johnson of California were outstanding candidates. The convention at Chicago (June 9, 1920) passed them all by, and gave the nomination to Sen. Warren G. Harding of Ohio. He was backed by a strong group of standpatters. Calvin Coolidge, governor of Massachusetts, was put on the ticket as vice-president The Democratic convention held at San Francisco was confronted with similar difficulties The nomination went to Gov. James Cox of Ohio, a man little known in national affairs, with Franklin D. Roosevelt

of New York, who had served as assistant secretary of the navy, as candidate for the vice-presidency In the campaign for the first time women were eligible to vote in every state. The election was a complete triumph for the Republicans, who elected Harding by a popular majority of about 7,000,000, and an electoral majority of 404 against 127 for Cox, besides securing solid majorities in both houses of congress.

The presidency was thus transferred to a man little experienced in national politics, whose task it was to take over the discordant elements and build out of them a coherent policy. President Harding began his administration under favourable auspices, although several members of his cabinet had been chosen in the face of strong opposition from various quarters. The new president displayed keen interest in all attempts to restore business to a sound basis and urged prompt action in the assistance of the railways. By nature conservative, he laboured to bring the country back to a state of "normalcy."

Harding's foreign policy was to remain outside the League of Nations. Special treaties of peace negotiated with Germany, Austria and Hungary were ratified by the U.S senate Oct 18, 1921. Of world-wide importance was his call for a conference at Washington of the different powers bordering on and interested in the Pacific ocean, to discuss both questions of the Pacific and the limitation of armaments. The conference assembled Nov. 12, 1921, and closed Feb. 6, 1922. The nine participants were the United States, Great Britain, France, Italy, The Netherlands, Belgium, Portugal, China and Japan Important agreements were signed; to limit construction of capital warships, against improper use of submarines; against gas warfare; for maintenance of the status of Pacific insular possessions; and other questions involving relations with Japan and China (*see* WASHINGTON CONFERENCE).

Before Harding came to the presidency, two constitutional amendments had crystallized some of the results of the war. The various prohibition measures passed by the congress led finally to passage and ratification of the 18th amendment The service of women in the war, together with the votes they already enjoyed, caused congress (June 7, 1919) to submit the 19th constitutional amendment annulling all restrictions of sex on suffrage. It received the ratification of the 36th state on Aug. 24, 1920, and went into force Aug. 26.

Political and Social Conditions, 1921–26.—A study of the political, social and economic history of the United States must take account of the extraordinary national elation following World War I. It produced a profound effect upon the national mind and was the beginning of an enlargement of national life in every direction. The nation felt free to expand its influence in the Caribbean and the Pacific. Hence the maintenance and enlargement of a policy of paramount interest in the three normally independent countries—Cuba, Haiti and the Dominican Republic, and a strengthening of the control over Panamá, Honduras and Nicaragua.

To carry out great national policies, the United States could call upon a population expanding from year to year. The total continental population rose from 92,000,000 in 1910 to 106,000,000 in 1920. Net immigration of 818,000 in 1910 sank to 19,000 in 1918, but rose in 1924 to 663,000. The wealth of the country, estimated at $187,000,000,000 in 1912 was counted at $321,000,000,000 in 1922, and was still swelling in volume Against these figures, such burdens as a national debt of $25,000,000,000, bearing $1,000,000,000 of annual interest, besides $6,000,000,000 of state and municipal debts were insignificant. Manufacturing, transportation, mining, distribution and financial business were all prosperous.

Political rancour and party spirit diminished during these years. President Harding drew several strong men into his cabinet in March 1921. Secretary of State Hughes had been a justice of the U.S. supreme court and candidate for the presidency in 1916 Secretary of the Treasury Andrew Mellon was a successful banker and financier who had never before appeared in public life. Herbert Hoover, secretary of commerce, contributed his extraordinary gift of business organization Henry C. Wallace, secretary of agriculture, was the editor of a great agricultural newspaper. President Harding's career was cut short by a very brief illness, however, and he died in San Francisco, Aug 2, 1923.

President Coolidge, now elevated from the vice-presidency, set up a new regime in the White House He proved to be a man of strong character, who consulted those whom he trusted and then made up his own mind and stood by his decisions Coolidge for the time being continued Harding's cabinet, but later changes were made, so that at the end of five years Secretary of the Treasury Mellon, Secretary of Commerce Hoover and Secretary of Labour James Davis were the only men left of Harding's first cabinet.

The growth in wealth and enterprise reacted upon the government where even the president's cabinet was disturbed and dismembered by a painful series of accusations and investigations For several years the government had conserved certain oil-bearing areas of public land as a supply of oil fuel for the navy. On April 7, 1922, jurisdiction over this matter was transferred from the navy department to the interior department by an order of President Harding Under this authority Secretary of the Interior Albert B. Fall leased to the Sinclair interest a large tract in the Teapot Dome district in Wyoming and also leased one of the California reserves to the oil magnate, Edward L. Doheny There was an investigation by a senate committee under the chairmanship of Sen. Thomas J. Walsh of Montana Secretary of the Navy E. Denby resigned and was replaced by Judge Curtis D Wilbur of California. Meanwhile Att. Gen Harry M. Daugherty came under attack. A special committee of the senate under Sen. B. K Wheeler of Montana unearthed questionable procedures and Daugherty refused to allow the files of his office to be examined by the senate committee President Coolidge demanded his resignation March 28, 1924. Criminal proceedings were instituted against Fall, Doheny and Daugherty, but legal technicalities were invoked by the defense and President Coolidge took a neutral attitude in these proceedings, which he considered to be outside the scope of the executive power. Daugherty was succeeded as attorney general by Harlan F. Stone of New York; then Stone was placed on the supreme court bench and John G. Sargent of Vermont became attorney general.

In the congressional elections of 1922 the Republicans had retained small working majorities in both house and senate There was, however, a return of earlier conditions in the appearance of a small group of independent Republicans, with Robert La Follette of Wisconsin as leader, who were able sometimes to hold the balance of power between the regular Republicans and Democrats President Coolidge's conduct during his eight months in office seemed to justify the confidence of his party; and when the Republican convention met in Cleveland there was little opposition to his nomination. The vice-presidency offered difficulties In the end the choice fell upon Charles G. Dawes, known through his association with the commission of 1923 which had devised a scheme for the payment of reparations by Germany The Democratic convention, held in New York city, was the longest and fiercest in 60 years. The vote was divided between William G. McAdoo, former secretary of the treasury, and Alfred E. Smith, who had won a national reputation as governor of New York.

The convention balloted 103 times; but neither candidate could secure the necessary two-thirds. The convention finally nominated John W. Davis of West Virginia, former ambassador to Great Britain, with Charles Bryan (brother of William J. Bryan) as vice-presidential candidate. The campaign was quiet; in the election (Nov. 1924) Coolidge received 15,725,016 votes, as against 8,386,503 for Davis and 4,822,856 for La Follette, who gathered up many discontented Republicans and the considerable vote usually cast for Socialist and other minor candidates. La Follette, however, had only the 13 electoral votes of his own state as against 136 for Davis and 382 for Coolidge. It was a substantial Republican victory, accompanied by a Republican majority over-all of 59 in the house and 16 in the senate. Vice-President Dawes on taking his seat in the senate for the first time (March 4, 1925) seized the occasion to suggest that the procedure of that body needed reform; and that its first duty was to pass

an efficient rule of closure.

Finance.—Throughout both his terms of presidential service Coolidge addressed himself to a policy of economy. He stood by the budget bill which President Harding had secured from an unwilling congress and continued the appointment of Gen. Herbert M. Lord as chief budget officer. This reform meant simply that congress would not begin to act on the main appropriation bills until a budget based upon the ascertained needs of all the various departments had been drawn up, totalled and submitted by the budget officials.

In 1913 the United States had adopted an income tax, made possible by the 16th amendment to the constitution. During World War I the tax was used to transfer some of the immense war profits to the public treasury. Thenceforward the income tax was the largest factor in the national revenue and was vigorously collected from individuals and corporations. The policy of the government was to break down the high scale of war expenditure, to dispense with superfluous employees and so to come back to the public needs in time of peace. Several acts of congress, begun in 1921, reduced the rate of income tax The result was that the amount paid in income taxes, which was $2,600,763,000 in 1919 and $3,056,936,000 in 1920, came down to $1,691,000,000 in 1923 but rose to $1,761,659,049 in 1925 By the act of Feb. 26, 1926, the rates were still further lowered but without any decrease in the total collected; and the provision in the statute of 1924, under which the amounts paid by individuals or corporations were open to the public, was repealed.

The Underwood tariff of 1913, passed by the Democrats and somewhat altered in 1916 and 1921, was repealed by a Republican majority after the inauguration of President Harding; and an emergency act was passed (May 27, 1921). Soon afterward the Republicans framed a new bill, the Fordney-McCumber tariff, signed by President Harding Sept. 21, 1922. It included a provision, never before a part of a United States statute, under which the President (informed by a tariff commission) was to have power to alter rates of duty if necessary to "equalize the differences in cost of production in the United States over similar articles produced elsewhere." The receipts from duties on imports, which were $334,000,000 in 1910 and $324,000,000 in 1920, rose to $549,000,000 in 1925. The public debt, which for many years previous to 1917 stood at about $1,000,000,000, was $26,594,268,000 after the close of World War I (Aug 31, 1919); but on June 30, 1926, had been reduced to $19,643,183,000, partly by selling surplus war material and chiefly by payments made out of surplus.

Industry and Commerce.—However much the wealth of the nation increased, large areas of the country were far from prosperous. The rural credits banks, established under President Wilson, furnished needed capital, and the farmers from 1917 to 1919 had a guaranteed government price of $2.20 per bushel for wheat. When that protection was taken off after the war, a group of members of congress in both house and senate, commonly called the agriculturist bloc, demanded special consideration for the agriculturists. Prices had tumbled and agricultural land values, inflated during the war, fell back to or below ante bellum prices. The cost of living had nearly doubled. Discontent was reflected in the large popular vote for La Follette in 1924 Various propositions were made by farmers' associations and sympathetic members of congress that the federal government permanently guarantee a price for the principal staples. The south was also affected by this movement because the inroads of the boll weevil for a time greatly reduced the output. In some degree the conditions of 1885–95 were reproduced; only it was no longer east against west so much as it was the farmers of all sections against the group of manufacturers and distributors wherever established.

In spite of federal suits and supreme court decisions substantially upholding federal control under the Sherman act, the Mann-Elkins act and other measures against combinations, consolidations of capital went on steadily. The railways, which had been sustained during World War I by the government, were returned to their owners in 1920. For several years, notwithstanding a great increase in passenger and freight rates during the war, they were unable to make a fair profit Under the Esch-Cummins act of 1920 they were allowed to retain a profit of 5½% earnings, plus one-half of 1% to make provision for improvements chargeable to capital accounts, all excess over 6% to be evenly divided with the government. Meanwhile the administrative commissions lost prestige. The Tariff commission was disregarded. The Labor board was unable to enforce its decisions. The Interstate Commerce commission and the Federal Trade commission suffered in prestige and influence from internal strains and quarrels The special Shipping commission, created during the war to build up a national merchant fleet, was left with a large number of vessels for which profitable business could not be found. The supreme court decisions, under which great corporations like the Standard Oil company and the American Tobacco company were regulated, left them more prosperous than ever. The hold of the great banks and the smaller banks and bankers on the finances of the country was unshaken Deposits in national and state-chartered banking institutions in 1925 aggregated more than $40,000,000,000.

Social Questions.—During World War I the United States offered extraordinary wages in order to activate the pursuits necessary to supply the armed forces This led to a general rise in wages of skilled workers, some increase for the unskilled and considerable increase in the earnings of domestic and agricultural workers The labour unions made it their business to see that no systematic reduction of wages should succeed. In 1923 and again in 1925 came serious strikes of the miners' unions. The last one endured 170 days, and was settled only with great difficulty

The most serious social question and most difficult governmental problem was national prohibition (*see* PROHIBITION) In 1918, while 30 states had laws on their statute books for the restriction of the liquor traffic, 28 states prohibited it outright. A prohibition (18th) amendment to the federal constitution was passed by the congress, was ratified by a vote of 46 state legislatures and became a part of the constitution Jan. 16, 1919 On Oct 28, 1919, the Volstead act for enforcing the amendment was passed by congress over the veto of President Wilson. It forbade the sale or transportation of "intoxicating liquor" which was defined as any liquor which contained one-half of 1% of alcohol. To administer this act required a large force of officials distributed over the country. The amendment contained a clause under which the states were to have "concurrent jurisdiction," which appeared to mean that state laws might continue in force and be carried out by state courts. From the very beginning there was an organized system of evasion of the laws. A regular system of "bootlegging," illegal sale and transportation sprang up It was countered by "highjackers"—that is, bandits who seized bootleggers' supplies and carried them off by force, knowing that they were not likely to be followed by officers of the law. An organized marine bootlegging trade placed a line of foreign sailing craft and steamers just outside the three-mile limit of the United States, whence they supplied the markets of the adjoining coasts

The United States entered into treaties with Great Britain and other nations in which it was agreed that vessels carrying their flags might be captured within that distance from the United States coast which could be traversed in one hour by the vessel suspected of endeavouring to commit an offense. Within the United States large numbers of otherwise law-abiding persons bought and sold or gave away bootleg liquor, and the difficulties of executing the law were shown by the figures of national enforcement In one fiscal year (1924–25) 20,000,000 gal. of distilled and fermented liquors were seized; 77,000 persons were arrested; 50,000 criminal cases were entered against bootleggers; 35,000 pleas of guilty were entered; and 38,000 convictions were obtained. A national law regulating the traffic in habit-forming drugs was enacted May 26, 1922.

National Defense.—The armies were returned and disbanded after World War I as quickly as possible; but a demand was made at once for some immediate acknowledgment of their services The government had attempted to head off this movement by an elaborate system of life insurance. It also instituted a large rehabilitation system for training disabled veterans in pursuits in which they could earn their own living. The government provided

hospitals and care for sick and disabled soldiers. Provision was made for special privileges to former soldiers. On Sept. 20, 1922, a national bonus bill was defeated by President Harding's veto On March 18, 1924, a bonus bill was passed by a large majority vote in congress, it was vetoed by President Coolidge but passed over his veto, May 17–19.

Notwithstanding the experience of the United States in 1917, when it declared a war without any mobile army, strong pressure was put on congress to reduce the regular army. By an act of Feb. 12, 1925, the force of the regular army was set at 125,000 enlisted men and 7,863 enlisted men of the Philippine scouts Many veterans joined the American Legion, the most widely distributed society of servicemen; and that body had considerable influence in the legislation for former soldiers.

International Relations.—President Coolidge, accepting the resignation of Charles E. Hughes from the department of state, appointed as his successor (Feb. 1925) Frank B. Kellogg, previously a senator and ambassador to Great Britain To the powerful chairmanship of the committee on foreign relations, after the death of Henry Cabot Lodge of Massachusetts, succeeded William E. Borah of Idaho (Dec. 1924). A great improvement in the conduct of foreign relations was introduced by the Rogers act, which took effect July 1, 1924, and under which the consular and diplomatic services were merged and the policy of training young men with the prospect of lifelong service was adopted.

The general policy of the United States toward other nations was much affected first of all by changes in international trade caused by the disruption of World War I; then by the refusal of the senate in 1919 to approve the Versailles treaty and further by a strong popular opposition to any formal relation with the League of Nations. A treaty with Germany (July 2, 1921) formally restored peace, provided for commerce and arranged for an adjustment of claims. Similar treaties were made shortly afterward with Austria and Hungary. The Lausanne treaty with Turkey, signed on July 24, 1923, was defeated in the senate on Jan. 18, 1927.

An important question of the early 1920s, partly social and partly international, was that of immigration, which went through a new phase because of the rush of people from other parts of the world as soon as the war was ended. Complaint was made that in the previous two decades the greater number of immigrants came from southern and eastern Europe, and were not by tradition and inheritance of the same type as most of the previous immigrants. Several changes were made in 1918 to reduce the number of "undesirables," yet the year 1920–21 brought 800,000 immigrants. By an emergency act of 1921 a quota was provided, assigning to each nation 3% of the nationals in the United States according to the census of 1910. By the act of 1924, a permanent quota system was enacted, based on 2% of the number of nationals of that country shown to be in the United States by the census of 1890. After July 1, 1927, the limit was placed at 150,000 annually.

Among the incidents of foreign relations after World War I was the recognition of various new countries created by the treaty of Versailles· Poland, Latvia, Lithuania, Estonia, Finland, Czechoslovakia, Yugoslavia, Hungary and the enlarged Rumania In 1924 the United States received a minister from the Irish Free State. The British government consented to the appointment of a Canadian representative at Washington.

The last U.S. troops were withdrawn from Germany in 1923. Meanwhile a joint commission on German claims was far advanced in its task. A troublesome difficulty was that a treaty with Prussia, entered into in 1828 and assumed in 1871 by the German empire, entitled German citizens in case of war to nine months to dispose of their property in the United States and leave the country. Instead, all discernible property of Germans, and particularly of German corporations, was seized at the beginning of the war and placed in the hands of a custodian of enemy property. Valuable German patents were turned over, for a very small payment, to U.S. manufacturing chemists. It was not until March 10, 1928, that President Coolidge signed a bill appropriating $50,000,000 to cover the value of the property seized.

Reparations and Allied Debts.—The United States was no party to the provisions of the Versailles treaty providing for German reparations, particularly to France, and the payment of an indemnity by Germany. However, the costs of the U.S. force of occupation were to be paid by Germany In 1921, when Germany did not pay the stipulated sums to the Allies, the French occupied the Ruhr valley The United States suggested a commission which, headed by Charles G Dawes, succeeded in working out a plan (1924) that was acceptable to France, Great Britain and Belgium, for a method of payment secured by a lien on German railways and factories. Financially the importance of the Dawes plan to the United States was that it cleared the way for considerable investments of private capital in German municipal and corporate securities.

A serious and difficult issue was that of the sums lent by the United States to other governments during World War I, aggregating $9,500,000,000. Without those large advances the Allies would have broken down economically before a U.S army could have been placed in Europe Nearly all the allied European countries shared in these advances At the end of 1922 the total principal was about $10,000,000,000 and the accumulated interest $1,500,000,000 more. This sum was funded in United States government bonds placed at about 4% interest, mostly in U.S hands, upon the same footing as other obligations of the government The interest was paid by the United States treasury. In 1923 the first important adjustment of the debt was made by an agreement with England (Feb 28, 1923). The whole amount of the principal and interest then due was funded at $4,600,000,000 to be paid in annual instalments beginning with $23,000,000 a year and increasing, until in the 62nd year the debt and accruing interest would be extinguished.

In April 1926, following an unsuccessful visit of a French debt commission to the United States in Sept. 1925, the Bérenger-Mellon settlement was finally arrived at with France

The total amount of the French indebtedness to be refunded, after a cash payment to adjust the sum to round figures, was declared to be $4,025,000,000, and the repayment of this amount with interest was to be spread over 62 years as in the other war debt settlements The total sum to be received by the United States under this agreement amounted to $6,847,674,104, an increase of approximately $627,000,000 over the previous French offer made by M Caillaux in 1925.

Comparing the French settlement with those of Great Britain and Italy, the figures worked out as follows: Great Britain's debt after discounting represented slightly more than 80% of its total obligation, France's approximately 50% and that of Italy 26%. The house of representatives voted approval June 2, but ratification by the senate was deferred pending the action of the French legislature The various agreements made to the end of April 1926 left only $295,000,000 of unfunded World War I debts to the United States, including $193,000,000 owed by Russia In nearly all cases the period of payment was so long and the interest so low that the settlements involved payment at the value of from one-quarter to more than three-quarters of the original advances by the United States.

Latin America.—With Latin America the United States in the main enjoyed peaceful relations during this period. The long-standing question of the Isle of Pines was adjusted by a treaty (March 13, 1925), under which the title of Cuba was acknowledged. At the request of Chile and Peru, President Harding agreed in 1922 to arbitrate the dispute over the ownership of the Tacna-Arica region. After Harding's death President Coolidge took up the task and rendered his decision (March 4, 1925) to the effect that the delayed plebiscite of the inhabitants should now be taken; and General Pershing was made the head of a commission to preside over this process. Chile objected, and nothing was done.

With Mexico relations became strained by a dispute over the application of the new Mexican constitution of 1917 under which aliens were forbidden to hold lands or concessions. Mexicans claimed that this was in accord with the practice of several states in the United States. In 1925 Secretary of State Kellogg pro-

U S. Party Affiliations—Congressional and Presidential

(Ad—administration; AM—Anti-Masonic; C—coalition, D—Democratic; DR—Democratic-Republican; Fed—Federalist; J—Jackson-lan, NR—National Republican, Op—opposition, R—Republican; U—Unionist; W—Whig)

Congress	Term	Speaker	House*			Senate*			President	
			Major party	Principal minority party	Other (exc vac)	Major party	Principal minority party	Other (exc vac)		
1st	1789–91	F A Muhlenburg	Ad-38	Op-26		Ad-17	Op-9		Fed—George Washington	
2nd	1791–93	Jonathan Trumbull	Fed-37	DR-33		Fed-16	DR-13		Fed—George Washington	
3rd	1793–95	F. A. Muhlenburg	DR-57	Fed-48		Fed-17	DR-13		Fed—George Washington	
4th	1795–97	Jonathan Dayton	Fed 54	DR-52		Fed-19	DR-13		Fed—George Washington	
5th	1797–99	Jonathan Dayton	Fed-58	DR-48		Fed-20	DR-12		Fed—John Adams	
6th	1799–1801	Theodore Sedwick	Fed-64	DR-42		Fed-19	DR-13		Fed—John Adams	
7th	1801–03	Nathaniel Macon	DR-69	Fed-36		DR-18	Fed-14		DR—Thomas Jefferson	
8th	1803–05	Nathaniel Macon	DR-102	Fed-39		DR-25	Fed-9		DR—Thomas Jefferson	
9th	1805–07	Nathaniel Macon	DR-116	Fed-25		DR-27	Fed-7		DR—Thomas Jefferson	
10th	1807–09	Joseph B Varnum	DR-118	Fed-24		DR-28	Fed-6		DR—Thomas Jefferson	
11th	1809–11	Joseph B Varnum	DR-94	Fed-48		DR-28	Fed-6		DR—James Madison	
12th	1811–13	Henry Clay	DR-108	Fed-36		DR-30	Fed-6		DR—James Madison	
13th	1813–15	H Clay and Langdon Cheves	DR-112	Fed-68		DR-27	Fed-9		DR—James Madison	
14th	1815–17	Henry Clay	DR-117	Fed-65		DR-25	Fed-11		DR—James Madison	
15th	1817–19	Henry Clay	DR-141	Fed-42		DR-34	Fed-10		DR—James Monroe	
16th	1819–21	H Clay and John W. Taylor	DR-156	Fed-27		DR-35	Fed-7		DR—James Monroe	
17th	1821–23	Philip P. Barbour	DR-158	Fed-25		DR-44	Fed-4		DR—James Monroe	
18th	1823–25	Henry Clay	DR-187	Fed-26		DR-44	Fed-4		DR—James Monroe	
19th	1825–27	John W Taylor	Ad-105	J-97		Ad-26	J-20		C—John Quincy Adams	
20th	1827–29	Andrew Stephenson	J-119	Ad-94		J-28	Ad-20		C—John Quincy Adams	
21st	1829–31	Andrew Stephenson	D-139	NR-74		D-26	NR-22		D—Andrew Jackson	
22nd	1831–33	Andrew Stephenson	D-141	NR-58	14	D-25	NR-21	2	D—Andrew Jackson	
23rd	1833–35	A Stephenson and John Bell	D-147	AM-53	60	D-20	NR-20	8	D—Andrew Jackson	
24th	1835–37	James K. Polk	D-143	W-98		D-27	W-25		D—Andrew Jackson	
25th	1837–39	James K Polk	D-108	W-107	24	D-30	W-18	4	D—Martin Van Buren	
26th	1839–41	R. M. T Hunter	D-124	W-118		D-28	W-22		D—Martin Van Buren	
27th	1841–43	John White	W-133	D-103	6	W-28	D-22	2	W—William H Harrison	
									W—John Tyler	
28th	1843–45	John W Jones	D-142	W-79	1	W-28	D-25	1	W—John Tyler	
29th	1845–47	John W Davis	D-143	W-77	6	D-31	W-25		D—James K. Polk	
30th	1847–49	Robert C. Winthrop	W-115	D-108	4	D-36	W-21	1	D—James K. Polk	
31st	1849–51	Howell Cobb	D-112	W-109	9	D-35	W-25	2	W—Zachary Taylor	
									W—Millard Fillmore	
32nd	1851–53	Lynn Boyd	D-140	W-88	5	D-35	W-24	3	W—Millard Fillmore	
33rd	1853–55	Lynn Boyd	D-159	W-71	4	D-38	W-22	2	D—Franklin Pierce	
34th	1855–57	Nathaniel P Banks	R-108	D-83	43	D-40	R-15	5	D—Franklin Pierce	
35th	1857–59	James L. Orr	D-118	R-92	26	D-36	R-20	6	D—James Buchanan	
36th	1859–61	William Pennington	R-114	D-92	31	D-36	R-26	4	D—James Buchanan	
37th	1861–63	Galusha A. Grow	R-105	D-43	30	R-31	D-10	8	R—Abraham Lincoln	
38th	1863–65	Schuyler Colfax	R-102	D-75	9	R-36	D-9	5	R—Abraham Lincoln	
39th	1865–67	Schuyler Colfax	U-149	D-42		U-42	D-10		R—Andrew Johnson	
40th	1867–69	Schuyler Colfax	R-143	D-49		R-42	D-11		R—Andrew Johnson	
41st	1869–71	James G Blaine	R-149	D-63		R-56	D-11		R—U S. Grant	
42nd	1871–73	James G Blaine	R-134	D-104	5	R-52	D-17	5	R—U S. Grant	
43rd	1873–75	James G. Blaine	R-194	D-92	14	R-49	D-19	5	R—U S. Grant	
44th	1875–77	Michael C. Kerr and Samuel J. Randall	D-169	R-109	14	R-45	D-29	2	R—U S. Grant	
45th	1877–79	Samuel J. Randall	D-153	R-140		R-39	D-36	1	R—Rutherford B. Hayes	
46th	1879–81	Samuel J. Randall	D-149	R-130	14	D-42	R-33	1	R—Rutherford B. Hayes	
47th	1881–83	Joseph W Keifer	R-147	D-135	11	R-37	D-37	1	R—James A Garfield	
									R—Chester A. Arthur	
48th	1883–85	John G Carlisle	D-197	R-118	10	R-38	D-36	2	R—Chester A. Arthur	
49th	1885–87	John G Carlisle	D-183	R-140	2	R-43	D-34		D—Grover Cleveland	
50th	1887–89	John G Carlisle	D-169	R-152	4	R-39	D-37		R—Grover Cleveland	
51st	1889–91	Thomas B Reed	R-166	D-159		R-39	D-37		R—Benjamin Harrison	
52nd	1891–93	Charles F Crisp	D-235	R-88	9	R-47	D-39	2	R—Benjamin Harrison	
53rd	1893–95	Charles F. Crisp	D-218	R-127	11	D-44	R-38	3	R—Grover Cleveland	
54th	1895–97	Thomas B Reed	R-244	D-105	7	R-43	D-39	5	D—Grover Cleveland	
55th	1897–99	Thomas B Reed	R-204	D-113	40	R-47	D-34	7	R—William McKinley	
56th	1899–1901	David B Henderson	R-185	D-163	9	R-53	D-26	8	R—William McKinley	
57th	1901–03	David B Henderson	R-197	D-151	9	R-55	D-31	4	R—William McKinley	
									R—Theodore Roosevelt	
58th	1903–05	Joseph G Cannon	R-208	D-178		R-57	D-33		R—Theodore Roosevelt	
59th	1905–07	Joseph G. Cannon	R-250	D-136		R-57	D-33		R—Theodore Roosevelt	
60th	1907–09	Joseph G. Cannon	R-222	D-164		R-61	D-31		R—Theodore Roosevelt	
61st	1909–11	Joseph G Cannon	R-219	D-172		R-61	D-32		R—William H. Taft	
62nd	1911–13	Champ Clark	D-228	R-161	1	R-51	D-41		R—William H Taft	
63rd	1913–15	Champ Clark	D-291	R-127	17	D-51	R-44	1	D—Woodrow Wilson	
64th	1915–17	Champ Clark	D-230	R-196	9	D-56	R-40		D—Woodrow Wilson	
65th	1917–19	Champ Clark	D-216	R-210	9	D-53	R-42		D—Woodrow Wilson	
66th	1919–21	Frederick H Gillett	D-190	R-240	3	R-49	D-47		D—Woodrow Wilson	
67th	1921–23	Frederick H. Gillett	D-303	R-131	1	R-59	D-37		R—Warren G Harding	
68th	1923–25	Frederick H. Gillett	R-225	D-205	5	R-51	D-43	2	R—Warren G Harding	
									R—Calvin Coolidge	
69th	1925–27	Nicholas Longworth	R-247	D-183	4	R-56	D-39	1	R—Calvin Coolidge	
70th	1927–29	Nicholas Longworth	R-237	D-195	3	R-49	D-46	1	R—Calvin Coolidge	
71st	1929–31	Nicholas Longworth	R-267	D-167	1	R-56	D-39	1	R—Herbert Hoover	
72nd	1931–33	John N. Garner	R-220	R-214	1	R-48	D-47	1	R—Herbert Hoover	
73rd	1933–35	Henry T Rainey and Joseph W. Byrns	D-310	R-117	5	D-60	R-35	1	D—F. D Roosevelt	
74th	1935–37	J W. Byrns and William B Bankhead	D-319	R-103	10	D-69	R-25	2	D—F D Roosevelt	
75th	1937–39	William B Bankhead	D-331	R-89	13	D-76	R-16	4	D—F D. Roosevelt	
76th	1939–41	W B Bankhead and Sam Rayburn	D-261	R-164	4	D-69	R-23	4	D—F. D Roosevelt	
77th	1941–43	Sam Rayburn	D-268	R-162	5	D-66	R-28	2	D—F D Roosevelt	
78th	1943–45	Sam Rayburn	D-218	R-208	6	D-58	R-37	1	D—F D Roosevelt	
79th	1945–47	Sam Rayburn	D-242	R-190	2	D-56	R-38	1	D—F. D Roosevelt	
									D—Harry S Truman	
80th	1947–49	Joseph W Martin, Jr.	R-246	D-188	1	R-51	D-45		D—Harry S Truman	
81st	1949–51	Sam Rayburn	D-263	R-171	1	D-54	R-42		D—Harry S Truman	
82nd	1951–53	Sam Rayburn	D-234	R-199	2	D-48	R-47	1	D—Harry S. Truman	
83rd	1953–55	Joseph W. Martin, Jr.	R-221	D-213	1	R-48	D-47	1	R—Dwight D. Eisenhower	

*Composition at opening of first session, except for 83rd congress (date as of Nov. 1952).

tested against the attitude of Mexico as unfriendly and declared that the government of Mexico was on trial before the world. In March 1926 a financial understanding was reached

The League of Nations.—After the refusal of the United States to ratify the treaty of Versailles or to take part in the League of Nations, no official relations with the League were established However, large numbers of U.S citizens were interested in the work of the League and some of them were appointed to advisory committees in which, however, they did not represent the U S. government. Eventually the United States consented to appoint official delegates or "observers" to the League commission on opium traffic. The United States became a party to treaties, with regard to the white-slave trade, drawn up by the League but to take effect for only such countries as might ratify them. Gradually even the warm friends of the League accepted the view that it was useless for the time being to urge participation by the United States in the League

The World Court.—Down to 1914 the International Court of The Hague, founded in 1899 and strengthened in 1907, was functioning and rendered occasional decisions. It was, however, entirely ignored by the contending parties in the six wars that broke out from 1900 to 1914 and after World War I it remained ineffective. Elihu Root, who had a share in framing the court, came forward in 1920 as the leader of an unofficial group of experts in international affairs, to propose a new world court with wide powers and jurisdiction An advisory committee of jurists sat at The Hague and drew up a plan for the Permanent Court of International Justice. The League of Nations accepted the project and established the court (Dec 1920) and chose the judges (Sept 1921). (*See* PERMANENT COURT OF INTERNATIONAL JUSTICE) The United States had no official relation with the court, but the force of U S. public sentiment for a world league concentrated on a proposition for qualified entrance of the United States into the World Court.

This was warmly urged by President Harding and later by Presidents Coolidge, Hoover and F. D Roosevelt. Strong opposition was made in the United States on the plea that the court was an entering wedge to the League of Nations. The whole discussion was presently merged in consideration of proposals for the outlawry of war (A B H ; E. E. R.)

FROM 1926 TO WORLD WAR II

President Coolidge and Congress.—In the mid-term congressional elections of 1926 the Democrats captured 7 of the contested seats in the senate, wiping out the Republican majority in the 69th congress, and gained 13 seats in the house, making the complexion of the 70th congress (1927–29) 237 Republicans, 195 Democrats, 3 Independents in the house, and 48 Republicans, 47 Democrats, 1 Farmer-Labourite in the senate. The election foreshadowed embarrassment for the administration Elimination of the Republican margin in the senate made it necessary for that body to conciliate the insurgent members who had supported La Follette in 1924 and had been punished therefor by being dropped from important committee assignments in the 69th congress The Republican progressives, like Robert La Follette (the younger), John Blaine, Lynn Frazier and Gerald P. Nye, were now restored to regular standing, and exacted from the floor leader, Charles Curtis, as the price of their support of the party the promise that "certain legislation of paramount interest to the people" (farm relief, investigation of U S policy in Latin America, a bill to regulate the issuance of injunctions) should be brought to a vote during the first session of the 70th congress On these questions, as on several others of major importance, such as the details of tax reduction, the disposition of Muscle Shoals, the naval program, Mississippi flood control, the method of prohibition enforcement, President Coolidge found himself at odds with congress. He did not, however, attempt to drive congress, as Theodore Roosevelt and Wilson had done. With characteristic patience he held to his policies, vetoing 16 bills and resolutions in the first session of the 70th congress (Dec. 5, 1927–May 29, 1929), and insisting in his messages and speeches on obedience to law and on rigid economy.

National Finances.—The era of prosperity which set in at about the time of Coolidge's accession to the presidency continued unabated during his entire administration Except in a few "spots," such as the bituminous coal and textile industries, production mounted steadily, consumption kept pace and labour was well employed and content. The national wealth, which had stood at about $7,000,000,000 in 1850, $25,000,000,000 in 1870, $65,000,000,000 in 1890 and $350,000,000,000 in 1920, was approaching the $450,000,000,000 mark by 1929. The annual income had reached $90,000,000,000 and annual savings were more than $17,000,000,000. The United States was investing about $2,000,000,000 of surplus wealth abroad and diminishing the national debt by nearly $1,000,000,000 each year The abundant receipts of the treasury (more than half from income taxes), combined with the careful co-operation of the committees of the administrative departments under President Coolidge and Director of the Budget Herbert M Lord, resulted in substantial surpluses at the end of every fiscal year. On Feb 26, 1926, the president signed a bill for a tax reduction of $388,000,000

In spite of the cut in taxes the surplus continued to mount, and on May 29, 1928, the president signed the third tax reduction bill of his administration (relieving corporations and certain industries but leaving the personal schedules unchanged), involving a cut of about $220,000,000. The refunding of the Second and Third Liberty Loans in 1928 effected a saving to the government of $75,000,000 a year in interest charges. As President Coolidge's term drew toward a close, however, the prospect for further tax reduction vanished, and there was even some apprehension that the treasury might be confronted for the first time in the administration with a deficit instead of a surplus This was caused by certain extraordinary demands on the government, such as the appropriation of $75,000,000 for the refund of taxes illegally collected, of $50,000,000 for the settlement of claims arising out of taking over alien property during World War I, of nearly $50,000,000 for a public buildings program and of about $20,000,000 for initiating work on the vast $315,000,000 program for federal engineering work on the lower Mississippi river.

National Defense.—Since it was still the view that the geographic position of the United States brought immunity from fear of attacks by strong and hostile neighbours, the country followed the traditional policy of a small and well-equipped army supplemented by state militia The regular army of about 132,000 men meant only 1.1 soldiers to every 1,000 of population and every $3,250,000 of national wealth Reduction of land armaments was not a problem in which the United States was directly interested But the government worked diligently for the reduction of naval armaments After the failure of a proposed conference on disarmament, President Coolidge came out more positively for a "policy of adequate defense." A five-year building program had been approved by Secretary of the Navy Curtis D Wilbur in the summer of 1926, calling for 71 new vessels (cruisers, submarines, destroyers and carriers) to cost nearly $800,000,000 Cutting this program to 15 cruisers and 1 aircraft carrier, the house, on March 17, 1928, passed a bill for the construction of the 16 vessels in three years at a cost of $274,000,000. The cruiser bill was put over to the short session of the senate, where it met sharp opposition, especially as it was pending at the same time as the ratification of the Kellogg pact for the renunciation of war as an instrument of national policy. However, the bill was passed on Feb 5, 1929, by a vote of 68 to 12, and was signed by the president. On Feb. 28, 1929, congress agreed to a $12,370,000 addition to the naval appropriation for the new vessels, $200,000 to be available at once for starting the 1929 group of five and $200,000 to be available on July 1, 1929, for the beginning 1930 group. The progress of aviation began to play a great part in the field of national defense

Railroads and Shipping.—During World War I the major agencies of transportation had been taken over by the government. The railroads were restored to their owners on March 1, 1920, by the Esch-Cummins Transportation act. The physical valuation of the railroads by the Interstate Commerce commission, as a basis for rate fixing, which had been authorized in 1913

and interrupted by World War I, was to serve as the basis of the "recapture" clause of the act of 1920, by which one-half of the earnings in excess of 6% should go to the government. This provision promised endless litigation. The validity of the commission's method of valuation was presented to the supreme court of the United States in the case of the St Louis and O'Fallon railroad, called "the greatest lawsuit in history" because of the immense sums involved in the right of the government to recapture excess earnings. This railroad's earnings in excess of 6% of the commission's valuation had been ordered paid to the government. The court, with Justices Oliver W Holmes, Louis Brandeis and Harlan Stone dissenting, rejected the commission's valuation on the ground that no weight had been given to "reproduction" cost. (49 Sup. Ct. Rep. 384.) But, since no criteria were laid down as to how much weight was to be given to this factor, the decision could not be said to be decisive.

At the close of World War I the United States Shipping board had on its hands a large number of merchant ships seized from Germany or constructed by the Emergency Fleet corporation. Many of the smaller cargo ships the board sold as junk, but it maintained the larger vessels in the passenger and freight service. In 1923 five ships of the "President" class were purchased by the Dollar line. By the Jones-White act of May 1928, congress reluctantly appropriated $250,000,000 for the maintenance of the fleet and loans for the construction of new vessels. On Jan 16, 1929, the Shipping board received a bid from the P. W. Chapman company of New York, which was to pay $16,082,000 for the "Leviathan," the "George Washington," the "America," the "Republic," the "President Harding," the "President Roosevelt" and the five ships of the American Merchant line, and promised to build, with the aid of a government loan, two new vessels "superior in type and size to the 'Leviathan.'"

Efforts at Farm Relief.—In the midst of general prosperity the farmers complained that they were poorer. The value of their capital investment had shrunk from $70,000,000,000 to $59,000,000,000 in the five-year period 1922–27, and the return on this capital was less than 3%. While overproduction kept the prices of their products down, state and local taxes and the cost of farm implements and machinery were rising. The farmers asked the government to come to their relief (as it helped the manufacturers by the tariff, and labour by the restriction of immigration) by purchasing their surplus product of wheat, corn, cotton, hogs and tobacco and selling it abroad for what it would bring in the world market, assessing the loss and the cost of the operation on the industries benefited (the "equalization fee"). The McNary-Haugen bills embodying these demands were kept before congress during the last three years of the Coolidge administration. The first bill failed of passage in the late spring of 1926, but in Feb. 1927 a McNary-Haugen bill went through both houses. President Coolidge vetoed it because it put the government into the farming business, though he was willing to help the farmers help themselves by generous contributions to co-operative marketing projects and by aid from the department of agriculture. The veto was accompanied by an opinion from Att. Gen. John Sargent condemning certain features of the bill as unconstitutional. Nothing daunted, the advocates of farm relief came forward with a third McNary-Haugen bill, which passed congress by increased majorities in the spring of 1928, only to meet with a second veto from the president (May 23). The senate failed by the margin of 50 votes to 31 to pass the bill over the veto. On the first day of the short session of the 70th congress (Dec. 4, 1928) the fourth McNary-Haugen bill was introduced, this time without the equalization fee. No action was taken on it during the session, but President Hoover called an extra session of the 71st congress to meet on April 15, 1929, to deal with farm relief and the revision of the tariff. President Coolidge's vetoes of the farm relief bills roused opposition in the west and led to predictions that the farming sections of the country would not support an administration candidate for the presidency in the campaign of 1928. But Hoover carried every one of the agricultural states (*see* below).

Latin-American Relations.—The controversy with Mexico over her legislation to put into effect the provisions of article 27 of the constitution of 1917, regulating alien exploitation of mineral and agricultural lands, was further embittered by the appeal made to the Catholics of that country against Pres. Plutarco Calles' measures against the foreign clergy of the Roman Catholic Church in Mexico, and by the report that the Mexican bolshevists were encouraging the rebels in Nicaragua in their resistance to the U.S. marines. So serious was the situation at the beginning of 1927 that the United States senate by a unanimous vote asked President Coolidge to submit the controversy with Mexico to arbitration. The president ignored the request, but in the autumn he sent Dwight W Morrow, of the firm of J. P. Morgan & Co., as ambassador to Mexico. Morrow's friendly and tactful diplomacy resulted in an early agreement with President Calles, and the amicable relations of the two countries were greatly strengthened when Col Charles A Lindbergh, after a nonstop flight from Washington, arrived at Mexico City (Dec. 14, 1927) as a U.S. "ambassador of good will."

President Coolidge, in spite of criticism in congress and in the liberal press of the country, held to his policy of maintaining about 5,000 marines in Nicaragua to quell the revolt against Adolfo Díaz and to protect U S. lives and property. The forces of Díaz and Juan Sacasa agreed to lay down their arms when Coolidge sent Henry L. Stimson to Nicaragua with an ultimatum in April 1927, but the rebel leader Augusto Sandino continued a guerrilla warfare in which 20 U.S. marines were killed and 50 wounded. When Sandino was overcome, both parties agreed to an election, which was held under the supervision of U S troops (Dec 4, 1928) and resulted in the victory of the Liberal candidate, José Moncada.

The sixth Pan-American congress was opened by President Coolidge in person, at Havana, Cuba, on Jan 16, 1928. Charles E. Hughes headed the U.S. delegation, and steered the conference away from the embarrassing political questions raised by the United States intervention in Nicaragua. A supplementary Pan-American Conference on Arbitration and Concihation met at Washington, D C, on Dec. 10, 1928, which not only negotiated a score of arbitration treaties between the Latin-American nations, but was influential in keeping Bolivia and Paraguay from going to war over disputed territory.

The Briand-Kellogg Peace Pact.—On the tenth anniversary of the entrance of the United States into World War I (April 6, 1927), the French foreign minister, Aristide Briand, proposed that the United States and France should agree to a treaty renouncing war as an instrument of national policy, and agreeing to settle disputes of whatever origin or nature by pacific means. Secretary of State Kellogg replied, suggesting that the treaty be extended to other nations. On Aug. 27, 1928, the representatives of 15 nations met at Paris and signed the Briand-Kellogg pact. Secretary Kellogg represented the United States at Paris. On Jan. 15, 1929, the senate ratified the pact.

The Election of 1928.—President Coolidge having announced that he would not run for the presidency in 1928, the field was left open for Secretary of Commerce Herbert C. Hoover, who was easily nominated, receiving 837 out of the 1,084 votes cast in the first ballot, at the nominating convention at Kansas City, June 12–15, 1928. The delegates to the Democratic nominating convention at Houston, Tex., on June 26–29, cast 849½ votes out of 1,100 for Alfred E. Smith, then serving his fourth term as governor of New York. Sen. Charles Curtis of Kansas and Sen. Joseph T Robinson of Arkansas were named as the respective vice-presidential candidates. Each of the four nominations was made on the first ballot cast. The platform of the Republican party promised farm relief and a careful revision of the tariff, defended the Coolidge policy in Nicaragua and adopted a prohibition plank written by Senator Borah, pledging the administration to a "vigorous enforcement" of the 18th amendment. The Democratic platform contained a scathing denunciation of the "sordid corruption and unabashed rascality" of Republican rule, which had left "agriculture prostrate, industry depressed, and workmen without employment," and pledged action instead of broken promises for the relief of the farmer. Governor Smith telegraphed to Chairman Joseph Robinson of the convention endorsing the platform in general, but adding that it was his duty as the chosen

leader of the party to say that he advocated "fundamental changes in the present provisions for national prohibition." Hoover made only a few campaign speeches. Governor Smith, on the other hand, toured the country and discussed definite policies which he proposed to adopt if he were elected. On election day, Nov. 6, 1928, Hoover carried 40 of the 48 states, including four (Virginia, North Carolina, Florida and Texas) which had been Democratic since the days of reconstruction. The electoral vote was 444 for Hoover to 87 for Smith. But the popular vote of 21,391,381 to 15,016,443 indicated no such crushing defeat for the Democratic candidate. The Socialist candidate, Norman Thomas of New York, polled 267,835 votes; the Communist party candidate, William Z. Foster, 21,181; the Socialist-Labour candidate, V. L. Reynolds, 21,603; and the Prohibitionist candidate, William Varney, 20,106. Hoover's invasion of the "solid south" was attributed by the Democrats to the prejudice in that section against Governor Smith as a "wet" and a Roman Catholic, while the Republicans saw in it the swing of the south toward tariff-protected industry and the recognition of Hoover's wide experience as an executive Soon after the election Hoover sailed from San Diego, Calif , on the battleship "Maryland," for a good-will tour to the countries of Central and South America He visited Honduras, Nicaragua, Costa Rica, Ecuador, Peru, Chile, Argentina, Uruguay and Brazil.

Hoover retained Secretary of the Treasury Mellon and Secretary of Labour Davis of the Coolidge cabinet in office, the former remaining until Feb. 1932 when he was appointed ambassador to Great Britain, and was succeeded in the treasury department by Undersecretary Ogden L. Mills; and the latter resigning the secretaryship of labour in 1930 to run for U.S. senator from Pennsylvania, being replaced in the cabinet by William N. Doak of Virginia. The eight new appointees (none from the states of the south which Hoover had carried) were Col. H. L. Stimson, governor general of the Philippines, for secretary of state; James W. Good of Iowa, secretary of war (succeeded in December by P. J. Hurley of Oklahoma); William De Witt Mitchell of Minnesota (a conservative Democrat), attorney general; Charles Francis Adams of Massachusetts, secretary of the navy; Walter F. Brown of Ohio, postmaster general; Ray L Wilbur of California, secretary of the interior; Arthur M. Hyde of Missouri, secretary of agriculture; and Robert P. Lamont of Illinois, secretary of commerce, succeeded in 1932 by Roy D. Chapin of Michigan.

The Agricultural Marketing Bill.—In accord with the campaign pledge President Hoover called the 71st congress (senate 55 R., 39 D., 1 F. L.; house 269 R , 165 D., 1 F. L.) in special session on April 16, to consider the problems of farm relief and the revision of the tariff. After the senate had tried in vain to insert a debenture clause into it, an agricultural marketing bill was passed by large majorities and signed by the president on June 15. The bill aimed at the encouragement of producer-owned and producer-controlled co-operative associations, which should eliminate wasteful methods of distribution and prevent the accumulation of surpluses which caused "undue and excessive fluctuations or depressions" in the prices of agricultural products. It created a federal farm board of nine members (including the secretary of agriculture), and provided a revolving fund of $500,000,000 from which loans were to be made to the farmers' co-operatives at a rate of interest not to exceed 4%. For a few months the Farm board promised to be a great success. New co-operatives were formed for the marketing of grain, fruit, cotton, vegetables and livestock, and the board approved loans to 132 co-operatives, totalling $165,000,000. But as farm prices continued to sag in the disturbed condition of world markets, it became evident that the farmers could not borrow themselves out of debt. The board then departed from its announced plan of not buying or selling farm products itself. The government entered the market and backed the grain and cotton Stabilization corporations by purchasing 330,000,000 bu. of wheat and more than 1,000,000 bales of cotton, in the endeavour to peg the prices of these commodities by holding the surpluses off the market. The endeavour failed; and at the close of 1931 the books of the board showed a loss of about 50% on the $378,000,000 advanced for the purchases It was evident that the agricultural problem was no nearer solution in 1932 than it had been in 1922 The farmer, because of high taxes, tariff walls and world depression, could not sell his staple crops for what it cost to raise them.

The Hawley-Smoot Tariff.—A "limited revision" of the tariff had been advocated in the Republican party platform and recommended by President Hoover. But the bill passed (264 to 147) by the house on May 28, 1929, bearing the name of W C Hawley of Oregon, chairman of the ways and means committee, increased the duties on more than 1,000 articles, raising the average rates far above those of the Fordney-McCumber act of 1922. In the senate the insurgents (Borah, George Norris, La Follette, Brookhart, Frazier and Nye) fought against the high rates. The final vote on the bill (June 13–14, 1930) was 44 to 42 in the senate and 222 to 153 in the house. President Hoover signed the bill, justifying his action on the ground that the "flexible" provision permitting him to alter the rates within a compass of 50% on advice of the Tariff commission would enable him to remedy any injustices in the bill. The evil effects of continuing to maintain a Chinese wall around the country, when the health of world commerce depended on international co-operation, were soon evident Before the close of 1931, about 25 foreign countries had raised their tariff walls, chiefly against U.S. goods, by way of reprisal Debtor nations, whose only means of payment was the shipment of merchandise to the U.S., found their goods shut out by the customs barrier. In the 17 months preceding June 1930, U.S. exports had been $6,828,000,000 and U.S. imports $5,766,000,000. In the next 17 months these figures had dropped to $4,007,000,000 and $3,262,000,000 respectively—a total shrinkage of $5,326,000,000 in U.S. foreign trade. Widespread depression in Europe, revolutions in Latin America and riots and civil war in India and China were playing havoc with world trade.

The Wickersham Commission.—President Hoover was concerned with the widespread disregard for law, as evidenced by the operations of bootleggers, highjackers, kidnapers and racketeers and the failure of the courts to convict and punish criminals. The United States led the world in the sinister statistics of homicide, burglary, holdups, graft and defalcations. Gangsters armed with machine guns and provided with high-powered motorcars terrorized the cities and defied, bribed or cowed the sworn guardians of the law. The court records showed that the chances that the criminal would be convicted and brought to condign punishment were only about 3 in 100.

On May 20, 1929, President Hoover appointed a commission of 11 citizens, headed by former Att. Gen. George W. Wickersham, and including Newton D. Baker, Dean Roscoe Pound of the Harvard law school, and 3 federal judges, to investigate and report on the "dominant national problem" of the observance and enforcement of the law. After 18 months of investigation the commission submitted the first instalment of its report (Jan 19, 1931). This report, described by one newspaper as "the most astonishing document ever submitted to our government by a responsible committee," instead of clearing up the confusion of opinion on prohibition only made it worse. Ten of the 11 members signed the body of the report, which opposed the repeal of the 18th amendment or the modification of the Volstead act; but in individual opinions appended to the report only four members favoured the continuance of the law as it stood, while five recommended modification and two absolute repeal. The commission subsequently submitted a dozen reports dealing with the causes of crime, the machinery of the courts, penal institutions, police methods, probation and parole and the deportation of aliens.

The Stock Market Crash.—Long before the Wickersham reports were submitted, public interest was absorbed in the sudden eclipse of the prosperity which had seemed to all but a few to be established on a firm and enduring basis. For the first six months of the administration the road to wealth for all seemed to stretch broad and smooth before the American people. The prices of stocks soared to fantastic heights. Billions of dollars were drawn from the banks into Wall street for brokers' loans to carry margin accounts. In the midsummer of 1929 about 300 000.000 shares of stock were being carried on margin.

In Oct. 1929 the market broke, and the wild rush to buy stocks gave way to an equally wild rush to sell. On Oct. 29 16,410,030 shares were thrown on the market for what they would bring Prime securities tumbled like the issues of bogus gold mines General Electric fell from 396¾ on Sept 3 to 210 on Oct. 29 American Telephone and Telegraph dropped 100 points. du-Pont fell from a summer high of 217¼ to 80; United States Steel from 261½ to 166¼; Delaware and Hudson from 224¾ to 141; Radio common from 505 to 26. Savings of a lifetime were wiped out. Political and financial leaders at first affected to treat the matter as a mere spasm in the market. President Hoover and Secretary Mellon made optimistic predictions that business was "fundamentally sound" and that a great revival of prosperity was "just around the corner." In Jan 1930 the president declared that the trend of business was "upward," in March, that the crisis would be over in 60 days, in May, that we had "passed the worst" and "would rapidly recover." Secretary Mellon saw "nothing in the present situation that warrants pessimism" But as the months passed it became evident that the nation was entering a period of severe depression. Foreign trade fell sharply, factories were closed, the number of unemployed grew alarmingly, mortgages were foreclosed, banks failed, dividends were passed, the prices of wheat, cotton, copper, oil and other commodities kept on sinking, the federal surpluses were turned into deficits and the buying power of the nation was paralyzed.

Efforts for Relief.—In Oct. 1930 President Hoover appointed a cabinet committee to formulate measures for the relief of unemployment. In December he laid before congress a vast program for road construction, public buildings, flood control and airways development, and signed 22 bills appropriating more than $300,000,000 for loans by the Federal Farm board, for emergency construction and for drought relief. In Oct 1931 he got the bankers to form a $500,000,000 pool to help rescue the weaker banks from failure, and on Jan. 22, 1932, he signed the bill creating a $2,000,000,000 Reconstruction Finance corporation, empowered to make loans to banks, insurance companies, agricultural associations, railroads and other industries. The management of the board was vested in seven directors under the chairmanship of Charles G Dawes, who had just resigned the post of ambassador at London. Democrats and Republicans joined in passing the bill.

The Plight of the Treasury.—It would have been comparatively easy for the treasury to provide the relief clamoured for if it had continued to enjoy the abundant revenues and the surpluses of the Coolidge administration. But the depression which had stopped the wheels of industry had also dried up the sources of revenue. Federal taxes from all sources were supplying only 50% of the expenses of the government at the beginning of 1932. Appropriations for national defense, the veterans' service and interest on the public debt absorbed every dollar of the national income The treasury deficit, which stood at $900,000,000 at the close of the fiscal year 1931, threatened to exceed $2,000,000,000 before June 30, 1932. Yet the demands on the treasury increased. In Feb 1931 both houses of congress had overridden by huge majorities (328 to 79 and 76 to 17) President Hoover's veto of a bonus bill, extending cash loans to the war veterans up to 50% of the face value of their adjusted certificates, at an estimated cost of $1,000,000,000. Agitation was immediately started for the full cash payment of the certificates, amounting to another $2,000,000,000, although the American Legion in its convention at Detroit in Sept. 1931 disapproved this "raid on the treasury" by a vote of 507 to 902. The treasury was still further crippled by the loss of about $238,000,000 which should normally have been collected from the debtor nations in Europe, when President Hoover, in order to save Germany from imminent financial collapse, proposed a year's moratorium on all Intergovernmental debts (June 20, 1931), both principal and interest.

Efforts to Balance the Budget.—The midterm elections, coming in the midst of the depression, naturally turned against the administration. The 72nd congress, which met on Dec. 7, 1931, saw the Democrats in control of the house (220 to 214) while the senate was almost equally balanced (48 R, 47 D.). However, a dozen senators from the agricultural states of the west who bore the Republican label could be counted on to join the Democrats in opposition to any administration policies that smacked of favours to the "special interests" Considering the distress under which the country was labouring, congress declared it would "postpone politics," much as it had done in the emergency of World War I, and Speaker John Nance Garner of the house rallied the Democrats to support the president's recommendations for the enlargement of the credit facilities of the banks (the Glass-Steagall act) and the creation of the $2,000,000,000 Reconstruction Finance corporation (Jan. 22, 1932). The leaders of both parties agreed that the budget must be balanced; but when it came to framing the necessary tax bill harmony ceased. Everybody knew that taxes must be increased if the deficit was to be wiped out, but nobody wanted them to be increased at his own expense The advocates of "soaking the rich" demanded high taxes on incomes, inheritances and stock transfers. Those who favoured spreading the burden over the consumers supported the sales tax recommended by the ways and means committee of the house. The bill which was passed by the house (April 1, 1932) and (after some inconsequential changes by the senate) signed by the president on June 6, was declared by Secretary of the Treasury Ogden Mills to be "inadequate" to check the growing deficit. About $1,118,000,000 was expected from its provisions, which raised the normal income tax to 8% on sums above $4,000, with supertaxes rising to 55% on incomes in excess of $1,000,000 Taxes were also levied on bank checks, telephone, telegraph and radio messages, and the sales of various luxury articles such as automobiles, radios and phonographs. But congress resisted the president's efforts to cut down government expenses In the first four months of the new fiscal year (July–Oct., 1932) the treasury deficit mounted by almost $700,000,000

Gestures Toward International Co-operation.—President Hoover was sincerely desirous of redeeming his inaugural pledge to co-operate with Europe in efforts for recovery from the political, financial and industrial chaos which World War I had produced throughout the whole world In 1929 an international committee of which Owen D. Young was chairman revised the Dawes plan (*see* REPARATIONS) of dealing with the reparations payments demanded from Germany. The Young plan, besides revising the amounts of the payments, tried to take the whole matter out of the realm of politics and national revenge and make it a scientific procedure of international finance, controlled by and operating through a bank of international settlements established at Basle, Switz. In October of the same year, the British prime minister, J. Ramsay MacDonald, visited the United States and held informal conversations with Secretary of State Stimson and President Hoover. The outcome was an invitation to the five naval powers of the Washington conference of 1921–22 to meet at London in Jan. 1930 for the purpose of controlling competition in those types of war vessels (cruisers, submarines, destroyers) which had not been included in the Washington agreement. The London conference lasted from Jan. 21 to April 22, 1930. France and Italy withdrew from the conference when they thought that their "security" in the Mediterranean was threatened; but the United States, England and Japan signed the London treaty, which extended the ban on battleship construction until 1936, fixed ratios for the building of auxiliary craft and established a definite naval "parity" between the United States and Great Britain. The treaty was disappointing to the advocates of naval limitation, however, because it permitted the nations to build up to a certain limit rather than scaling down naval construction and, by the "escalator clause," allowed them to increase the ratios if their security seemed to be threatened by other nations (France and Italy). Though Europe's armies were of less concern to the United States than the navies, the United States sent a full delegation to the Limitation of Armaments conference at Geneva on Feb. 2, 1932—and accomplished nothing.

The League of Nations and the World Court.—While not departing from the official position of nonmembership in the League, the United States gave some endorsement to Hoover's pledge in his acceptance speech of Aug. 11, 1928, that the country would be "glad to co-operate with the League in its en-

deavours to further scientific, economic and social welfare and to secure the limitation of armaments" By the autumn of 1931 the government had signed more than a dozen international agreements made under the League's auspices. In October of that year Prentiss B. Gilbert, U.S consul general at Geneva, sat at the table of the League council when it discussed the Japanese aggression in Manchuria, and a U S. general (Frank R. McCoy) served on the Lytton commission appointed by the League to visit Manchuria and report on the situation. The deadlock over the adherence to the World Court continued during the Hoover administration The venerable Elihu Root (who had helped frame the original statute of the court) went to Geneva late in 1928 and secured the assent of the statesmen there to the "Root Formula," which so guarded U.S. interests in the matter of advisory opinions that Secretary of State Stimson instructed our acting minister at Geneva to sign the protocol of adherence (Dec. 9, 1929). Just a year later President Hoover presented the protocol to the senate for ratification Senator Borah and the other determined opponents of the court in the committee on foreign relations prevented the protocol from being reported out to the senate until May 1932. By that time the presidential campaign was beginning to absorb the attention of the country, and there was little probability that the senate would take any action on the protocol until the election was over. Then the emergency measures of the New Deal under Pres. Franklin D. Roosevelt so absorbed congress and the public that action on the World Court was not taken until Jan 29, 1935. On that date 52 senators voted in favour of joining the court and 36 against—thus failing by seven votes to register the two-thirds necessary for ratification.

Campaign of 1932.—The Republican national convention met at Chicago on June 14, 1932, and renominated Hoover and Curtis on the first ballot. The platform stood pat on the merits of the Hoover administration, warned against the danger to business interests and national finances if the Democrats should come into power, and rejected a plan for a repeal of the prohibition amendment. The Democrats met on June 27, in the same building that the Republicans had vacated a few days before Though the primaries had given Gov. Franklin D. Roosevelt of New York a substantial majority of the delegates, he was still far short of the two-thirds (770) necessary for nomination An anti-Roosevelt group headed by Alfred E Smith, John J. Raskob and Jouett Shouse developed considerable strength in New England and New York. Nine candidates were put in nomination, including, besides Roosevelt and Smith, four state governors and the speaker of the house, John N. Garner of Texas Roosevelt had 666½ votes on the first ballot, to 201½ for Smith, 90½ for Garner and 195¼ divided among the other candidates. On the fourth ballot Garner released his delegates to Roosevelt and William G. McAdoo, who had been supporting Garner, threw the entire California delegation to the New York governor, who was nominated with 945 of the 1,154 votes. Roosevelt immediately flew from Albany to Chicago to deliver his acceptance speech to the assembled delegates. Garner was named for vice-president In the campaign which followed, Roosevelt had little difficulty in persuading the people that a change of administration, a "New Deal," was the only hope of recovery from the depression. Banks were failing by the hundreds. Mills and factories were shut down. The unemployed numbered more than 10,000,000. Mortgages on farms and homes were being foreclosed. National, state and local taxes were taking one dollar out of every three of the national income, and the public debt was increasing at the rate of $2,000,000,000 a year A "bonus army" of 10,000 to 20,000 men marched on Washington in the midsummer, determined to remain until congress voted them full cash payment of their adjusted certificates. A thousand farmers in Iowa picketed the roads to prevent the delivery of their grain, milk and livestock at prices which did not pay them for production. Roosevelt toured the country attacking the Republican administration and promising economy, a balanced budget, relief for the farmers and rehabilitation of business. Prominent Republicans, including Senators Johnson and Norris, supported him openly. Toward the end of the campaign President Hoover attempted to stem the tide that was running more strongly against him every week But it was of little avail The verdict at the polls on Nov 8 was a Democratic landslide. Roosevelt carried every state in the union except six (Maine, New Hampshire, Vermont, Connecticut, Delaware and Pennsylvania) with 472 electoral votes to 59 for Hoover, and a popular majority of approximately 7,000,000 The Democrats secured a majority of 191 in the house and 22 in the senate.

Two New Amendments.—The final short session of congress, which met in Dec. 1932, was the last of the "lame duck" sessions. For in Jan 1933 the 20th amendment to the constitution was ratified, which provided that thereafter the congress elected in November should begin its session on the third day of the following January, and that the president should be inaugurated on Jan. 20. The last "lame duck" congress also passed a 21st amendment in Feb. 1933 (ratified in December) repealing the 18th (prohibition) amendment.

The New Administration.—The cabinet, announced on the eve of the inauguration, consisted of Cordell Hull of Tennessee (state); William B. Woodin of New York, who resigned in December and was succeeded by Henry Morgenthau, Jr. (treasury); Homer S Cummings of Connecticut (attorney general); Gov. George H. Dern of Utah (war); Sen. Claude A. Swanson of Virginia (navy); James A. Farley of New York, chairman of the Democratic state and national committees (postmaster general); Harold L Ickes of Illinois (interior); Henry A. Wallace of Iowa (agriculture); Frances Perkins of New York, the first woman to have a cabinet seat (labour); and Daniel C. Roper of Washington, D C (commerce). Besides these official heads of departments, President Roosevelt took intimate counsel from a number of advisers who were called the "brains trust" because many of them were college professors. Notable among them were Raymond Moley (for a time assistant secretary of state), Rexford G Tugwell (later undersecretary of agriculture) and A A Berle of Columbia university, Felix Frankfurter (later supreme court justice) and O. M. W Sprague of Harvard; and George F Warren of Cornell. In his brief inaugural address the president scored the prevailing practices in industry and finance which he said had brought the country to distress in the midst of plenty, promised to drive the "money-changers" out of the temple, declared that the only thing the country had to fear was fear itself, and in words recalling Woodrow Wilson's inaugural of 20 years before asked the people to join him in a "national consecration" to the work of restoring prosperity through united effort.

Meeting the Crisis.—Shortly after the election President Hoover had invited President-elect Roosevelt to Washington to confer with him on measures that might ease the situation during the four months "interregnum" before the latter's inauguration. But Governor Roosevelt was not willing to commit himself to policies before the power and responsibility were actually in his own hands. The winter of distress wore on, and when inauguration day arrived the country was confronted with a crisis of the first magnitude. Beginning with Michigan in mid-February, state after state had closed its banks to prevent runs by panic-stricken hoarders. In the eight days preceding March 4, more than $1,500,000,000 had been drawn from the banks which were still open. The New York banks closed that morning by order of Gov. Herbert Lehman, and by noon every bank in the country had shut its doors. After a White House conference lasting well into the night of Sunday, March 5, President Roosevelt issued a proclamation closing all the banks for four days; and at the same time summoned congress to meet in extra session on March 9. On that day the house, without the formality of a roll call, and the senate, with only seven dissenting votes, passed the administration's Emergency Banking bill, giving the secretary of the treasury power to appoint "conservators" (quasi-receivers) for all the national banks in the country and to reopen them according to his discretion Confidence was restored and deposits began to flow into the banks again. But, unfortunately, too many of the weaker banks were reopened. The president's Economy bill, designed to save $500,000,000 by reducing federal salaries and veterans' pensions (signed March 20), was hailed with enthusiasm by the

country; but its effect was neutralized a year later (March 28, 1934) when congress passed over the presidential veto the Independent Offices bill, restoring most of the cuts. On March 22, 1933, a bill was signed legalizing the sale of 3.2% beer, from which a revenue of from $100,000,000 to $150,000,000 was expected for the treasury

The AAA.—The extra session sat from March 9 to June 16, 1933. In those 99 days an amazing amount of legislation was adopted The Agricultural Adjustment act of May 12 was designed to raise the prices of farm products and relieve the farmers, who were burdened by a mortgage indebtedness of $8,500,000,000. The plan was to take about 40,000,000 ac. out of cultivation, and to reimburse the farmers for the value of the crops and the hogs they would lose by a processing tax levied on flour millers, meat packers, etc. Of course this would raise the price of bread, bacon and clothing, because the processor would pass along the tax to the consumer Since there was a large group in congress who favoured inflation of the currency as the means of raising prices, it was necessary, in order to get the bill through, to adopt an amendment of Sen Elbert Thomas of Colorado, empowering the government to issue $3,000,000,000 of paper money and to reduce the gold content of the dollar by not more than 50% No greenbacks were issued, but on April 19 the government abandoned the gold standard by forbidding the export of gold, and the next January the president by proclamation reduced the gold content of the dollar to 59 06 cents This action, which made public and private bonds payable at 60 cents on the dollar, was subject to violent attack, but the supreme court, in Feb. 1935, upheld the devaluation by a vote of five to four The processing tax of the AAA brought in more than enough to pay the benefits to the farmers in the first year of its operation, but in 1935 was falling far behind, as cases involving its constitutionality came before the courts. In Jan 1936 the supreme court, by a vote of six to three (Stone, Brandeis, Benjamin Cardozo) declared the AAA unconstitutional.

The NRA.—Perhaps the most startling measure of the New Deal was the National Industrial Recovery act of June 16, 1933, by which the government assumed control over the major industries of the country Representatives of the industries were invited to come to Washington to work out with the NRA administrator, Gen. Hugh S Johnson, codes of fair dealing to be followed. These codes fixed *maximum hours* and *minimum* wages, abolished sweatshop and child labour in many industries, gave labour the right to bargain with employers through representatives of their own choosing (as against the open shop or the company unions), and required businessmen to open their books to government inspectors. Violators of the codes would have the Blue Eagle (the symbol of co-operation) taken away from them, and industries refusing to formulate a code were brought under a blanket code imposed by the president. More than 700 codes were drawn up by representatives of business From the first the NRA met violent opposition on both constitutional and economic grounds. The act was to expire in June 1935, and the administration was bent on asking for its extension when the supreme court, in the Schechter Poultry Corporation case, on May 27, handed down a unanimous decision that the codes by their wages and hours provisions exceeded the powers of congress under the interstate commerce clause, and that hence the NRA was unconstitutional At the same time the Frazier-Lemke Mortgage Relief act was unanimously declared unconstitutional.

Emergency Relief.—Two objects, not always easily separable, were envisaged in the program of the New Deal. immediate (emergency) relief for the millions of unemployed who could no longer be taken care of by private charity or state and local funds, and long-time plans for the recovery of business and agriculture On May 12, 1933, a Federal Emergency Relief act appropriated $500,000,000 for direct aid, one-half the sum going as a gift to supplement the amounts raised by the states and the other half to match state appropriations in the ratio of one to three. This was followed by various acts to create jobs for the unemployed at federal expense, such as the Civilian Conservation corps and the Civil Works administration. By June 1934, the total "emergency" expenditures of the government under such public works schemes, the RFC and the AAA amounted to more than $5,000,000,000 Dismayed at the burden of public debt being piled up for a future generation to pay in taxation, critics of the New Deal called for an end to extravagant spending, tinkering with the dollar, price and wage fixing and, in the words of the Republican *New York Herald Tribune*, "the whole succession of unrelated and hastily devised remedies . . . that had produced an economic chaos with no end in sight." President Roosevelt still had the confidence of the people, however. In the mid-term elections of 1934 the administration won a complete victory. The Democrats secured 322 of the 435 seats in the house and 69 of the 96 senators for the 74th congress.

President Roosevelt asked and obtained from the new congress in Jan 1935 the sum of $4,880,000,000, to be spent virtually at his own discretion Scores of alphabetical agencies were at work dispensing huge sums for relief and for constructive work. The projects of the Tennessee Valley authority and the Grand Coulee and Bonneville irrigation plants were being pushed The public debt in the autumn of 1935 passed the $30,000,000,000 mark—exceeding by nearly $4,000,000,000 the World War I debt at its peak. With the adjournment of congress in Aug. 1935, after the passage of the National Security act providing for old-age and unemployment pensions, the attention of the country turned to the approaching presidential race.

The Recovery of Business.—Shortly after the adjournment of congress President Roosevelt wrote (Sept. 6, 1935) to Roy Howard, in reply to a letter asking for "the grant of a breathing spell to business and a recess from further experimentation," that the basic program of the administration "has now reached substantial completion and the breathing spell of which you speak is here—very decidedly so" Since the autumn of 1934 the upturn in business had been steady, if not rapid. Railroads, banks and insurance companies were paying back their loans from the RFC. Firms which had been deep in the red were cutting their deficits and going on to make profits. Dividends were resumed. Wages and salaries were stepped up The farm income rose from $5,300,000,000 in 1932 to $8,000,000,000 in 1935. Foreign trade, which had reached its nadir of $2,933,000,000 in 1932, increased to $4,329,000,000 in 1935. Opponents of the New Deal insisted that the tide of prosperity would be rising far more rapidly were it not for the uncertainty in business circles as to what further measures of government interference the president might recommend Nevertheless the indisputable fact of business improvement, a fact which the president emphasized more and more strongly in his speeches and press conferences, was a powerful factor in holding for him the continued confidence of the nation.

The Growing National Debt.—In spite of the fact that business was improving, the treasury was showing staggering deficits from year to year. The numbers of the unemployed still remained, after three years of enormous expenditures for relief, somewhere between 10,000,000 and 12,000,000. In his budget message of Jan. 1936 the president asked congress for $1,425,000,000 for relief work, in addition to the $4,880,000,000 which he had obtained the previous year. By June 1936 it was estimated that close to $9,000,000,000 had been appropriated for relief, direct and indirect, and two further features added to the immense burden of debt which the relief work was imposing upon the government. First, the disallowance of the AAA by the supreme court on Jan. 6, 1936, cut off the revenue of nearly $1,000,000,000 accruing from the processing tax, which was relied on to compensate the farmers for curtailing their production of wheat, cotton, tobacco and hogs. Then, three days later, congress, by an overwhelming vote, passed over the president's veto the bonus bill, which provided for the immediate payment to World War I veterans of their adjusted compensation certificates, due in 1945. Eight months earlier (May 22, 1935) the president had appeared before congress to read in person his veto of a similar bill, and had been able to prevent the senate (by a vote of 54 to 40) from overriding his veto. But this time both houses repassed the bill immediately, and the treasury found itself obligated to the payment of more than $2,000,000,000. The veterans were paid on June 15, 1936, in

Summary of Presidential Elections in the United States, 1860-1932

(Successful candidate in boldfaced type; unsuccessful, in lightface type Candidates receiving no electoral vote are not mentioned)

Year	Candidate	Party	Popular Vote	Electoral Vote
1860	**Lincoln**	Republican	1,866,452	180
	Douglas	Democrat	1,375,157	12
	Breckinridge	Democrat	847,953	72
	Bell	Union	590,631	39
1864	**Lincoln**	Republican	2,213,665	212
	McClellan	Democrat	1,805,237	21
1868	**Grant**	Republican	3,012,833	214
	Seymour	Democrat	2,703,249	80
1872	**Grant**	Republican	3,597,132	286
	Greeley	Democrat	2,834,125	66*
1876	**Hayes**	Republican	4,036,298	185
	Tilden	Democrat	4,300,590	184
1880	**Garfield**	Republican	4,454,416	214
	Hancock	Democrat	4,444,952	155
1884	**Cleveland**	Democrat	4,874,986	219
	Blaine	Republican	4,851,981	182
1888	**Harrison**	Republican	5,439,853	233
	Cleveland	Democrat	5,540,309	168
1892	**Cleveland**	Democrat	5,556,918	277
	Harrison	Republican	5,176,108	145
	Weaver	People's	1,041,028	22
1896	**McKinley**	Republican	7,104,779	271
	Bryan	Democrat	6,502,925	176
1900	**McKinley**	Republican	7,207,923	292
	Bryan	Democrat	6,358,133	155
1904	**Roosevelt, T.**	Republican	7,623,486	336
	Parker	Democrat	5,077,911	140
1908	**Taft**	Republican	7,678,908	321
	Bryan	Democrat	6,409,104	162
1912	**Wilson**	Democrat	6,293,454	435
	Roosevelt, T.	Progressive	4,119,538	88
	Taft	Republican	3,484,980	8
1916	**Wilson**	Democrat	9,129,606	277
	Hughes	Republican	8,538,221	254
1920	**Harding**	Republican	16,152,200	404
	Cox	Democrat	9,147,353	127
1924	**Coolidge**	Republican	15,725,016	382
	Davis	Democrat	8,386,503	136
	La Follette	Progressive	4,822,856	13
1928	**Hoover**	Republican	21,391,381	444
	Smith	Democrat	15,016,443	87
1932	**Roosevelt, F. D.**	Democrat	22,821,857	472
	Hoover	Republican	15,761,841	59
1936	**Roosevelt, F. D.**	Democrat	27,751,597	523
	Landon	Republican	16,679,583	8
1940	**Roosevelt, F D**	Democrat	27,244,160	449
	Willkie	Republican	22,305,198	82
1944	**Roosevelt, F. D.**	Democrat	25,602,504	432
	Dewey	Republican	22,006,285	99
1948	**Truman**	Democrat	24,105,695	303
	Dewey	Republican	21,969,170	189
	Thurmond	States' Rights Democrat	1,169,021	39
1952	**Eisenhower**	Republican	33,927,549	442
	Stevenson	Democrat	27,311,316	89

*Greeley died before electoral vote was cast

ten-year 3% bonds of $50 each which they might turn into cash at will at any one of the 300 main post offices of the country

The result of these outlays, both anticipated and unforeseen, was to raise the national debt at the end of the fiscal year 1935–36 to more than $34,500,000,000, or double the amount of the debt at the beginning of the Hoover administration. Republicans asserted that such pyramiding of the debt would endanger the credit of the government, and deplored the burden of taxation that its servicing would entail upon future generations.

But the administration leaders replied that the government was able to borrow all the money that it needed at the lowest interest rates in U.S history and that the debt was much lower per capita than those of the leading European states.

The National Conventions of 1936.—On June 9, 1936, the Republicans met at Cleveland, O., to write their platform and select their candidates for the presidential campaign. The platform condemned the Roosevelt administration for its regimentation of business, its contempt for the constitution, its waste of the taxpayers' money, its flouting of the civil service regulations, its encouragement of class hatred and its march toward a dictatorship in concentrating unprecedented power in the hands of the executive. It recommended turning the administration of relief over to the states, with subsidies from the national government, pledged efficient aid to the farmer and the labourer, advocated the restoration of a stable currency and promised to balance the national budget without either neglecting the worthy poor or increasing taxes. For several weeks the tide of popular favour had been setting strongly toward Gov Alfred M. Landon of Kansas as the Republican nominee. On the first ballot he received all the votes of the convention except those of 18 delegates from Wisconsin and 1 from West Virginia who voted for Sen William Edgar Borah of Idaho. Col. Frank Knox, owner of the *Chicago Daily News* and, like Landon, a follower of Theodore Roosevelt in 1912, was unanimously named for the vice-presidency. On June 23 (two days after the end of the 74th congress) the Democrats held their convention at Philadelphia, Pa., and renominated Roosevelt and Garner by acclamation. The president, in his acceptance speech, stood pat on his program of relief, recovery and reform, scored the "economic royalists," and pledged himself to the necessary readaptation of social and economic life within the bounds of the constitution. The Socialists nominated Norman Thomas again; the Communists put up Earl Browder; and a new party appeared under the title of the Union for Social Justice, sponsored by Father Charles E. Coughlin of Detroit, F. E. Townsend, and the political heirs of Sen. Huey P. Long, nominating as its candidate Rep. William Lemke of North Dakota.

The Campaign of 1936.—The main issue, of course, was the approval or disapproval of the New Deal. The Republicans were hampered by the fact that their representatives and senators in congress had voted for many of the administration measures and by the anomalous position of Governor Landon, who condemned the New Deal and at the same time promised to continue the program of relief and recovery A split in the Democratic ranks had been threatened when prominent members of the party, calling themselves "Jeffersonian Democrats," led the formation of the Liberty league. Alfred E. Smith and former Secretary of State Bainbridge Colby accused President Roosevelt of having repudiated the party platform of 1932. It was believed that the opposition of these dissidents, added to that of the Coughlin-Lemke party, the long existing campaign of the utility companies against the TVA and the hostility of conservatives to deficit financing and to extensive control of business would so far reduce President Roosevelt's strength as to make his victory in any case a narrow one. Indeed a *Literary Digest* poll gave Landon a popular lead of 1,293,669 to 972,897 and predicted a Landon victory of 370 to 161 in the electoral college But the vote on Nov. 3 registered an overwhelming victory for Roosevelt. He carried 46 of the 48 states (all except Maine and Vermont), with 523 electoral votes to 8 for Landon. His popular plurality over the Republicans in a vote of 45,647,117 exceeded 11,000,000. The various minor parties polled 1,490,861 votes combined, of which Lemke (Union party) had 882,479. The Republicans elected governors in only three states (Vermont, New Hampshire and South Dakota) in which gubernatorial contests were held. The Democrats gained a dozen seats in the house and five in the senate. It was a complete endorsement of President Roosevelt and the New Deal, won despite almost complete opposition of the press

Foreign Affairs.—Absorbed in his program of relief and recovery at home, President Roosevelt had paid comparatively little attention to foreign matters. The questions of the Allies' debt to the United States and of limitation of armament were not pushed. The tariff and international trade got little attention. In Nov. 1933, the government recognized the U S.S.R., sending William C. Bullitt as the first ambassador to that country since the overthrow of the tsar's regime. The government participated in the seventh Pan-American congress at Montevideo, Urug., in the same autumn, with Sec. Cordell Hull again leading the delegation. By the McDuffie-Tydings act of 1934 the United States gave independence (to be final in ten years) to the Philippine Islands and in 1935 Manuel Quezon was elected first president of the

Commonwealth of the Philippines; and the United States at last freed Cuba from what the islanders considered an embarrassing dependence, by abrogation of the Platt amendment (May 1934). On June 12, 1934, the president signed a Reciprocal Tariff act, under which Secretary of State Hull negotiated 24 reciprocity agreements with foreign nations, which at once resulted in an increase in U.S. foreign trade. What was thought to be a guarantee of the preservation of U.S. neutrality in the event of another European war was provided by the Neutrality act of April 1935, forbidding Americans to furnish munitions or money to foreign belligerents and refusing protection to Americans sailing on belligerent ships

But the launching of an attack on Ethiopia by Italy in the autumn of 1935, the steady encroachment of Japan on the territorial integrity of China and the outbreak, in July 1936 of civil war in Spain brought the problem of U.S neutrality into sharp relief. While temporary neutrality legislation was passed in 1935 and 1936, the arguments continued in congress and the country between the advocates of a mandatory law, leaving no discretion to the president in case of the outbreak of war, and a flexible law, permitting the president to handle each case as it should arise.

The outcome was the War Policy act of May 1, 1937, which embodied a compromise. The mandatory provisions of an embargo on arms and ammunition, the prohibition of loans to belligerents and the refusal to allow Americans to travel on ships of the belligerents were retained; but the president was granted the all-important power of determining whether the law was to be put into effect by proclamation that a war actually existed, and was allowed wide discretion in other respects.

The President and Congress.—President Roosevelt was inaugurated for his second term on Jan. 20, 1937, in accordance with the 20th amendment to the constitution. The first session of the 75th congress, which assembled on Jan 3, contained enormous Democratic majorities (334 to 105 in the house and 76 to 20 in the senate) which had been returned in the party's victory in the election of 1936. Interpreting the victory as an endorsement of the New Deal, the president announced in his inaugural address that he had "just begun to fight" for his program, and in his message to congress he asked that "action now" be taken on proposed measures for the regulation of hours and wages, the relief of farm tenants, the extension of social security, the control of speculation, federal health insurance and a housing program for the elimination of slums. The president also wanted legislation for a more effective crop control, for the creation of six great regional projects like the TVA and for authorization to reorganize the agencies of public works, relief and loans according to his discretion. But the congress proved to be unwieldy and unmanageable Factions developed, and adjournment came on Aug. 21, 1937, without the enactment of any of the major measures.

The "Recession" of 1937.—A sharp decline in prosperity set in during the latter half of the year. In midsummer the production index stood higher than it had in a decade. The first quarter's output of steel had exceeded by 600,000 tons the previous high record of 1929. The national income had risen from less than $40,000,000,000 in 1932 to nearly $70,000,000,000. Then there began a decline which sent the business index down from 111.2 in August to 88.9 in November. Steel production fell from 80% to 31% of capacity. The average price of 50 stocks fell from 135 5 to 82; relief rolls swelled and the number of unemployed rose to about 10,000,000. The president called an extra session of congress on Nov. 15 to try again to get through some of the measures which he had proposed at the beginning of the year. But the session adjourned six weeks later without accomplishing any more than its predecessor had done.

The Supreme Court Issue.—Still further friction between the president and congress developed when Roosevelt proposed the addition of six new justices to the supreme court (with the purpose of inducing the six actual members more than 70 years of age to resign), and advocated a similar "infusion of new blood" into the lower federal courts. The latter proposition did not arouse much interest, but the so-called attempt to "pack" the supreme court with men who would uphold the legislation of the New Deal met with immediate opposition The court had nullified nine of the measures of the New Deal, including such important ones as the NRA and the AAA; and on the occasion of the NRA unanimous decision in May 1935 the president had commented impatiently on the judges who were still living in the "horse and buggy days." During the entire four years of his first term President Roosevelt had had no opportunity to make an appointment to the supreme court, whereas, President Taft, for example, had six vacancies to fill in his single term. The controversy over the court reform occupied much of the attention of congress during the spring and early summer, until the president gave up the struggle when the senate, by a vote of 70 to 22, defeated the reorganization plan on July 22. Meanwhile the court had receded somewhat from its hostility to "progressive" measures. On March 29 it upheld the Washington Minimum Wage law for women. On April 12 it sanctioned the Wagner Labor Relations act. On May 27 it held the Social Security act of 1935 constitutional. The decision in practically all these cases was by a five to four vote. Justices James McReynolds, George Sutherland, Pierce Butler and Willis Van Devanter taking the negative and Chief Justice Hughes and Stone, Brandeis, Owen J. Roberts and Cardozo the affirmative.

Rapid changes in the personnel of the court from the summer of 1937 on gave the president the opportunity to create a "liberal" tribunal without resorting to innovating proposals On June 2 Justice Van Devanter, taking advantage of the law permitting retirement at the age of 70, left the court, and was replaced by Sen. Hugo Black of Alabama, a staunch advocate of the New Deal. In 1938 Justice Sutherland of Utah, another conservative, resigned, to be succeeded by Roosevelt's solicitor general, Stanley Reed of Kentucky. Justice Cardozo died the same year, and Felix Frankfurter of the Harvard law school was appointed in his stead. In 1939 the aged Justice Brandeis, an appointee of Woodrow Wilson in 1916, left the bench and the president appointed William O. Douglas of Connecticut to succeed him. Justice Butler of Minnesota, a consistent conservative, died in 1939, and was replaced by the former governor of Michigan and of the Philippines, Atty Gen. Frank Murphy. In 1941 Justice McReynolds, the most conservative member of the court, resigned, to give place to Sen. James F. Byrnes of South Carolina. Finally, in 1941 Chief Justice Hughes resigned after 11 years of service. The president promoted the Coolidge appointee Harlan F. Stone to the chief justiceship, and named Robert H. Jackson of New York (who had taken Murphy's place as attorney general) to fill the vacancy. So by 1942 every member of the court except Chief Justice Stone and Justice Roberts was an appointee of President Roosevelt.

The Labour Struggle.—The year 1937 saw the fiercest conflict in the field of labour since the demoralizing period immediately following World War I. The battle started late in 1935 with the formation, by John L. Lewis, president of the United Mine Workers of America, of the Committee for Industrial Organization (later changed to the Congress of Industrial Organizations) to supplant the craft unions of the A.F. of L. by industrial or "vertical" unions comprising all the workers in a given industry, something on the pattern of the "one big union" advocated by the Industrial Workers of the World (I.W.W.) a generation earlier. The new weapon used by the C.I.O. in its bitter fights with automobile and steel industries was the "sit-down strike" in which the strikers intrenched themselves in the factories and refused to work or to let others in to work. Although this trespassing was an infringement on property rights, Gov. Frank Murphy of Michigan refused to evict the strikers by force, lest bloodshed should ensue. President Roosevelt declined to take part in the struggle, crying "a plague on both your houses." Secretary of Labor Perkins at first took a complacent view of the matter, saying that the legality of the sit-down strike had not been determined; but later she condemned the movement. It petered out after a few months, but the C.I.O. grew rapidly, until by midsummer of 1937 it claimed to have drawn away more than half the members of the older organization. General Motors came to terms with the C.I.O. in March, and the major steel companies

followed suit Fully aware that the split in the ranks of labour was hurting the cause, the two presidents of the rival organizations tried in a series of conferences to come to some agreement. But neither William Green of the A F. of L. nor John L. Lewis of the C.I.O would yield a point, in spite of the pleas of some of their important lieutenants for harmony. It was hoped that the National Labor Relations board (NLRB), set up under the Wagner-Connery act of July 1935, would serve to iron out disputes in the industrial field, as the Railway Labor board in 1926 had averted serious strikes on the railroads, and, indeed, up to the close of the year 1938, the NLRB did handle more than 10,000 cases involving approximately 2,000,000 workers with fair success. It provided protection to workers in interstate commerce industries, in the formation of associations to elect their own representatives to conduct collective bargaining with the employers, and forbade the latter to interfere with labour organizations or to refuse to bargain collectively. The board might issue "cease and desist" orders, subject to judicial review, to prevent employers from violating the act However, the board encountered opposition from the beginning The A F of L. complained that it constantly favoured the C I.O. in its rulings and demanded its revision. The employers protested against its unfairness in allowing appeals from the workers only Although the NLRA was declared constitutional by the supreme court in April 1937, the effort to have it amended or repealed was continuous. Between Jan. and Aug. 1937 more than 3,200 strikes affecting 1,470,000 workers were reported by the bureau of labour statistics To be sure, the number of strikes decreased in the next two years, averaging 231 a month in 1938 and 192 a month in the first seven months of 1939, as against 395 a month in the year 1937 But still the hostility of the two great labour organizations to each other and of both to the NLRB continued, in spite of the president's sporadic efforts to bring peace in the labour ranks. A concession was made to industry in July 1939, when employers were given the right to call for an election to determine the proper body for collective bargaining. Also the supreme court by a six to two decision reversed a decision of the board which had ordered the Fansteel Metallurgical company to rehire the men discharged in the sit-down strike of 1937.

The outbreak of World War II in Sept. 1939 invested the labour controversy in the United States with more than a domestic significance Following labour-management conferences, a new policy was adopted early in 1942, proscribing strikes and lockouts for the duration of the war, and in place of the NDMB the president appointed a War Labor board of 12 men (4 labour leaders, 4 industrialists and 4 members of the public) with William H Davis as chairman. Lewis (who had resigned the presidency of the C.I O. after turning against Roosevelt and threatening to resign if the latter were re-elected) then proposed a united front in labour: both President Green of the A.F of L. and Pres Philip Murray of the C.I O should resign, and George Meany should become president of the merged organization, with Lewis as vice-president. But neither Green nor Murray (who was not consulted) favoured the suggestion; nor did President Roosevelt.

Political Rivalry.—When the president met the final session of the 75th congress on Jan. 3, 1938, he asked for legislation on farm relief and on wages and hours in industry. He disclaimed any hostility to business in general, but accused a minority of big businessmen of antisocial practices in tax evasion, unfair competition and the maintenance of high prices As contrasted with the "do nothing" sessions of 1937, congress passed two acts of major importance. On Feb. 14 came the elaborate Crop Control act of 1938 which had for its purpose what Secretary Wallace called the "ever normal granary," that is, the maintenance of a fairly steady ratio between the production and consumption of the chief surplus crops of the United States: wheat, corn, cotton, tobacco and rice. The government was to store the surplus in fat years and release it in lean years, extending loans of the stored surpluses through the Commodity Credit corporation. A novel feature of the act was the provision for a referendum among the raisers of the crops in question to determine whether or not they agreed to the quotas of production which were fixed by the Agricultural administration.

In June 1938 congress passed a Fair Labor Standards act (or Wages and Hours act) for industries entering into interstate commerce The act was designed to "put a floor under wages and a ceiling above prices" Wages were to increase from a minimum of 25 to 40 cents an hour, and hours to decrease by the same sliding scale from a maximum of 44 to 40 a week But in spite of these major measures, opposition to the president's program went on. A combination of Republicans and anti-New Deal Democrats slashed hundreds of millions from appropriation bills, defeated the reorganization of the executive departments, refused to amend the Neutrality act, ignored the request for the establishment of six regional projects like the TVA and so amended the tax bill of 1938 in favour of the corporations that the president allowed it to become a law without his signature

As the head of his party the president deemed it proper to intervene in the primaries of 1938 by letters, conferences and speeches, to eliminate certain discordant Democrats (notably Sen Millard Tydings of Maryland, Ellison Smith of South Carolina, Walter George of Georgia and Guy Gillette of Iowa and Rep John O'Connor of New York) from congress. This course, taken against the advice of Chairman James Farley, proved to be a boomerang All the senators attacked were easily renominated and re-elected, while two prominent New Deal senators (James Pope of Idaho and William McAdoo of California) were defeated. Farley had predicted that the Republicans might gain 40 seats for the 76th congress, but they actually increased their numbers from 89 to 170 in the house, and gained 8 seats in the senate. They elected 11 governors, and outside the "solid south" polled 51.5% of the popular vote, as compared with 40 1% in the election of 1936.

WORLD WAR II

The Problem of Neutrality.—The outbreak of war in Europe with Adolf Hitler's invasion of Poland on Sept. 1, 1939, and the immediate declaration of war on Germany by Great Britain and France brought a decided change in the policy of the administration and in the attitude of the public Since his inauguration in 1933 the president had subordinated questions of foreign policy to his battle for the reforms of the New Deal. During the first session of the 76th congress (Jan 3–Aug. 5, 1939) he was still labouring with the most recalcitrant congress of all his six years to secure additional appropriations for housing, to have the provisions of the Social Security act of 1935 liberalized, to maintain in vigour the undistributed profits and capital gains taxes, to get $2,800,000,000 appropriated for his "spending-and-lending" plan and to persuade congress to amend its neutrality legislation so as to leave him a free hand in dealing with foreign aggressors in the time-honoured way of *ad hoc* diplomacy.

To meet the overwhelming desire of the American people to keep out of war, congress passed a joint resolution on Aug 24, 1935, providing the most sweeping neutrality legislation in U.S history By the act of May 1, 1937, the shipment of arms and ammunition and the extension of loans and credits to any belligerent were forbidden. All purchases of nonmilitary supplies made in the United States must be paid for "on the barrelhead" and carried away in non-U.S. ships (the cash and carry provision); and Americans were forbidden to travel on merchant ships of a country at war. The president was empowered to declare when a war existed between foreign nations and to embargo other exports besides munitions and arms It was proclaimed at once by the president in the case of the Spanish Civil War.

Having no discretion to discriminate between "aggressor" and "nonaggressor" belligerents, the president asked congress to rescind the mandatory provisions of the act, but on July 11, 1939, the senate committee on foreign relations refused by a vote of 12 to 11 to consider any changes in the law during that session of congress. Seven weeks later the war in Europe came. Roosevelt, eager to keep the United States out of war but convinced that the only way to do so eventually was to give all aid possible to France and Great Britain, called congress in extra session on Sept 21, 1939, for the purpose of amending the neutrality provisions of the legislation of 1937.

He would keep the cash and carry provision and the denial of war credits to belligerent nations. He would even approve barring U.S merchant ships from combat areas But he pleaded that the embargo on arms be lifted

After a spirited debate the senate, on Oct. 27, repealed the embargo by a vote of 63 to 30, and the house concurred on Nov 2. An amendment of Senator La Follette (reviving the Ludlow amendment of two years before), providing for a popular referendum on the declaration of war, was rejected by a vote of 17 to 73.

The following year saw the rapid German conquests of Denmark, Norway, Belgium, the Netherlands and France. Roosevelt was certain that only "all-out" aid to the democracies could save the United States.

In Sept. 1940 he transferred 50 overaged destroyers to Great Britain in exchange for leases for naval bases at eight points on the Atlantic coast from Newfoundland to British Guiana. He told the new session of the 77th congress in Jan 1941 that the U S must become the "arsenal of democracy." A few days after it had assembled the house received a bill numbered 1776, calling for the supply to the enemies of Hitler of every sort of material to help them win the war In spite of opposition by the noninterventionists in congress and out, the Lend-Lease bill was passed in March, and was followed immediately by an appropriation of $7,000,000,000 (later increased by another $6,000,000,000) for its implementation. The Lend-Lease act was a virtual declaration of war against the totalitarian powers and the abandonment of neutrality. It needed only the increasing sinkings of U.S. merchant ships and destroyers by German submarines during the summer and autumn of 1941 to lead congress to obliterate the last remnants of the neutrality legislation and permit U.S. ships to sail with unrestricted cargoes to any part of the world.

The *Election of 1940*.—Meantime the quadrennial election year had come and gone. Despite the fact that the limit of two terms for the presidency seemed to be firmly established by the example of Washington and Jefferson, and that congress had twice (1875 and 1928) passed a resolution that a third term would be "fraught with danger to our republican institutions," the critical situation in 1940 led most of the Democratic leaders to insist that Roosevelt should run for a third term. The president himself made no move to secure or refuse the nomination and was unanimously nominated on the first ballot at Chicago in mid-July Secretary of Agriculture Henry A. Wallace was named as his running mate. The chief Republican aspirants were Sen Robert A. Taft of Ohio and Sen Arthur Vandenberg of Michigan, and District Attorney Thomas E. Dewey of New York, who had nearly defeated Governor Lehman two years before The Republican convention at Philadelphia, however, responded to a widely supported movement for Wendell Willkie, president of the Commonwealth and Southern utilities corporation and nominated him on the sixth ballot, with Sen. Charles L. McNary of Oregon for the vice-presidency.

Willkie aroused great enthusiasm by a vigorous and forthright campaign, but his case was weakened by the fact that he had had no experience in political life He polled 22,305,198 votes to Roosevelt's 27,244,160 in the election of Nov. 5, but carried only 10 states with 82 electoral votes, to 449 for his opponent. The election made little change in the new (77th) congress, the Democrats gaining 7 seats in the house and the Republicans 8 in the senate. The vote for the minor parties (Socialist, Communist and Prohibition) was insignificant.

National Defense.—The problems of national defense absorbed the attention of the administration increasingly during 1940 and 1941, affecting not only the policies of the army and the navy, but also the whole field of production, transportation, labour, finance and education. On May 28, 1940, as France was succumbing to the drive of the German armies, President Roosevelt set up an advisory Council of National Defense, patterned on Wilson's council of 1916, with six cabinet members and seven expert industrial advisers, headed by William S. Knudsen, president of General Motors. Seven months later, as defense preparations were lagging, a "supercommission" of four was created, called the Office of Production Management (OPM). Knudsen retained the chairmanship and Sidney Hillman, president of the Amalgamated Clothing Workers, was a kind of cochairman, representing the interests of labour Secretary of War Henry Stimson and Secretary of the Navy Frank Knox were the other two members. President Wilson's council had been converted early in 1918 to a virtual dictatorship over industry by Bernard M. Baruch; but Roosevelt refused at first to appoint a "defense tsar," declaring that the business of arming the United States was "too large and complex a job for any one man." Conflicts of authority and policy within the board, difficulties attending the conversion of manufacturing plants for the production of war materials and the constant setbacks caused by strikes caused the president to give way, however, and after the United States formally entered the war he appointed Donald M Nelson, formerly of Sears, Roebuck and company, as the head of a new War Production board (WPB) in Jan. 1942, with powers exceeding even those of Baruch in 1918 Nelson was authorized to overrule the army, the navy and all other departments of government in matters of production. He could take over plants, open new plants, hire and fire workers and commandeer materials. He was subject to the president alone in his orders.

The most controverted measure of the U.S. defense program was the conscription of American youth. A Gallup poll taken just after Munich showed only 37% in favour of military training, but when Hitler took Paris in June 1940 the figure rose to 64%. The Burke-Wadsworth Selective Service and Training bill was introduced into congress, providing for the registration of men between the ages of 21 and 35, no more than 900,000 to be called into service at any one time during peace. The act was to expire on May 15, 1945. The opposition was strong, but the bill passed by majorities of about two to one and was signed by the president in September. Clarence A. Dykstra was made administrator of the draft. The drawing of numbers began on Oct 29, the same glass bowl being used that had served for the Selective Service act of 1917 So for the first time when the nation was not actually at war the government resorted to compulsory military service. When war became imminent, registration was extended up to men of 64 (those between 19 and 44 being liable for active service), and restrictions as to the length and place of service were removed.

Latin-American Relations.—The Roosevelt administration from the beginning was intent on the substitution of the "good neighbour" policy for the "big brother" policy in U.S. relations with the republics south of the Rio Grande. As an earnest of this policy the last of the U S. marines were withdrawn from Haiti and the Platt amendment to the constitution of Cuba (giving the United States the right of intervention) was abrogated in 1934 Pacts of reciprocal trade were negotiated by Secretary Hull, and in the Pan American conferences held at Montevideo, Urug. (1933), Buenos Aires, Arg. (1936), and Lima, Peru (1938) the delegations from the United States stressed the solidarity and the political equality of all the American republics. Relations with Mexico were strained when Pres. Lázaro Cárdenas, in March 1938, seized the oil properties of British and U.S. firms in Mexico.

After World War II broke out the Latin-American republics were inclined to closer relations with the United States, both because of the penetration of axis propaganda and because the League of Nations, of which most of the Latin-American countries were originally members, showed itself in the cases of China, Ethiopia, Austria and Czechoslovakia impotent to protect the weaker nations. At the conference of Panamá, in Oct. 1939, they took a long step toward hemispheric defense in agreeing to pool their navies to patrol the 6,000 mi. of the eastern coast of South America from the mouth of the Amazon to Cape Horn; and at Havana, Cuba, the next July, they adopted the policy announced by the United States of not recognizing the transfer of any region of the western hemisphere from one non-American power to another and agreed to consult for the protection of any of the republics which should be threatened by the subversive actions of fifth columnists. Trade pacts, large money loans, exchanges of students, delegations of professional and business men and the

various activities of Nelson A. Rockefeller's committee for the cultivation of cultural and commercial relations between the American republics all helped to bring the Latin-American peoples closer to the United States When the United States went to war with the axis powers in Dec 1941, nine of the Latin-American countries (including all the Central-American republics) promptly followed by either breaking off relations with them or declaring war.

Foreign Relations.—*Germany.*—In the middle of April 1939, after Hitler had entered Prague and Mussolini had seized Albania, President Roosevelt sent a message to both leaders, asking them to agree for a period of ten years not to attack any of 31 weaker nations which he listed, promising to secure like guarantees of nonaggression from those nations. Mussolini took no notice of the request, but Hitler refused some days later in an address to the *reichstag* Again, late in August, when Hitler was on the point of invading Poland, the president made another futile attempt to avert a general European war through mediation or conciliation. When the war came on Sept. 3 the sympathy of the United States with the cause of the Allies was unmistakable; and after Hitler's rapid conquest of Denmark, Norway, the Low Countries and France, and his air assaults on Great Britain, that sympathy was changed into active co-operation with Britain in the face of the common nazi danger The transfer of the 50 destroyers to Britain, the repeal of neutrality, the aid given in the Lend-Lease act, occupation of the Danish islands of Greenland and Iceland as lying in waters "necessary for the defense of the United States" and the patrol of North Atlantic waters by U S destroyers were in effect a declaration of war against Germany, and the Germans did not hesitate to retaliate During 1941 they sank U.S.-owned merchant vessels and launched torpedoes at three U.S. destroyers, missing the "Greer," severely damaging the "Kearny" and sinking the "Reuben James." President Roosevelt did not ask congress for a declaration of war, but on Sept. 11 he gave orders to naval vessels protecting lines of commerce to "shoot at sight" on any hostile craft It was not until the Japanese attack on Pearl Harbor on Dec 7 that the president asked congress to declare war formally on Germany and Italy, which it did in both houses.

Great Britain.—The ties between the British Commonwealth and the United States meanwhile became stronger Prime Minister Winston Churchill and President Roosevelt met on a battleship in the Atlantic ocean on Aug. 14, 1941, and drew up the Atlantic charter of eight points, somewhat similar to the first five of Wilson's fourteen points of 1918, outlining the nature of the peace to follow the Allied victory. Later Churchill visited the United States and spent the Christmas season at Washington in conference with the president. He received an ovation when he addressed the joint session of congress

As a result of the conferences a union of nations originally comprising 26 countries, was formed early in 1942, and plans were made for the joint conduct of the war against the totalitarian powers.

Japan.—In the far east the constant encroachments of Japan on the territory of China since her seizure of Manchuria in 1931 became a source of friction between Tokyo and Washington. Accused of breaking article xvi of the League covenant, Japan withdrew from the League of Nations in 1933. Her adherence to the Anti-Comintern pact in 1936 increased her hostility to the western powers. In 1937 war between Japan and China broke out. The sinking of the U.S. gunboat "Panay" on the Yangtze river by a Japanese bomb on Dec. 12, 1937, brought an apology and an indemnity from the Tokyo government; but no pledge of the abandonment of the Japanese policy to create "a new order" in China. On Jan. 26, 1940, the United States abrogated its commercial treaty of 1911 with Japan; but still the United States continued to sell to Japan more than half of the material Japan was using in its war against China. When the Japanese armies invaded French Indochina in Sept. 1940, with the apparent purpose of establishing bases for an attack on the East Indies (the source of many products indispensable to the United States, like rubber, tin, tungsten, hemp, jute and various vegetable oils), the U S put an embargo on scrap iron and steel to Japan; and Japan replied by signing a triple alliance with Germany and Italy (Sept 27) The alliance was evidently aimed at the United States, and Japanese Foreign Minister Yosuke Matsuoka, though asserting that his country wished to preserve peace with the United States, acknowledged that if the axis powers should become involved in war with the United States Japan would be in duty bound to join them. As the year 1941 progressed the Japanese encroachments continued Secretary Hull told Ambassador Adm. Kichisaburo Nomura that "a showdown" would have to come. In November a special envoy, Saburo Kurusu, was sent from Tokyo to join Nomura in negotiations with the president and Secretary Hull.

But even as the conferences were proceeding, Japanese planes descended on Pearl Harbor, Hawaii, on Sunday morning, Dec 7, destroyed two American battleships and five other war vessels, wrought havoc with grounded planes and inflicted about 2,000 casualties. Simultaneous attacks were made on the Philippines (Manila falling at the beginning of Jan 1942), Wake and Guam. On Dec. 8 congress declared war on Japan with only a single dissenting vote (For the military events of the war, *see* WORLD WAR II) (D. S. MU.; E. E. R.)

Election of 1944.—Once before in national history a presidential election had been held while the issue of war was in the balance. As in 1864 so in 1944 there was no thought on the part of responsible leaders that the election would not be held. Indeed, there were men who felt a greater need because of the fourth-term candidacy of President Roosevelt, which was finally accepted by the Democratic party in July. Prior to that nomination the president had made clear his program for peace as well as war in his messages to the congress. He pointed out that the costs of war, so far, had been six times the costs of World War I He estimated that the actual war cost would exceed $200,000,000,000 by the middle of the year. At the same time looking to the future, he called for a "five-point plan," which dealt with the days of peace to follow the war. He envisaged a vast government spending plan, and a new eight-point "bill of rights." These were to include the right to a job; to earn money for adequate food, clothing and recreation, for farmers there was to be a decent living, for businessmen freedom from unfair competitions; there was to be protection for all in old age, during sickness and unemployment; and provision should be made for an education for all.

In mid-February the congress passed a tax bill which, although approved by both administration and legislative party leaders, did not meet the plans of the president. His veto message caused a violent outburst in the press and among his own party supporters. The bill was passed over his veto by overwhelming majorities.

The year was marked by violent labour disputes, and long-drawn-out controversy between the president and his representatives on the one hand, and the representatives of organized labour (in particular musicians and coal miners) and of business on the other. Each added some uncertainty to a wartime election.

In their national convention held at Chicago June 26–28, the Republicans nominated Gov. Thomas E. Dewey of New York, and as vice-presidential candidate, Gov. John W. Bricker of Ohio As had been expected for some months, the Democratic convention meeting in Chicago July 19–21 nominated Roosevelt for the fourth term, and instead of renominating Vice-Pres. Henry A. Wallace, chose Sen. Harry S. Truman of Missouri.

Labour took an unusually active part in the canvass. Not only had the Political Action committee (P.A.C.) and Congress of Industrial Organizations (C.I.O.) been active in the preliminary campaign for Wallace as vice-presidential candidate, but in October Philip Murray of the C.I.O. and Sidney Hillman of the P.A.C. issued statements calling on labour to support the Democratic ticket.

There had been an early discussion of the "soldier vote," estimated at nearly 10,000,000. Various devices were used to poll it, but it did not change the final result. The result of the November election was decisive. Roosevelt polled 25,602,504 votes to

22,006,285 for Dewey. Only 367,474, or less than 1%, were cast for other parties It was notable that although the electoral majority was overwhelming (432–99), the minority vote was not only great (45 9% of the total vote), but spread over two-thirds of the country. Congress remained in the possession of the Democrats. (E. E. R.)

AFTER WORLD WAR II

End of the War.—First in importance in 1945 were of course the events that brought the end of the war. On May 7 all forces of Germany were unconditionally surrendered. On Aug. 6 an atomic bomb was dropped on Hiroshima, and on Aug. 9 one on Nagasaki. On Aug 10 the Japanese government agreed to unconditional surrender. On Sept. 2, on the battleship "Missouri" in Tokyo harbour the surrender was signed. As at the conclusion of World War I the armed forces abroad, except those assigned to occupation in Germany and Japan, were speedily returned home.

President Truman.—Upon the death of President Roosevelt (April 12, 1945) scarcely three months after his inaugural for the fourth term, Truman became president. The problems he faced were known to him only in a general way, for he had not had close association with the administration. First of all were the problems of the war; but second only in importance to the actual realization of the results of the war was the problem of inter-Allied co-operation. These were dramatically presented to the world by conferences with the Russian and British leaders at Yalta and Potsdam The problem of world peace was emphasized by the San Francisco conference, which produced the charter of the United Nations (*q.v.*). The domestic problems that pressed upon President Truman at once had to do most of all with the demands of labour and the danger of inflation following the removal of controls and early steps to return to a peace economy. The 79th congress, however, passed few of the president's major recommendations, since a number of southern Democrats who were opposed to the continuance of New Deal policies had joined with the Republican minority to form an opposition bloc. Moreover, there was disagreement among top administration men on issues such as price control, labour legislation and subsidies.

The United Nations.—On April 18, 1946, the League of Nations ceased to exist. The early moves of the United Nations did not promise an easy course; there were exciting disagreements as to forms and procedures, and in particular as to the location of headquarters. Various sites within the United States were considered by a U.N. committee, and final decision was deferred for some time. But the Security council met at New York city and on Oct. 23 the general assembly meeting at temporary headquarters was opened by President Truman. By the end of the year the question of the veto power had become the leading problem, not only of discussion but also of procedure, because of the attitude of the Soviet Union.

The 80th Congress.—The congressional elections of 1946 were of unusual interest because of the fact that Truman's leadership had never been tested, and because of the shifts in domestic policies following the close of the war which had given a new impetus to both political parties, as yet untested at the polls. There was greater interest than in 1942, evidenced by a vote greater by nearly 7,000,000. The Republicans carried 30 states, and gained control of both houses of congress. It was the first time in 16 years that the Republicans had control of both houses and the first time since Woodrow Wilson's second administration that the president and the majorities in congress were of opposite parties.

On June 16, 1947, Truman vetoed a bill to reduce taxes. The 80th congress passed the Taft-Hartley bill of 1947 over his veto by votes of 320 to 79 in the house and 54 to 17 in the senate. It forbade the closed shop and secondary boycott, authorized injunction proceedings in certain cases and generally held labour unions responsible for complying with the regulations which business had to observe in its financial operations. A controversial part of the act proved to be the section requiring officers of unions to file affidavits disclaiming any connection with communism. The question was whether the regulation applied to the heads of the unions. The C.I.O. was bitterly opposed to the requirement, but William Green of the A.F. of L., who also opposed the law, was inclined to accept that provision. John L. Lewis then withdrew his 600,000 United Mine Workers from the A.F. of L., which they had rejoined a few months before. Other measures passed in 1947 included the ratification of peace treaties with Italy, Hungary, Rumania and Bulgaria; a constitutional amendment limiting the presidency to two terms (ratified in Feb. 1951 as the 22nd amendment), a law fixing the presidential succession (the speaker of the house and then the president pro tem of the senate); an act merging the armed forces into a single department of defense; and a $400,000,000 appropriation to implement the "Truman doctrine," a proposal to combat Communist influences in Greece and Turkey.

A major episode in the continuing "cold war" with the Soviet Union occurred during 1948–49, when the Russians blockaded the Allied sectors of Berlin. The U.S. and Great Britain were, nevertheless, able to maintain a successful airlift for the delivery of food and supplies. The blockade was officially ended on May 12, 1949, but the airlift was continued until Sept. 30.

In April 1948 congress voted an initial grant of $5,300,000,000 for the European Recovery program, a plan for economic aid proposed by Secretary of State George Marshall in June 1947. An Economic Cooperation administration was created and Paul G. Hoffman became the director.

Election of 1948.—The election of 1948 was marked by unusual features from the outset. A considerable portion of the party organization was opposed to the nomination of Truman, some because of disagreement with his policies, both domestic and foreign, and many because of a conviction that his defeat was a foregone conclusion. Many of those differing with the policy in foreign affairs, particularly with the utterances of the administration in the political conflict with the U.S.S.R., united in supporting an independent movement, and eventually presented Henry A. Wallace as a candidate on the platform of a newly formed Progressive party. The more extreme members of the Democratic party in a number of southern states left the Democratic convention after the adoption of a platform stressing civil rights and formed an independent party, the States' Rights Democrats (Dixiecrats), and nominated Gov. J. S. Thurmond of South Carolina for president.

Despite the seeming certainty of defeat because of these revolts, the Democratic convention nominated Truman with Alben W. Barkley as vice-presidential candidate, and called for repeal of the Taft-Hartley act restricting the scope of labour union activities.

The Republican party entered the campaign confident of success, and after a sharp contest in convention—most of all over personalities—united in supporting the ticket, Gov. Thomas E Dewey of New York for president, and Gov. Earl Warren of California for vice-president.

The campaign was listless, the Republican candidate on the whole agreeing with the Democratic program, except for calling for retention of the Taft-Hartley act and for a limitation upon the social-service activities of the federal government. President Truman campaigned actively and with unusual vigour. The methods and speeches of Truman was reminiscent of popular campaigns of Democratic candidates of the preceding 50 years. The result was unexpected by almost everyone except the president and his closest advisers. All public-opinion polls had indicated his defeat. Despite the fact that he lost four states because of States' Rights defection (1,169,021 votes) and that 1,156,103 votes presumably nearer Democratic than Republican, were cast for Wallace, Truman won 24,105,695 votes (303 electoral votes) to 21,969,170 for Dewey (189 electoral votes).

Second Administration of Truman.—Both houses were Democratic as they organized in Jan. 1949. The president called for a vigorous advancement of his Fair Deal program. A combination of Republicans with conservative Democrats, however, prevented action throughout the meeting of this congress. More and more Sen. Robert A. Taft of Ohio became the recognized leader of this opposition, as he had been in the previous congress.

Congress did ratify the North Atlantic treaty, and voted additional funds to the Economic Recovery program. Increased funds were voted for national defense, but proposals for higher taxes were defeated

The Taft-Hartley act was not repealed, nor was the civil rights program enacted The president's party was shown to be a minority in congress on critical domestic issues. In foreign affairs there was a continuation of bipartisan co-operation

In Jan. 1950 Truman announced that he had asked the U.S. atomic energy commission to produce a hydrogen bomb, which theoretically had the potential of being 1,000 times as powerful as an atomic bomb. In March of that year the first shipment of arms, in accordance with previous agreements, was sent to western Europe.

Long before the nominations for seats in the house and senate, it was evident that the campaign of 1950 would be fought at random, that issues would be confused, that personalities would be more than ever in the news As always, however, the call to support the program of the administration was much used by those Democrats who had upheld the Fair Deal in the sessions of the preceding two years. But in Maryland, Ohio, California and New York, and only to a less extent elsewhere, the campaign was fought most of all on the position of one or both candidates on questions growing out of labour demands and of "softness" toward Communists at home and abroad. Near the close of the campaign Truman denounced the program of his opponents in congress and called for endorsement of his program.

Democrats retained control of both houses, but by a greatly reduced margin in the house and by only one seat in the senate. This was generally interpreted as a Republican victory, in particular because of the triumphant victory of Senator Taft in Ohio, and in state contests the re-election of Governor Dewey in New York and Governor Warren in California.

On Dec. 16, 1950, Truman declared a national emergency and outlined plans for placing the U.S. on a war footing. In the same month Gen. Dwight D. Eisenhower was appointed supreme commander of a 12-nation force to be mobilized for the defense of western Europe

In the meantime, attention shifted to Korea, where, in late June 1950, forces of the Korean People's Republic, supported by soviet Russia, advanced south of the 38th parallel separating the northern Korean Communist state from the Republic of Korea, which had been established in 1948.

The issue was presented by the United States to the United Nations, where strong measures were advocated to suppress "aggression" in Korea. Led by the United States, the Security council (the Russian member not attending) voted for intervention by armed forces of the United Nations. Under the command of Gen. Douglas MacArthur, the campaign for the liberation of South Korea was brought to a successful conclusion. As the year ended, however, the issue of the conflict in North Korea was reversed, and the United Nations armies were forced into a costly and precarious retreat by overwhelming forces of the Chinese Communists, whose entrance into the struggle had been foreseen as a possibility but not expected.

The national situation of the United States, as the leader in an attempt to suppress aggression by Communist forces in the far east, became critical, and congress supported the president in a gigantic program for defense in the far east, in Europe and at home. (E. E. R.)

General MacArthur was relieved of his Allied, U.N. and U.S. commands by President Truman on April 11, 1951. He was succeeded in all commands by Lt. Gen. Matthew B. Ridgway, commander of the U.S. 8th army in Korea, who was later promoted to general. By May 31, 1951, U.N. forces had driven Communist armies back across the 38th parallel, and most of the ground lost to the Communists during their spring offensive had been retaken by the United Nations.

After an exchange of radio messages, General Ridgway and the Communist commanders, Gen. Kim Il Sung, of North Korea, and Gen. Peng Teh-huai, of China, agreed on July 5 to begin negotiations in the field for a cease fire. The chief negotiators, Vice-Adm Charles Turner Joy, U.S. navy commander in the far east, and Lt Gen. Nam Il, North Korean army chief of staff, began their talks on July 10 in Kaesong. In October the truce site was moved to Panmunjom Many months later, however, the negotiators still remained deadlocked (X)

The U S took the lead in concluding a peace treaty with Japan, which was signed in San Francisco, Calif , on Sept 8, 1951, by 49 nations, including Japan. Japan and the U S. agreed upon a bilateral security treaty which provided that U.S. troops could be stationed in Japan for an indefinite period, and the U S. also signed defense pacts with Australia and New Zealand In Oct. 1951 Truman signed the Mutual Security act, and appropriations alloting $7,300,000,000 in new funds and $817,000,000 in unexpended funds were provided for the foreign aid program. The E C.A., abolished on Dec. 31, 1951, was succeeded by the Mutual Security agency In April 1952 Eisenhower stated in his annual report that the free world was better able to defend itself than a year before On June 1, 1952, Eisenhower, who was increasingly mentioned as a possible candidate for the Republican presidential nomination, was relieved of his command at his request. Gen. Matthew B. Ridgway succeeded him

On April 8, 1952, Truman had ordered Charles Sawyer, secretary of commerce, to seize control of the nation's steel mills in order to avert a strike in the industry. But on June 2, 1952, the U S. supreme court held by a vote of six to three that the executive order was unconstitutional. Congress rejected requests to pass legislation authorizing the seizure and they were returned to private management.

On July 1, 1952, the senate ratified, by a vote of 77 to 5, a peace contract between western Germany and the western Allies.

Election of 1952.—While he was serving in western Europe, General Eisenhower had been entered in various Republican state primaries, a number of which he won by impressive margins After retiring from his post in western Europe on June 1, 1952, he campaigned actively for the nomination. Sen. Robert A. Taft was the other leading candidate, but Eisenhower was nominated at the national convention on the first ballot at Chicago, Ill , on July 11. Sen. Richard Nixon of California was named the Republican vice-presidential candidate. The Democratic national convention, which also met in Chicago, nominated Gov. Adlai E Stevenson of Illinois and Sen. John Sparkman of Alabama as the presidential and vice-presidential candidates.

Eisenhower vigorously attacked the Democratic administration, charging it with responsibility for the events leading up to the Korean war and for the scandals among top administrators in the internal revenue bureau, justice department and other government offices. Charges of communism in government were also made. Although both candidates had indicated their desire to restrict the campaign to the issues at question rather than personalities, vociferous charges were made by both parties President Truman conducted a "whistle-stop" tour, defending his administration and supporting Stevenson's candidacy.

In the November election, the popular vote of 61,547,861 was the largest in the nation's history. Eisenhower received 33,927,549 votes, which was several million more than the record of 27,751,597 set by Franklin D. Roosevelt in 1936. In a landslide in the electoral college, Eisenhower swept 39 states, with a total of 442 electoral votes, and Stevenson carried only 9, with 89 votes. Eisenhower shattered several political precedents and carried the southern states of Florida, Virginia, Tennessee and Texas The Republicans, who also gained control of the house, won a 48 to 47 margin in the senate, not including one independent Republican. (E E. R., X.)

Eisenhower's Administration.—The first months of the new administration were characterized by caution as Republican leaders studied domestic and foreign policies. Proposals for sweeping tax cuts and statehood for Alaska and Hawaii were postponed, but the controversial off-shore oil bill was signed. In July the signing of the Korean armistice provided a dramatic highlight. In his address to the nation Eisenhower noted that "We have won an armistice on a single battleground—not peace in the world. We may not now relax our guard nor cease our quest." (X.)

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(E. E. R.)

UNITED STATES COAST GUARD, THE: *see* COAST GUARD.

UNITED STATES COAST GUARD ACADEMY at New London, Conn , an institution of higher learning for the training of commissioned officers for the coast guard, was founded by act of congress in 1876, and embraces a four-year curriculum of liberal, theoretical and practical education.

Prior to the advent of World War II, the Coast Guard academy had a cadet corps of between 200 and 300 cadets, but in recent years many new duties with peacetime implications were added to the work under the administration of the coast guard, and it was anticipated that the postwar enrolment at the academy would approximate 500 cadets.

Entrance to the Coast Guard academy, which is beautifully located overlooking the Thames river, is restricted to unmarried men between the ages of 17 and 22 at the time of their appointment. Unlike the Naval and Military academies, appointment to the Coast Guard academy is obtained exclusively through nationwide competitive examinations. There are no political nominations. Examinations are held early in May each year, and application to take the examinations must be made through the coast guard commandant, Washington, D.C. Prospective cadets are examined in mathematics, English and general adaptability. A rigid physical examination is given, and no cadet is accepted who stands less than 5 ft 6 in.

The pay of coast guard cadets is $780 a year with extra allowances for food. A cadet is required to deposit $200 upon entrance to the academy for uniforms, and a portion of his pay is put aside for the purpose of outfitting him at the time of his commissioning

The new class enters the academy during the summer, usually in July The "swabs," or fourth classmen, spend their first summer in becoming indoctrinated to military life They are introduced to small boats, seamanship and military drill, in addition to attending their first classes, which include mathematics and history.

While acute needs of the service early in World War II resulted in the adoption of an accelerated three-year curriculum, the Coast Guard academy later returned to a four-year course of intensive instruction At the same time, the curriculum was revised along lines intended to liberalize the education of a cadet without reducing his theoretical and practical schoolmg. The subjects of instruction include mathematics, English composition, English and comparative literature, history, maritime economics, chemistry, physics, mechanics, electricity, radio, navigation, nautical astronomy, mechanical and ship drawing, naval construction, engineering, thermodynamics, marine engineering, engineering materials, seamanship, law, tactics, gunnery, ordnance and ballistics, communications and machine tool laboratory The Coast Guard academy confers on its graduates the bachelor of science degree as well as a commission as ensign in the United States coast guard.

The present home of the Coast Guard academy was constructed in 1932 at a cost of more than $2,000,000, and was expanded, just prior to the war, at a similar cost. The buildings are of red brick in the Georgian colonial style, and centre around the administration building, Hamilton hall, named after Alexander Hamilton, the first secretary of treasury, who founded the coast guard in 1790. During World War II, ten temporary buildings were erected as quarters for a reserve officers' training school which graduated approximately 4,000 ensigns, a large percentage of them formerly coast guard enlisted personnel detached for officer training from assignments at sea. Facilities of this school are also utilized for special post-graduate work by both regular and reserve officers.

Although, as in any military establishment, discipline and regulations play a very important role, the life of a coast guard cadet has its lighter aspects. Among them are athletics, social events and cruises. In peacetime, the first and third classes make an annual extended summer cruise aboard the larger coast guard cutters, while the second class normally remains at the academy to assist in the indoctrination of the "swabs" and to go on a shorter cruise, generally along the New England coast. The Coast Guard academy's athletic program supports teams in basketball, baseball, boxing, cross country, fencing, golf, rifle and pistol, sailing, soccer, swimming, tennis and wrestling, with each cadet undergoing a rigorous training in physical education.

The cadets are organized in a battalion of four or more companies. The officers of the battalion are first classmen and the battalion organization plays an important role in the life of the cadet, for his official, social and recreational life centres about this basic organization. The highest honour which may come to any cadet of the academy is to be chosen battalion commander in his first-class year. The choice is based on such leadership qualities as honour, personality, tact, courage, truthfulness and military knowledge and bearing.

(J. F. Fv.)

UNITED STATES MILITARY ACADEMY: *see* WEST POINT.

UNITED STATES NAVAL ACADEMY, an institution of higher learning conducted by the U.S. navy department and located at Annapolis, Md., for the purpose of preparing young men to enter the lowest commissioned ranks of the navy and marine corps. It is the principal source of officers. It was founded as the Naval school in 1845 by the Hon. George Bancroft, historian, educator and secretary of the navy, to improve the then

unsatisfactory methods of instructing midshipmen (*q.v.*). At first the course was five years, of which only the first and last were spent at the school, the intervening three years being spent on board ships on active service. It was reorganized in 1850–51 as the U.S Naval academy, with a course of study of four consecutive years A summer practice cruise replaced the omitted sea service, and gave better opportunities for intensive training.

During the Civil War the academy was moved to Newport, R.I, but was brought back to Annapolis in 1865. In the following years great improvements were effected in the organization and curriculum. During the Civil, Spanish-American and World Wars I and II, the course was shortened to provide more officers for the fleets. During World Wars I and II large classes of reserve officers were also trained at the academy.

Under the superintendent, the academy is organized into the following departments: the executive department, headed by the commandant of midshipmen, who is charged with interior discipline, drills and tactical instruction; and the academic departments of seamanship and navigation, ordnance and gunnery, marine engineering, mathematics, electrical engineering, English, history and government, languages, hygiene and physical training. The superintendent, commandant of midshipmen, and the heads of the academic departments constitute the academic board, which determines policies. There are also medical and supply departments, station ships, a hospital, a rifle range and a postgraduate school

Considering that the Naval academy does not attempt to produce specialists in any one subject, the course is equal to those of the best colleges and technical schools. Candidates are appointed upon nomination by the president from the United States at large, by the vice-president, and from the several states and territories upon nomination by the senators, representatives and delegates in congress. Also 100 each year from the navy and marine corps and 50 from the naval and marine corps reserve by competitive examination, and 40 by competitive examination from among the sons of officers, soldiers, sailors and marines who died as a result of World War I. The entrance examinations are designed to admit competent graduates of first-class secondary schools. The physical requirements are rigid. A fourth-classman or "plebe" enters in June or July, between 16 and 20 years of age, and spends the summer in drills designed to fit him for his new environment. Of the next three succeeding summers, two are spent on three months' practice cruises in battleships, and one is devoted to practical instruction in aviation, engineering, navigation and seamanship at the Naval academy, in addition to a month's coastal cruise in destroyers. The academic year runs from October to June The course covers higher mathematics, physics, chemistry, engineering, naval construction, electricity, seamanship, communications, military and international law, elementary strategy and tactics, military tactics, aeronautics, ordnance and gunnery, navigation, English, naval history, modern history, government, French, Spanish, German or Italian, hygiene and physical training. Theoretical and practical instruction are combined to the fullest extent Graduates are awarded degrees of bachelor of science.

In the early part of the century, the academy was almost completely rebuilt. The grounds, comprising 225 ac. in Naval academy proper, present a most pleasing appearance, with imposing buildings in granite, reinforced concrete, white brick and terra cotta, in the French Renaissance style, after the designs of Ernest Flagg. There are 150 major buildings, including officers' quarters, the estimated value of which is (1940) about $31,500,000. In 1939 there were 2,307 midshipmen.

In 1909 the postgraduate school was established. Selected officers are sent there from sea for a year or more of advanced work to qualify them in design, repair, construction and operation of material. One or more years of instruction at a civilian university or technical school is provided for selected groups of these officers. In 1927 a "general line course" was established, consisting of a year's work at the postgraduate school in professional subjects, followed by a year of practical work elsewhere on shore.

See Benjamin, *The United States Naval Academy;* Earle, *Life at the U.S Naval Academy;* Soley, *Historical Sketch of the United States Naval Academy;* Naval Academy Registers; and *Regulations Governing the Admission of Candidates into the U.S. Naval Academy*, published by the Bureau of Navigation, Navy Department. (C. W. N.)

UNITED STATES RUBBER COMPANY is a consolidation of more than 80 companies, several of them dating from the inception of the rubber manufacturing industry in 1839. Incorporated in 1892 as a merger of manufacturers of rubber boots, shoes and clothing, other companies were acquired to round out the complete line of products which includes every article made of rubber The company, and subsidiaries, operate in the United States 13 rubber factories, 3 cotton mills, chemical plant, reclaimed rubber factory and a shoe hardware plant, as well as a central development laboratory. In Canada, five factories are operated and there are sales offices and warehouses in the principal U.S. cities, and throughout the world.

The company has owned and operated since 1910 the largest rubber plantations in the world. They comprise 99,500 acres planted with 10,000,000 trees and the annual capacity exceeds 70,000,000 pounds. These estates were among the first to develop bud-grafting and now have areas with a current output of 1,500 pounds per acre and a potential of 2,000 pounds. (E C Bu.)

UNITED STATES SHIPPING BOARD, a board created by an act of congress approved Sept. 7, 1916, entitled:—

An act to establish a United States Shipping Board for the purpose of encouraging, developing and creating a naval auxiliary and naval reserve and a merchant marine to meet the requirements of the commerce of the United States with its territories and possessions and with foreign countries; to regulate carriers by water engaged in foreign and interstate commerce of the United States; and for other purposes

Under the act the board was authorized to form a shipping corporation with a capital stock not exceeding $50,000,000, of which a majority was to be held by the United States, for the purchase, construction, equipment, lease, charter and operation of merchant vessels in the commerce of the United States. The act provided that the $50,000,000 to be placed at the disposal of the board would be raised through the sale of Panama canal bonds. The shipping corporation provided for in the act was incorporated under the name of the Emergency Fleet corporation, but in 1927 congress changed the name to the U.S Shipping Board Merchant Fleet corporation.

In the spring of 1917, when the United States entered World War I, there were in the country 37 steel shipyards with 162 ways and 24 wooden shipyards with 72 ways, capable of launching vessels of 3,500 dead-weight tons. At the signing of the Armistice in 1918, there were in all 223 shipyards, steel and wood, with a total of 1,099 ways. At the close of the war the shipping board controlled a total fleet of 1,196 vessels of 6,540,205 dead-weight tons. These vessels were acquired by: (1) New ships built by the Shipping Board. (2) American ships requisitioned on "time" and "bare boat" charters (3) Seized German ships. (4) Commandeered Dutch ships. (5) Chartered neutral ships.

The shipping board is an independent department of the executive branch of the government The powers given the board under the act to regulate the operation of common carriers by water make its powers not unlike those of the Interstate Commerce commission. However, it is expressly provided in the act that the board has not concurrent jurisdiction with the Interstate Commerce commission in matters within the latter's power.

Following the directions of congress, contained in the Merchant Marine act of 1916, as amended in 1920, the shipping board has gradually disposed of its vessels to American citizens. Some vessels were disposed of with the obligation that the vessel would be used in a definite service and trade. The sale of some vessels carried with it the obligation to undertake alterations, betterments and reconditioning under approved plans and specifications.

UNITED STATES STEEL CORPORATION, a U.S. holding company, was incorporated under the laws of the state of New Jersey, on Feb. 25, 1901. On its formation it acquired the steel properties of many of the major steel-making interests in the United States together with anterior properties supplying the steel-making interests with raw materials, ore, coal, gas and

fluxes, including transportation facilities for servicing the steel-making operations During the years after its organization many changes have been made by merger and consolidation in the subsidiary corporations.

The subsidiary manufacturing companies operate 87 blast furnaces, 22 Bessemer converters, 360 open-hearth and electric steel furnaces and finishing mills for a wide range of steel products, and for production of cement The steel ingot capacity is about 27,627,600 net tons annually, about 34.8% of the total U S. ingot capacity. The capacity of output for rolled and other steel finished products is 19,759,000 net tons annually. For year 1939 the total sales had a value at producing plants of $801,089,000 and covered the disposal of 11,707,251 net tons of steel products, together with sales of by-products and miscellaneous items. In addition, its gross revenue from transportation and distribution service was $103,113,000. For that year the number of employees was 223,844 with a total pay roll of $368,578,000. The output of finished steel products in 1939 was 60 77% of the total capacity, the economic conditions in the United States prevailing in 1939 not calling for the full output of the properties.

Capital stock of the corporation consisted, at close of 1938, of 8,703,252 shares of no par common and 3,602,811 shares of preferred of the par value of $100 per share In 1938, the common shares were changed to a no par value stock, the same number of shares of common of no par value being substituted for previously existing common shares of $100 par value each The no par value common shares were given a stated value of $75 per share, thus making the stated value of the common shares issued $652,743,000, plus the par of the preferred shares, $360,281,100, a total stated value for both classes of stock of $1,013,025,000, which, with a stated capital surplus of $38,462,800 89, makes a grand total of stated capital value of $1,051,487,800.89 The total bonded debt, mortgages and purchase money obligations at Dec. 31, 1939, were $246,061,588, of which total $97,854,500 were obligations of the United States Steel corporation and $148,207,088 were subsidiary companies' issues. The balance of earned surplus at Dec 31, 1939, was $263,319,270. The number of stockholders was 219,727. (W. J. F.)

UNITED SYNAGOGUE, one of the six chief organizations of London Jews. These are, in order of seniority· (1) the Spanish and Portuguese Jews' congregation, founded in 1657: principal synagogue, Bevis Marks, Aldgate (built 1690–1701); three constituent synagogues The post of *Haham* has not been filled since Dr. M. Gaster resigned in 1917 after 37 years' tenure. President of the Elders, Sir Francis Montefiore, Bart. (2) West London synagogue of British Jews (Reform), founded in 1841 mainly by members of the preceding synagogues, 34 Upper Berkeley street, W.I. Minister Emeritus, Rev. M Joseph; minister, Rev. V. C Simmons, B.A.; chairman of council, P. S. Waley (3) The United synagogue, founded by act of parliament in 1870 by a union of the Duke's place and other Ashkenazic synagogues and consisting of 18 constituent, two district and 13 associated synagogues: the chief Rabbi is Dr. J. H Hertz (*q v*) and the president is Lionel de Rothschild, O B.E. (4) The Federation of Synagogues (38 constituents). (5) The Adas Yisroel (Rabbi V. Schonfeld), 124. Green lanes, N 16 (6) The Liberal Jewish synagogue, established 1910, 28 St. John's Wood road, N W 8 Rabbi I I Mattuck and Rev. M. L. Perlzweig. President, Dr C G. Montefiore Besides these six organizations there are many independent synagogues. The United synagogue is confined in its direct spiritual, educational and charitable work to London, but it exercises considerable influence over the Jews of the empire by reason of the high respect felt towards its Chief Rabbi. (*See* pp. 18. *sqq.* of H. P. Stokes, *Studies in Angl. Jew. Hist.* 1913.)

BIBLIOGRAPHY.—Details of the United Synagogue and other bodies, metropolitan, provincial and colonial, will be found in the current issue of the *Jewish Year Book.*

The United Synagogue of America is a federation of Jewish congregations, sisterhoods and young people's organizations, in the United States, Canada and Cuba. It was founded in 1913 by the late Prof. Solomon Schechter, for the purpose of advancing the cause of Judaism in America and the maintenance of Jewish tradition in its historical continuity. It was incorporated on April 24, 1916 The United Synagogue of America does not endorse innovations introduced by any of its constituent bodies, yet embraces all elements essentially loyal to traditional Judaism. In 1918, the Women's league was organized with the object of advancing traditional Judaism by furthering Jewish education among women, by creating and fostering Jewish sentiment in the home, by promoting the observance of Jewish dietary laws and home ceremonials, Sabbath and Festivals, and by generally strengthening the religious institutions of the home and the community. In 1921, the Young People's league was established for the purpose of enlisting the activity of the Jewish youth in the advancement of traditional Judaism by extending their knowledge of Judaism, deepening their devotion to its precepts and establishing closer relations between them and the Synagogue; to foster a knowledge of Hebrew and to encourage an active interest in the Zionist cause.

UNITS, DIMENSIONS OF: *see* DIMENSIONAL ANALYSIS.

UNIVERSAL, in logic, means that which our thought conceives to be common to several instances which are thus considered to be of the same kind, whether as instances of the same quality or relation or as members of the same class Universals in this sense can not be apprehended in sense-perception, only in thought, that is by means of ideas or concepts. Hence the tendency sometimes to identify "universals" with "ideas" (or "Ideas" with a capital), as in Plato, for instance, without however confusing them with mental processes as such. The predicate of a judgment or proposition is always a universal term, except perhaps in the unimportant cases in which the proposition simply refers singular terms to the same subject. Hence universals are sometimes called predicates, and the five predicables (*q v*) are known as *the* universals or the highest universals.

UNIVERSAL ATLAS CEMENT COMPANY: *see* ATLAS PORTLAND CEMENT COMPANY.

UNIVERSALIST CHURCH, a religious body organized in the United States, and represented chiefly by parishes and churches in that country and Canada A distinction should be noted between Universalism and the Universalist denomination. Universalism—the belief that the whole human race will be "saved" —was a doctrine of some of the greatest of the church fathers, notably Clement of Alexandria and Origen, and is now held by many in other communions. The Universalist denomination arose in the United States in the latter part of the 18th century.

History.—The origin of this church is commonly associated with the landing and preaching of Rev. John Murray at Good Luck, N J, in Sept 1770. Murray, a disciple of James Relly (1720–1778), a Calvinistic Universalist of London, was seeking refuge in the new world from sorrow and trouble. Persuaded that he should be an apostle of this new faith, he became an itinerant minister in Massachusetts, New York, New Jersey, Pennsylvania and settled in Gloucester, Mass. (1774). His Universalism was a protest against the doctrine of endless punishment.

Under the leadership of Hosea Ballou (1771–1852), the most influential and honoured minister of the sect for half a century, Universalists became largely Unitarian and also broke with the Calvinism of Murray. The first period of the denomination's history was largely controversial. Religious and sectarian feeling pro and contra Universalism was intense. After 1820, ministers and churches began to multiply, and newspapers were established.

Doctrine.—The fundamental tenet of Universalism may be said to be the illimitable love and goodness of God, assuring triumph over evil in human society as a whole and in the life of every individual. The historic symbol of the denomination is the Winchester Profession, adopted at the meeting of the General Convention—then a spontaneous yearly gathering of Universalists, without ecclesiastical authority—in Winchester, N.H, in Sept. 1803. It consists of three brief articles:

Article I.—We believe that the Holy Scriptures of the Old and New Testaments contain revelation of the character of God and of the duty, interest and final destination of mankind.

Article II.—We believe that there is one God, whose Nature is Love, revealed in one Lord Jesus Christ, by one Holy Spirit of

Grace, who will finally restore the whole family of mankind to holiness and happiness.

Article III —We believe that holiness and true happiness are inseparably connected, and that believers ought to be careful to maintain order and practise good works, for these things are good and profitable unto men.

At a session of the general convention in Boston in 1899 a brief statement of essential principles was adopted as follows.

1. The Universal Fatherhood of God; 2. The Spiritual Authority and leadership of His Son, Jesus Christ; 3. The Trustworthiness of the Bible as containing a revelation from God; 4 The certainty of just retribution for sin; 5. The final harmony of all souls with God

Polity.—Universalist parishes govern themselves but acknowledge (theoretically) the authority of the Universalist general convention, constituted of its officers, a board of trustees of 11 members, active ordained clergymen, two lay delegates (one a woman) from each parish and officers of the several state conventions, which are subordinate to the general convention.

Statistics.—In 1929 there were 44,599 Universalists in the United States

The number of churches was given as 443 in 1927.

BIBLIOGRAPHY.—*The Universalist Quarterly Review* (1843–91); T. Whittemore, *Modern History of Universalism* (1830); Richard Eddy, *Universalism in America* (2 Vols, 1884); J. C. Adams, *Fifty Notable Years* (1882); Abel C. Thomas, *A Century of Universalism* (1870); T. B. Thayer, *The Theology of Universalism* (1862); J. M. Atwood (ed), *The Latest Word of Universalism*, Essays by Thirteen Representative Clergymen (1880); O. Cone, *Essays Doctrinal and Practical* (1889). (J. M. AT)

UNIVERSAL LANGUAGE. The term international language is generally used to denote a second, or auxiliary, language for international use. The concept has been a constant one, as we are reminded by the story of the curse of Babel; but the ancient and modern solutions have a crucial point of differentiation. Formerly the universal language was the langage of the conqueror, and that concept has been urged in modern times in support of French, as the traditional language of diplomacy, and of English, as that of commerce. The modern world, however, tends to favor the adoption of some new linguistic medium, because it has been found that such a medium is easy to use and because it is inoffensive to national pride.

Greek, Latin and Arabic have had, at various times, the status of international languages. French occupied a similar position, particularly in the 18th and early 19th centuries, in diplomacy, social life and literature; it is still the usual international language of Europe and the Levant. English, however, has come to share the prestige of French in diplomacy, while in the orient the normal international language is English, often in the debased forms known as *Pidgin* (*q.v.*), or "business" English. Italian was used as the basis for a similar international commercial language in the Mediterranean countries during the Crusades, and has persisted in common use under the designation *lingua franca* The international language of high local prestige has been a constant phenomenon along linguistic frontiers· the Chinook of the Columbia river valley and the "pidgin" Malay of Polynesia are examples in point.

Of some 200 schemes for the creation of a suitable language on scientific principles the vast majority are projects only. They may be roughly divided into (a) *a priori* (philosophical, arbitrary) and (b) *a posteriori* (based on one or more existing languages)

Most early schemes were of the *a priori* type alluded to by Roget in his *Thesaurus*. Solresol, based on the seven notes of the scale (1817), Lingualumina (1875), Blaia Zimondal (1884), Cabe aban (1887), Zahlensprache (1901) are more recent examples. Such schemes are based on a classification of ideas translated into words bearing no relation to any other language. Obviously they depend on the caprice of the inventor; though usable as codes. they impose a great strain on the memory. One such scheme still advocated is Ro, invented in 1904 by the Rev P. Foster. It has some vocabularies, a monthly sheet *Roia*, and as literature the first chapter of St. John.

It is, however, now generally agreed that the international language must be *a posteriori*. It should be international, easy for all, neutral, euphonious, phonetic, flexible, unambiguous, logical, regular, adaptable, and must be tested by long-continued practical use on a large scale.

Esperanto.—Initiated in 1887 by Dr. L. L Zamenhof, Esperanto is claimed to possess all these characteristics. It is neutral and international in its elements, logical and regular in construction, and euphonious. The grammar can be grasped in half an hour, every rule is without exception, the spelling is phonetic and the dictionary small. Nevertheless, it has literary power, beauty, precision, flexibility and power of growth. There are some 4,000 Esperanto books, original and translated, including the Bible; the literature is rapidly growing, 100 magazines appearing regularly. The League of Nations has published a favourable memorandum (compiled from government reports) on the teaching of Esperanto in the schools of the world. The Paris chamber of commerce and the London county council teach Esperanto in their commercial schools, the London chamber of commerce examines in Esperanto In 1925 the International Telegraphic Union officially recognized Esperanto as a "clear language." The British association in 1919 appointed a committee, which in 1924 definitely recommended Esperanto as its choice. In May 1927 the Union Internationale de Radiophonie recommended broadcasting stations to use Esperanto, and in Dec. 1927, 44 stations were giving regular Esperanto transmissions. Twenty annual International Esperanto congresses have already been held, attended by from 1,000 to 4,000 members from all parts of the world On a foundation they regard as sound they are rearing a superstructure of technical vocabularies with the co-operation of expert committees The majority of universal language partisans, and nearly all the literature, are Esperantist, but there are considerable differences in pronunciation in different countries

Ido.—In 1907 Couturat and de Beaufront produced a modification of Esperanto which they named simplified Esperanto. Owing to Esperantist protests, the "linguo internaciona" was renamed Ido (an Esperanto word meaning offspring). Ido is said to be Esperanto rendered more scientific and natural; it abolishes accented letters, correlatives, the compulscry accusative, the agreement of the adjective with the noun.

Over 50 schemes have appeared for "reformed" Esperanto, "reformed" Ido or some compromise; none of these projects, however, has had any success. Prof R de Saussure, believing that some minor features of Esperanto handicap propaganda, proposed to eliminate them while preserving the essential qualities of the language From 1907 onward a stream of experimental projects and literature has issued from his language laboratory—Antido I. Antido II, Lingvo Kosmopolita, Esperantido and finally Novo-Esperanto (1925) His attitude of scientific detachment and research, however, has been insufficiently appreciated.

The first international language to be used in fact was the once famous Volapük. This was invented in 1880 by an Austrian priest, the Rev. F. Schleyer. It was founded, as to 40%, on English, but the roots were so distorted in accordance with arbitrary rules that they were almost unrecognizable, and the language was further encumbered by an almost Greek profusion of terminations and variations. The collapse of Volapük, which in 1889 claimed a million adherents and had held three successful congresses, was ensured by the refusal of Bishop Schleyer to permit any modification The central Volapük academy, Kadem Bevüretik Volapüka, directed by Dr W. Rosenberger (d. 1918), nevertheless continued its researches into the best possible form of an international language. In 1898 it issued a vastly improved language which it called Idiom Neutral and changed its own name to *Akademi de Lingu Internasional* From that time, both within and without the academy, research has not ceased, nor has the stream of proposed languages. Latinesce (by Henderson), Nov-Latin (by Rosa), Monario (by Lavagnini), Occidental (by de Wahl), Europan (by Weishart), Optex (by S. Bond), Romanal (by Michaux), deserve particular mention

The greatest advance has perhaps been made by Prof. G Peano, since 1908 director of the academy, now the Academia pro Interlingua. Peano's Interlingua arises out of an address written by

him in 1903; he began in good classical Latin and pointed out that certain features—*e.g.*, conjugation, gender, irregularity of verbs, agreement of adjectives—were no longer necessary.

As he proved each point he removed the offending practice from his own text and the address, which began in Ciceronian Latin, finished in "Latino sine flexione," a tongue now known as Interlingua, which consists of the living Latin roots in all European languages, with the modern rules of the order of words, and without grammar.

See L. Couturat and L. Leau, *Histoire de la langue universelle* (1903); W. J. Clark, *International Language, Past, Present and Future* (1912); G. Peano, *Vocabulario Commune* (1915), A. L. Guérard, *Short History of the International Language Movement* (1922); Otto Jespersen, *An International Language* (1928).

UNIVERSE OF DISCOURSE, in logic, is the limited sphere of reference within which an assertion is intended to hold good. Hence the alternative name, "limited universe." The expression "universe of discourse" was first introduced by A. De Morgan, who states his meaning as follows. "For the most part the objects of thought which enter into a proposition are supposed to be taken, not from the whole universe of possible objects, but from some more definite collection of them. Thus when we say 'All animals require air' . . . we should understand that we are speaking of things on this earth the planets, etc. . . . not being included" (*Formal Logic*, ch. iv). Boole and Jevons used the term in the same sense, namely, for a part of the real world. Subsequently the notion was extended so as to include also merely imaginary spheres of reference—the world of illusions, supernatural worlds, worlds of sheer madness and vagary, etc. (*see* W. James, *Principles of Psychology*, vol. ii, ch. xxi). In logic the question is of some importance in connection with the problem of the existential import of propositions, especially of categorical propositions.

See A. Wolf, *The Existential Import of Categorical Predication: Studies in Logic* (1905).

UNIVERSITIES. The mediaeval Latin term *universitas* was originally employed to denote any community or corporation When used in its modern sense of a body devoted to learning and education, it required the addition of other words, such as *magistrorum et scholarium* In the course of time, probably towards the latter part of the 14th century, the term began to be used by itself, with the exclusive meaning of a lawfully recognized community of teachers and scholars. But the more ancient and customary designation of such communities in mediaeval times (regarded as places of instruction) was *studium* (and subsequently *studium generale*), a term implying a centre of instruction for all.

A university often had a vigorous virtual existence long before it obtained that legal recognition which entitled it, technically, to take rank as a *studium generale*.

The university appears to have started as a scholastic guild—a spontaneous combination, that is to say, of teachers or scholars, or of both combined, and formed, probably, on the analogy of the trades guilds and the guilds of aliens in foreign cities, which, in the course of the 13th and 14th centuries, sprang up in most of the great European centres. The design, in the first instance, was little more than that of securing mutual protection. And so the university, composed as it was to a great extent of students from foreign countries, was a combination formed for the protection of its members from the extortion of the townsmen and the other annoyances incident in mediaeval times to residence in a foreign state.

It was a first stage of development in connection with these primary organizations when the chancellor of the cathedral or some other authority began to accord to other masters permission to open other schools than the cathedral school in the neighbourhood of his church; a further stage was reached when a licence to teach—granted only after a formal examination—empowered a master to carry on his vocation at any similar centre that either already existed or might afterward be formed throughout Europe —*facultas ubique docendi*.

It was a still further development when it began to be recognized that, without a licence from either pope, emperor or king, no *studium generale* could be formed possessing this right of conferring degrees, which originally meant nothing more than licences to teach.

Meaning of "Studium Generale."—In the north of Europe licences to teach were granted by the chancellor scholasticus or some other officer of a cathedral church, in the south it is probable that the guilds of masters (when these came to be formed) were at first free to grant their own licences, without any ecclesiastical or other supervision Gradually, however, toward the end of the 12th century, a few great schools claimed, from the excellence of their teaching, to be of more than merely local importance Practically, a doctor of Paris or Bologna would be allowed to teach anywhere; and those great schools began to be known as *studia generalia; i e*, places resorted to by scholars from all parts. Eventually the term came to have a more definite and technical significance. The emperor Frederick II in 1225 set the example of attempting to confer, by an authoritative bull, upon his new school at Naples the prestige which the earlier *studia* had acquired by reputation and general consent. Gregory IX did the same for Toulouse in 1229 and added to its original privileges in 1233 a bull by which anyone who had been admitted to the doctorate or mastership in that university should have the right to teach anywhere without further examination. Other *studia generalia* were subsequently founded by papal or imperial bulls, and in 1292 even the oldest universities, Paris and Bologna, found it desirable to obtain similar bulls from Nicholas IV. From this time the notion began to prevail among the jurists that the essence of the *studium generale* was the privilege of conferring the *ius ubicunque docendi*, and that no new *studium* could acquire that position without a papal or imperial bull. There were, however, a few *studia generalia* (*e g*, Oxford) whose position was too well established to be seriously questioned, although they had never obtained such a bull; these were held to be *studia generalia ex consuetudine* A few Spanish universities founded by royal charter were held to be *studia generalia respectu regni*. The word *universitas* was originally applied only to the scholastic guild (or guilds) within the *studium*, and was at first not used absolutely, the phrase was always *universitas magistrorum* or *scholarium* or *magistrorum et scholarium* By the close of the mediaeval period, however, the distinction between the terms *studium generale* and *universitas* was more or less lost sight of, and the term *universitas* began to be used alone.

ITALIAN UNIVERSITIES IN THE MIDDLE AGES

Rise of University of Salerno.—To understand why the earliest universities arose it is necessary to take account not only of their organization but also of their studies. By the 6th century the secular pagan schools of the Roman empire had been swept away. By the 12th, the cathedral and monastic schools which replaced them had attained to their highest degree of influence and reputation. But these schools taught only what was supposed to be necessary for the education of the priest and the monk. The *studia* arose out of efforts to provide instruction beyond the range of the cathedral and monastic schools Salerno, the first great *studium*, became known as a school of medicine as early as the 9th century Its medical system was originally an outcome of the Graeco-Roman tradition of the old Roman world. In the first half of the 9th century the emperor at Constantinople sent to the caliph Mamoun at Baghdad a collection of Greek manuscripts. These texts were translated into Arabic by Syrian Christians, and the Arabic was later rendered into Latin for the use of teachers in the west. Of the existence of such versions we have evidence, according to C. M. G. Bréchillet-Jourdain, long before Constantine the African (d. 1087) began to lecture on medicine at Salerno Under his teaching the fame of Salerno as a medical school became diffused all over Europe. It was distinguished by its catholic spirit; at a time when Jews were the object of religious persecution throughout Europe, they were to be found both as teachers and learners at Salerno. In 1231 it was constituted by the emperor Frederick II the only school of medicine in the kingdom of Naples. It remained a medical school only. "Nothing approaching a

regular university ever existed there" (H Rashdall, *The Universities of Europe in the Middle Ages*, vol. i, part 3, p 82)

Bologna.—The great revival of legal studies which took place at Bologna about the year 1000 had been preceded by a corresponding activity elsewhere—at Pavia by a famous school of Lombard law and at Ravenna by a yet more important school of Roman law In Bologna itself we have evidence that the *Digest* was known and studied before the time of Irnerius (1100–30), a certain Pepo being named as lecturing on the text about the year 1076 The secular character of this new study and its close connection with the claims and prerogatives of the western emperor aroused papal suspicion, and for a time Bologna and its civilians were regarded by the church with distrust But the appearance of the *Decretum* of Franciscus Gratianus, about 1140, invested the studies of the canonist with fresh importance. It was quickly regarded as official canon law, and so numerous decrees of past and almost forgotten pontiffs now claimed to take their stand side by side with the enactments contained in the *Corpus Juris Civilis* They constituted, in fact, the main basis of those new pretensions asserted by the papacy in the course of the 12th and 13th centuries It was necessary, accordingly, that the *Decretum* should be known and studied beyond the walls of the monastery or the episcopal palace Such a centre of instruction was found in Bologna, which became recognized as the chief school of both civil and canon law. But the statement that university degrees were instituted there as early as the pontificate of Eugenius III (1145–53) rests on no good authority The students found their first real protector in the emperor Frederick I, Barbarossa. Finding that their grievances were real, especially against the landlords in whose houses they were domiciled, he granted the foreign students substantial protection by conferring on them certain special immunities and privileges (Nov 1158) These privileges were embodied in the celebrated *Authentica, Habita*, in the *Corpus Juris Civilis* of the empire (book iv, tit. 13), and were eventually extended to all the other universities of Italy.

Nevertheless, Bologna did not possess a university as early as 1158 Its first university was not constituted until the close of the 12th century. The "universities" at Bologna were, as H S Denifle has shown, really student guilds. These were originally only two in number, the *Ultramontani* and the *Cismontani*, and arose out of the absolute necessity under which residents in a foreign city found themselves of obtaining by combination that protection and those rights which they could not claim as citizens Originally, they did not include the native student element and were composed exclusively of students in law Denifle thinks that the "universities" at Bologna were at one time certainly more than four in number, and we know that the Italian students alone were subdivided into two—the Tuscans and the Lombards. In the centres formed by secession from the parent body a like subdivision took place. At Vercelli there were four *universitates*, composed, respectively, of Italians, English, Provençals and Germans; at Padua there were similar divisions into Italians, French (*i.e.*, *Francigenae*, comprising both English and Normans), Provençals (including Spaniards and Catalans). According to Odofred, in the time of the eminent jurist Azo, who lectured at Bologna about 1200, the number of the students there amounted to about 10,000, of whom the majority were foreigners. It seems, therefore, reasonable to conclude that the number of these confederations of students (*societates scholarium*) at Bologna was yet greater.

The Rector.—In marked resemblance to the guilds, these confederations were presided over by a common head, the *rector scholarum*, an obvious imitation of the *rector societatum* or *artium* of the guild, but to be carefully distinguished from the *rector scholarum*, or director of the studies, with whose function the former officer had, at this time, nothing in common. Like the guilds, again, the different nations were represented by their *consiliarii*, a deliberative assembly with which the rector habitually took counsel. The students at Bologna were mostly of mature years. As the civil law and the canon law were, at first, the only branches of study, the class they attracted was often composed of men already filling office in some department of the church or state —archdeacons, heads of schools, canons of cathedrals and like functionaries forming a considerable element in the aggregate

About the year 1200 were formed the two faculties of medicine and philosophy (or the "seven liberal arts"), the former being somewhat the earlier. It was developed, as that of the civil law had been developed, by a succession of able teachers, among whom Thaddeus Alderottus was especially eminent The faculty of arts, down to the 14th century, scarcely attained to equal eminence. The teaching of theology at Bologna remained for a long time exclusively in the hands of the Dominicans, and it was not until the year 1360 that Innocent VI recognized the university as a *studium generale* in this branch.

The term "college" at Bologna long had a different meaning from that it now ordinarily conveys. The masters formed themselves into *collegia* (that is, organizations), chiefly for the conferment of degrees. Places of residence for students existed at Bologna at a very early date, but it was not until the 14th century that they possessed any organization, the humble *domus*, as it was termed, was at first designed solely for necessitous students who were not natives of Bologna. A separate house, with a fund for the maintenance of a specified number of scholars, was all that was originally contemplated Such was the character of that founded by Zoen, bishop of Avignon, in Feb. 1256 (O.S.), the same month and year. It is to be noted, in which the Sorbonne was founded in Paris. It was designed for the maintenance of eight scholars from the province of Avignon, under the supervision of three canons of the church, maintaining themselves in the university. The college of Brescia was founded in 1326 by William of Brescia, archdeacon of Bologna, for poor foreign students, without distinction as to nationality. The Spanish college was founded in 1364 for 24 Spanish scholars and two chaplains.

Other Italian Centres.—The earliest foundations in Italy after that of Bologna were the universities of Reggio nell' Emilia and Modena, both of which had flourishing schools of civil law before the close of the 12th century. Vicenza (founded 1204) and Padua (1222) both originated in migrations of students from Bologna. The University of Naples was founded by the emperor Frederick II in 1225 and was temporarily suppressed after his death. It was reconstituted in 1258. Piacenza, founded by papal charter in 1248, had little importance until 1398 when it was reconstituted by Galeazzo Visconti, duke of Milan, who caused the University of Pavia to be transferred to Piacenza. Pavia had long been famous as a school of Roman law, and for a time its fame was transferred to Piacenza. From 1404 to 1412 both universities ceased to exist. But after that date Pavia became almost as famous a school of civil law as Padua itself. Arezzo was a centre for legal study from 1215 to 1470. Rome (1303) had schools of canon and civil law for poor foreign students throughout the 14th and 15th centuries. Perugia (1308) specialized in civil law, Pisa (1343) was closed from 1403 to 1476, when it was reopened by Lorenzo dei Medici. The University of Florence (1349) had a brilliant existence in the first half of the 15th century, but was closed in 1472. Graduates of Siena, whose importance dates from 1357 though it was nominally founded in 1241, were accorded the same privileges as those of Bologna. Ferrara was famous in the latter half of the 15th century. The University of Turin was founded about the year 1400, that of Parma not until 200 years later.

PARIS IN THE MIDDLE AGES

Origin of University of Paris.—The commencement of the University of Paris well illustrates the fact that the universities arose in response to new needs The study of logic, which, prior to the 12th century, was founded exclusively on one or two meagre compends, received about the year 1100 a powerful stimulus on two occasions—first from the memorable controversy between Lanfranc and Berengarius, and second from the no less famous controversy between Anselm and Roscellinus The belief arose that intelligent appreciation of spiritual truth depended upon correct use of prescribed methods of argument. Dialectic was looked upon as the "science of sciences", and when, somewhere in the first decade of the 12th century, William of Champeaux opened in Paris a school for the more advanced study of dialectic as an art, his teaching was attended with marked success. Among his pupils

was Peter Abelard, in whose hands the study made a yet more notable advance By the middle of the century John of Salisbury could say that all learned Paris had gone well-nigh mad in its pursuit and practice Abelard taught first at the cathedral school at Notre Dame and later at the schools on the Mont Ste Geneviève, of which he was the founder and where he imparted to logic its new development.

The schools out of which the university arose were those attached to the cathedral on the Île de la Cité and presided over by the chancellor—a dignitary who must be carefully distinguished from the later chancellor of the university For a long time the teachers lived in separate houses on the island, and it was only by degrees that they combined themselves into a society and that special buildings were constructed for their classwork The flame which Abelard's teaching had kindled was not destined to expire Among his pupils was Peter Lombard, who was bishop of Paris in 1159 and widely known to posterity as the compiler of the famous volume of the *Sentences* The design of this work was to place before the student, in as strictly logical a form as practicable, the views (*sententiae*) of the fathers and all the great doctors of the church upon the chief and most difficult points in the Christian belief. The logicians seized upon it as a great storehouse of indisputable major premises, on which they argued with renewed energy and with endless ingenuity of dialectical refinement It was probably this development of new methods of instruction concurrently with new material upon which to exercise them which finally distinguished the university from the cathedral schools.

Early Organization.—The University of Paris, as already stated, took its rise entirely out of the movement carried on by teachers on the island, who taught by virtue of the licence conferred by the chancellor of the cathedral. In the second decade of the 13th century, it is true, we find masters repairing to the left bank of the Seine and placing themselves under the jurisdiction of the abbot of the monastery of Ste. Geneviève; but it was around the bestowal of this licence by the chancellor of Notre Dame, on the Île de la Cité, that the university grew up. It is in this licence that the whole significance of the master of arts degree is contained; for what is technically known as admission to that degree was really nothing more nor less than receiving the chancellor's permission to "incept," and by "inception" was implied the master's formal entrance upon, and commencement of, the functions of a duly licensed teacher and his recognition as such by his brethren in the profession. The previous stage of his academic career, that of bachelordom, had been one of apprenticeship for the mastership; and by emancipation from this state was symbolized by placing the magisterial cap (*biretta*) upon his head, a ceremony which, in imitation of the old Roman ceremony of manumission, was performed by his former instructor. He gave a formal inaugural lecture, and was then welcomed into the society of his professional brethren with set speeches and took his seat in his master's chair.

Some time between the years 1150 and 1170 the University of Paris came formally into being. Its first written statutes were not, however, compiled until about the year 1208, and it was not until long after that date that it possessed a "rector." Its earliest recognition as a legal corporation belongs to about the year 1211, when a brief of Innocent III empowered it to elect a proctor to be its representative at the papal court. By this permission it obtained the right to sue or to be sued in a court of justice as a corporate body. Papal recognition did not imply episcopal recognition, but with papal support Paris became the great transalpine centre of orthodox theological teaching Successive pontiffs, down to the great schism of 1378, cultivated friendly relations with the university and systematically discouraged the formation of theological faculties at other centres. In 1231 Gregory IX, in the bull *Parens Scientiarum* (which has been called the Magna Carta of the university), gave full recognition to the right of the several faculties to regulate and modify the constitution of the university. The fully developed university was divided into four faculties: three "superior," those of theology, canon law and medicine; and one "inferior," that of arts, which was divided into four "nations" These nations, which included both professors and scholars, were (1) the French, composed, in addition to the native element, of Spaniards, Italians and Greeks; (2) the Picard, representing the students from the northeast and the Netherlands; (3) the Norman, (4) the English, comprising, besides students from the provinces under English rule, those from England, Ireland, Scotland and Germany. The head of each faculty was the dean, of each nation the proctor. The rector, in the first instance, was head of the faculty of arts Eventually he became the head of the collective university, by the incorporation under him, first, of the students of the canon law and of medicine (which took place about the end of the 13th century), and, second, of the theologians, which took place about half a century later.

In the course of the 16th and 17th centuries this democratic constitution of the middle ages was largely superseded by the growth of a small oligarchy of officials. The tribunal of the university—the rector, deans and proctors—came to occupy a somewhat similar position to the old "Hebdomadal board" of heads of colleges at Oxford and the *caput* at Cambridge. Moreover, the teaching functions of the university, or rather of the faculty of arts, chiefly because of the absence of any endowment for the regents or teaching graduates, practically passed to the colleges Almost as much as the English universities, Paris came to be virtually reduced to a federation of colleges, though the colleges were at Paris less independent of university authority, while the smaller colleges sent their members to receive instruction in the larger ones (*collèges de plein exercace*), which received large numbers of nonfoundation members. This state of things lasted till the French Revolution swept away the whole university system of the middle ages It may be noted that the famous Sorbonne (*see* PARIS UNIVERSITY) was really the most celebrated college of Paris—founded by Robert de Sorbon in 1257—but as this college and the College of Navarre were the only college foundations which provided for students in theology, the close connection of the former with the faculty, and the use of its hall for the disputations of that body, led to the word Sorbonne becoming a popular term for the theological faculty of Paris.

In the 14th century the University of Paris had 40 colleges, governed either by secular or religious communities, and numbered among its students representatives of every country in Europe. The university became known as the great school where theology was studied in its most scientific spirit, and the decisions of its doctors upon those abstruse questions which absorbed so much of the highest intellectual activity of the middle ages were regarded as almost final. The popes, as already stated, discouraged the creation of faculties of theology elsewhere. The apparent exceptions to this policy are easily explained: the four faculties of theology which they sanctioned in Italy—Pisa (1343), Florence (1349), Bologna (1362) and Padua (1363)—were designed to benefit the Italian monasteries, by saving the monks the expense and dangers of a long journey beyond the Alps; while that at Toulouse (1229) took its rise under circumstances entirely exceptional, being designed as a bulwark against the heresy of the Albigenses. The popes, on the other hand, favoured the creation of new faculties of law, and especially of the canon law, as the latter represented the source from which Rome derived its most warmly contested powers and prerogatives.

ENGLISH MEDIAEVAL UNIVERSITIES

Oxford.—The University of Paris became the model for French universities north of the Loire and for those of central Europe and England Of the universities modelled on that of Paris, Oxford would appear to have been the earliest. Certain schools, opened within the precincts of the dissolved nunnery of St. Frideswyde and of Oseney abbey, are supposed to have been the nucleus round which it grew up. In the year 1133 one Robert Pullen, a theologian of considerable eminence (but whether an Englishman or a Breton is uncertain), arrived from Paris and delivered lectures on the Bible. Denifle maintains that there is, at best, only presumptive evidence of a *studium generale* at Oxford in the 12th century. Rashdall inclines to find the beginning in a migration of English students from Paris about 1167 or

1168. In the first-mentioned year we are told by John of Salisbury that "France, the mildest and most civil of nations," has "expelled her foreign scholars" (*Materials for the History of Thomas Becket*, ed. by Robertson, VI, pp 235–236). At about the same time we hear of an edict of Henry II, during the quarrel with Becket, recalling all clerks holding benefices in England (as they loved their benefices) and forbidding all clerks in England to cross the channel (*ibid*, I, pp 53–54). Paris was at this time the great place of higher education for English students. Immediately after 1168 allusions to Oxford as a *studium* and a *studium generale* begin to multiply The natural inference is that the breaking off of relations between England and Paris, in 1167 or 1168, led to the growth of a *studium generale* in Oxford, formed, no doubt, in the first instance of seceders from Paris In the 13th century mention first occurs of university "chests," especially the Frideswyde chest, which were benefactions designed as funds for the assistance of poor students. Hall, or places of licensed residence for students, also began to be established In the year 1257, when the bishop of Lincoln, as diocesan, had trenched too closely on the liberties of the community, the deputies from Oxford, when preferring their appeal to the king at St Albans, could venture to speak of the university as *schola secunda ecclesiae*, or second only to Paris Its numbers about this time were probably about 3,000; but whenever plague or tumult led to a temporary dispersion, a serious diminution in its numerical strength generally ensued for some time after. Against such vicissitudes the foundation of colleges proved the most effectual remedy. Of these the three earliest were University college, founded in 1249 by William of Durham; Balliol college, founded about 1263 by John Balliol, the father of the king of Scotland of the same name; and Merton college, founded in 1264. The last-named is especially notable as associated with a new conception of university education; viz, that of collegiate discipline for the secular clergy, instead of for any one of the religious orders, for whose sole benefit all similar foundations had previously been designed The statutes given to the society by Walter de Merton are not less noteworthy, being characterized not only by breadth of conception but also by a careful and discriminating attention to detail, which led to their adoption as the model for later colleges not only at Oxford but at Cambridge.

Cambridge.—The University of Cambridge, although it rose into existence somewhat later than Oxford, may reasonably be held to have had its origin in the same century There was probably a certain amount of educational work carried on by the canons of the church of St. Giles, which gradually developed into the instruction belonging to a regular *studium* In the year 1112 the canons crossed the river and took up their residence in the new priory in Barnwell, and their work of instruction acquired additional importance In 1209 a body of students migrated there from Oxford. Then, as early as the year 1224, the Franciscans established themselves in the town and, somewhat less than half a century later, were followed by the Dominicans. At both the English universities, as at Paris, the mendicants and other religious orders were admitted to degrees, a privilege which, until the year 1337, was extended to them at no other university. Their interest in and influence at these three centres were consequently proportionably great. In the years 1231 and 1233 certain royal and papal letters afford satisfactory proof that by that time the University of Cambridge was already an organized body, with a chancellor at its head In 1229 and 1231 the numbers were largely augmented by migrations from Paris and from Oxford Cambridge, however, in its turn suffered from emigration, while in the year 1261, and again in 1381, the records of the university were wantonly burned by the townsmen. Throughout the 13th century, indeed, the university was still only a very slightly and imperfectly organized community. Its endowments were of the most slender kind; it had no systematic code for the government of its members; the supervision of the students was very imperfectly provided for Although both Oxford and Cambridge were modelled on Paris, their higher faculties never developed the same distinct organization; and while the two proctors at Cambridge originally represented "north" and "south," the "nations" are scarcely to be discerned. An important step in the direction of discipline was, however, made in the year 1276, when an ordinance was passed requiring that everyone who claimed to be recognized as a scholar should have a fixed master within 15 days after his entry into the university. The traditional constitution of the English universities was, in its origin, an imitation of the Parisian, modified by the absence of the cathedral chancellor. But the feature which most served to give permanence and cohesion to the entire community at Cambridge was, as at Oxford, the institution of colleges. The earliest of these was Peterhouse, first founded as a separate institution by Hugh Balsham, bishop of Ely, in the year 1284. In 1324 was founded Michaelhouse, and two years later, in 1326, Edward II instituted his foundation of "king's scholars," afterward forming the community of King's hall Both these societies, in the 16th century, were merged in Trinity college To these succeeded Pembroke hall (1347) and Gonville hall (1348). All these colleges were expressly designed for the benefit of the secular clergy The foundation of Trinity hall (*Aula*) in 1350 by Bishop William Bateman, on the other hand, as a school of civil and canon law was probably designed to further ultramontane interests That of Corpus Christi (1352), the outcome of the liberality of a guild of Cambridge townsmen, was conceived with the combined object of providing a house of education for the clergy, and at the same time securing the regular performance of masses for the benefit of the souls of departed members of the guild. But both Trinity hall and Corpus Christi college, as well as Clare hall, founded in 1359, were, to a great extent, indebted for their origin to the ravages caused among the clergy by the great plague of 1349.

FRENCH AND SPANISH MEDIAEVAL STUDIA

France.—Montpellier was a recognized school of medicine as early as the 12th century. Before the end of the century it possessed also a faculty of jurisprudence. The university of medicine and that of law continued, however, to be totally distinct bodies, with different constitutions. On Oct. 26, 1289, Montpellier was raised by Nicholas IV to the rank of a *studium generale*.

The University of Toulouse is to be noted as the first founded in any country by virtue of a papal charter. It took its rise in the efforts of Rome for the suppression of the Albigensian heresy, and its foundation formed one of the articles of the conditions of peace imposed by Louis IX on Count Raymund of Toulouse In the year 1233 it first acquired its full privileges as a *studium generale* by virtue of a charter given by Gregory IX. The University of Orléans had a virtual existence as a *studium generale* as early as the first half of the 13th century, but in the year 1305 Clement V endowed it with new privileges and gave its teachers permission to form themselves into a corporation. The schools of the city had an existence long before—as early, it is said, as the 6th century. In the 14th century its fame as a school of law was surpassed by no other university in Europe. Before the 13th century it had been famed for its classical learning.

The other French universities famous in the middle ages were Angers, Avignon, Cahors (1331) and Grenoble (1339). At Perpignan and Orange there were schools of small note.

Spain.—Valladolid, which received its charter from Pope Clement VI in 1346, attained great celebrity. In 1418, at the Council of Constance, Martin V decreed that Valladolid should take rank not only as a *studium generale* but also as a *universitas theologiae*. From this time, accordingly, the advance of the university in numbers was steady and continuous throughout the 15th century, and, along with Salamanca, it served as the model for Alcalá in 1499

Seville was founded in 1254 by Alphonso the Wise, simply for the study of Latin and of the Semitic languages, especially Arabic. Salamanca had been founded in 1243 by Ferdinand III of Castile as a *studium generale* in the three faculties of jurisprudence, the arts and medicine But the main stress of its activity, as was the case with all the earlier Spanish universities, was laid on the civil and the canon law. In the early part of the

15th century, however, the efforts of Martin V established a school of theology which was afterward regarded almost as an oracle by Catholic Europe. About the year 1600 the students are shown by the matriculation books to have numbered more than 5,000. According to Cervantes they were noted for their lawlessness. The earliest of the numerous colleges founded at Salamanca was that of St Bartholomew, long noted for its ancient library and valuable collection of manuscripts.

The only Portuguese university in mediaeval times was founded at Lisbon in 1290 and had its seat alternately there and in Coimbra, until, in the year 1537, it was permanently attached to Coimbra. It had received from King Dinis a charter, the provisions of which were mainly taken from those of the charter given to Salamanca. In 1772 the university was entirely reconstituted.

MEDIAEVAL UNIVERSITIES IN CENTRAL EUROPE

Prague.—Of the mediaeval universities in central Europe, Prague, which existed as a *studium* in the 13th century, was the earliest. It was at first frequented mainly by students from Styria and Austria, countries at that time ruled by the emperor Charles IV, who was also king of Bohemia, and at whose request Pope Clement VI, on Jan. 26, 1347, promulgated a bull authorizing the foundation of a *studium generale* in all the faculties. In the following year Charles himself issued a charter for the foundation. Charles had been a student in Paris, and the organization of his new foundation was modelled on that university, a like division into four "nations" (although with different names) constituting one of the most marked features of imitation. The numerous students—and none of the mediaeval universities attracted in its earlier history a larger concourse—were drawn from a gradually widening area, which at length included not only all parts of Germany but also England, France, Lombardy, Hungary and Poland.

Cracow.—The University of Cracow, in Poland, was founded in May 1364 by virtue of a charter given by King Casimir III the Great, but its real commencement must be considered to belong to the year 1400, when it was reconstituted. Toward the close of the 15th century the university is said to have been in high repute as a school of both astronomical and humanistic studies.

Vienna.—The Avignonese popes appear to have regarded the establishment of new faculties of theology with special jealousy; and when, in 1364, Duke Rudolph IV founded the University of Vienna, with the design of constituting it a *studium generale* in all the faculties, Urban V refused his assent to the foundation of a theological school. Because of the sudden death of Duke Rudolph, the university languished for the next 20 years, but after the accession of Duke Albert III, who may be regarded as its real founder, it acquired additional privileges.

Heidelberg.—The University of Heidelberg (the oldest of those of the German realm) received its charter (Oct. 23, 1385) from Urban VI as a *studium generale* in all the recognized faculties save that of the civil law. It was granted at the request of the elector palatine, Rupert I. But the real founder, as he was also the organizer and teacher, of the university was Marsilius of Inghen, to whose ability and energy Heidelberg was indebted for no little of its early reputation and success. In spite of the omission of the civil law in the original charter, this was included among its faculties almost from its first creation. No mediaeval university achieved a more rapid and permanent success.

Cologne.—As a result of the labours of the Dominicans, Cologne had gained a reputation as a seat of learning long before the founding of its university; and it was through the advocacy of some leading members of the mendicant orders that, at the desire of the city council, its charter as a *studium generale* (May 21, 1388) was obtained from Urban VI. It was organized on the model of the University of Paris, as a school of theology and canon law and "any other recognized faculty," the civil law being incorporated as a faculty soon after the promulgation of the charter. In common with the other early universities of Germany—Prague, Vienna and Heidelberg—Cologne owed nothing to imperial patronage, while it would appear to have been, from the first, the object of special favour with Rome. This circumstance serves to account for its distinctly ultramontane sympathies in mediaeval times, and even far into the 16th century.

Erfurt.—Erfurt, no less noted as a centre of Franciscan than was Cologne of Dominican influence, received its charter (Sept. 16, 1379) from the antipope Clement VII, as a *studium generale* in all the faculties. Ten years later it was founded afresh by Urban VI. In the 15th century the number of its students was larger than that at any other German university—a fact attributable partly to the reputation it had acquired as a school of jurisprudence and partly to the ardour with which the nominalist and realist controversies of the time were debated in its midst; its readiness in according a hearing to novel theories caused it to be known as *novorum omnium portus*.

Leipzig.—The conditions connected with the rise of the University of Leipzig are especially noteworthy, it having been the result of the migration of almost the entire German element from the University of Prague. This element comprised (1) Bavarians, (2) Saxons, (3) Poles (this last-named division being drawn from a wide area which included Meissen, Lusatia, Silesia and Prussia), and, being represented by three votes in the assemblies of the university, while the Bohemians possessed but one, had acquired a preponderance in the direction of affairs to which the latter could no longer submit. Religious differences, again, evoked mainly by the preaching of John Huss, further intensified the existing disagreements, and eventually, in the year 1409, King Wenceslaus, at the prayer of his Bohemian subjects, issued a decree which exactly reversed the previous distribution of votes—three votes being assigned to the Bohemian nation and only one to all the rest. The Germans took deep umbrage and seceded to Leipzig, where, a bull having been obtained from Alexander V (Sept. 9, 1409), a new *studium generale* was founded by the landgrave of Thuringia and the margraves of Meissen. The members were divided into four nations composed of natives of Meissen, Saxony, Bavaria and Poland.

Rostock.—At Rostock, in the north, the dukes John and Albert of Mecklenburg conceived the design of founding a university from which the faculty of theology should be excluded. The university was accordingly founded as proposed in 1419, but in 1431 Eugenius IV instituted a faculty of theology. Six years later, the whole academic community having incurred the papal ban, was fain to migrate to Greifswald, returning, however, to Rostock in 1443, but with one important exception, that of a master of arts named Henry Rubenow, who remained to become burgomaster of the former city and succeeded in persuading Duke Wratislaw of Pommern to make it the seat of a university. Calixtus III granted a bull in 1456, but it was stipulated that the rector should be a bishop, and the professorial chairs were also made partially dependent for endowment on canonries. Greifswald thus became exposed to the full brunt of the struggle which had ensued when the endeavour to nationalize the German church was terminated by the Concordat of Vienna (1448).

Freiburg.—The universities of Freiburg, in Baden, and Tübingen, in Württemberg, alike owed their foundation to the countess Matilda, by whose persuasion her husband, the archduke of Austria, known as Albrecht VI, was induced to found Freiburg in 1455, and Count Eberhard (her son by a former marriage) to found Tübingen in 1477. At Freiburg, under the supervision of its first rector, Matthew Hummel of Villingen, the numbers were soon largely augmented by migrations of students from Vienna and from Heidelberg, while its resources, which originally were chiefly an annual grant from the city council, were increased by the bestowal of canonries and prebends. Erasmus made Freiburg his residence from 1529 to 1535, during which time he may have originated the tradition of liberal learning, but in 1620, under the rule of the archduke Maximilian, the control of the humanistic studies and of the entire faculty of philosophy was handed over to the Jesuits, who also gained possession of two of the chairs of theology.

Tübingen.—The University of Tübingen was founded in 1477 with the usual four faculties, and numbered Johann Reuchlin and Philipp Melanchthon among its teachers.

Louvain.—In the Netherlands the growing wealth and pros-

perity of the different states especially favoured the formation of new centres of learning In the flourishing duchy of Brabant the University of Louvain (1426) was to a great extent controlled by the municipality, and its patronage, although ultimately attended with detrimental results, long enabled Louvain to outbid all the other universities of Europe in the munificence with which it rewarded its professors In the course of the next century the "Belgian Athens," as styled by Justus Lipsius, ranked second only to Paris in numbers and reputation It possessed no fewer than 28 colleges, while its active press afforded facilities to the author and the controversialist of which both Cambridge and Oxford were at that time almost destitute It embraced all the faculties, and no degrees in Europe stood so high as guarantees of general requirements Erasmus recorded it as a common saying that "no one could graduate at Louvain without knowledge, manners and age."

Budapest.—In Hungary, Matthias I, Hunyadi, obtained permission in 1465 to found a university where he thought best in his realm The university at Ofen (Hungarian *Buda*) was founded in 1475 It had a school of law at Pressburg, the sole remains of the university there founded by Matthias in 1465

THE PASSING OF MEDIAEVALISM

France.—The earliest 15th-century university in France was that of Aix in Provence It had originally been nothing more than a school of theology and law, but in 1409 it was reorganized as a *studium generale* on the model of Paris. Its students were divided into Burgundians, Provençals and Catalans.

The University of Poitiers was instituted by Charles VII in 1431 with the design of creating a centre of learning less favourable to English interests than Paris had at that time shown itself to be He conferred on Poitiers all the privileges collectively possessed by Paris, Toulouse, Montpellier, Angers and Orléans, and at the same time placed the university under special royal protection

The University of Caen was founded under English auspices during the short period of the supremacy of the English arms in Normandy in the 15th century Its charter (May 1437) was given by Eugenius IV, and the bishop of Bayeux was appointed its chancellor. After the expulsion of the English from France, it received a new charter. From this time the University of Caen was distinguished by its loyal spirit and firm resistance to ultramontane pretensions, and, although swept away at the French Revolution, it was afterward restored, owing to the sense of the services it had thus once rendered to the national cause. Other French 15th-century foundations are Bordeaux (1441), Valence (1452), Nantes (1463) and Bourges (1465).

Central and Northern Europe.—The University of Basle was opened in 1460, under the auspices of its own citizens, and Pius II (Aeneas Sylvius) granted the charter (Nov. 12, 1459). During the first 70 years of its existence the university prospered, and its chairs were held by eminent professors, among them historical scholars such as Sebastian Brant and Jacob Wimpheling But with the Reformation Basle became the arena of contests which menaced the very existence of the university itself, the professors being, for the most part, opposed to the new movement with which the burghers warmly sympathized Eventually the statutes were revised, and in the latter half of the 16th century the university may be said to have attained its apogee.

The University of Ingolstadt was founded on April 7, 1459. But it was not until 1472 that the work of teaching was actually commenced there. Some long-existing prebends, founded by former dukes of Bavaria, were appropriated to the endowment. Nowhere did the Reformation meet with more stubborn resistance, and it was at Ingolstadt that the Counter Reformation commenced. In 1556 the Jesuits made their first settlement in the university.

At Trier and Mainz universities were established in the second half of the 15th century. Trier received its charter as early as 1450, but the first academical session did not commence until 1473. Sixtus IV granted the charter to Mainz (Nov 23, 1476) at the request of Archbishop Diether, who was himself a great humanist.

Other foundations were those of Uppsala (1477) and Copenhagen (1479), which, although lying outside the political boundaries of Germany, reflected its influence. The charter for Copenhagen was given by Sixtus IV as early as 1475

The university founded at Wittenberg by Maximilian I (July 6, 1502) was the first established in Germany by imperial decree. Its charter is, however, drawn up with the traditional phraseology of the pontifical bulls and is evidently not conceived in any spirit of antagonism to Rome. Wittenberg was constituted a *studium generale* in all the four faculties, the right to confer degrees in theology and canon law having been sanctioned by the papal legate several months before, on Feb. 2, 1502. Wittenberg was the first academic centre north of the Alps where the Latinity and antiquated methods of the scholastic era were overthrown.

Frankfurt-on-Oder received its charter in 1506.

Scotland.—The first Scottish foundation was at St. Andrews, founded in 1411 by Henry Wardlaw, bishop of that see, and modelled chiefly on the constitution of the University of Paris It acquired all its three colleges—St. Salvator's, St Leonard's and St. Mary's—before the Reformation. The most ancient of the universities of Scotland, with its three colleges, was thus reared in an atmosphere of mediaeval theology, and undoubtedly designed as a bulwark against heresy and schism But "by a strange irony of fate, two of these colleges became, almost from the first, the foremost agents in working the overthrow of that Church which they were founded to defend" St. Leonard's more especially became a noted centre of intellectual life and Reformation principles.

The University of Glasgow was founded as a *studium generale* in 1453. Among its objects also was "the extension of the Catholic faith", but it was to produce John Knox. It was founded on the model of Bologna, but in its customs largely imitated Louvain, whose rector at the time was a Scotsman Though founded on "flourish in theology, canon and civil law, and in any other lawful Faculty," for long only the faculty of arts had a constitution Throughout the 15th century this faculty flourished exceedingly.

The University of Aberdeen was founded in 1494, mainly through the efforts of Bishop William Elphinstone, who had earlier been successively dean of the faculty of arts and rector of Glasgow university. He avoided two defects in the constitutions of St. Andrews and Glasgow by providing salaries for teachers in the higher faculties and establishing a visitorial power.

The fourth Scottish university, Edinburgh, was a post-Reformation foundation.

General Aspects.—Generally speaking, the mediaeval universities were conservative Alexander Hegius, Johan Wessel and Rodolphus Agricola carried on their work as reformers at places like Deventer, remote from university influences That there was a considerable amount of mental activity going on in the universities themselves is not to be denied; but it was mostly of that unprofitable kind which, while giving rise to endless controversy, turned upon questions in connection with which the implied postulates and the terminology employed rendered all scientific investigation hopeless. At almost every university—Leipzig, Greifswald and Prague (after 1409) being the principal exceptions—the so-called Realists and Nominalists represented two great parties occupied with an internecine struggle. At Paris, because of the overwhelming strength of the theologians, the Nominalists were, indeed, under a kind of ban, but at Heidelberg they had altogether expelled their antagonists It was much the same at Vienna and at Erfurt. At Basle, under the leadership of the eminent Johannes a Lapide, the Realists with difficulty maintained their ground Freiburg, Tubingen and Ingolstadt, in the hope of diminishing controversy, arrived at a kind of compromise, each party having its own professor and representing a distinct "nation." At Mainz the authorities adopted a manual of logic which was essentially an embodiment of nominalistic principles

In Italian universities, it was decided that these controversies were endless and that their effects were pernicious. It was resolved, accordingly, to expel logic and allow its place to be filled by rhetoric, thereby effecting that important revolution in aca-

demic studies which constituted a new era in university learning and largely helped to pave the way for the Reformation. Hence the Italian universities enjoyed a fortunate immunity from dissensions such as those which distracted the centres of learning in Germany.

The professorial body in the great Italian universities attained an almost unrivalled reputation throughout Europe For each subject of importance there were always two, and sometimes three, rival chairs, and a powerful and continuous emulation was thus maintained among the teachers "The call to a Paduan or Pisan chair was deemed the highest of all literary honours. The status of professor was, in Italy, elevated to a dignity which in other countries it has never reached, and not a few of the most illustrious teachers in the Italian seminaries were of the proudest nobility of the land While the universities of other countries had fallen from Christian and cosmopolite to sectarian and local schools, it is the peculiar glory of the Italian that, under the enlightened liberality of their patrons, they still continued to assert their European universality. Creed and country were, in them, no bar—the latter not even a reason of preference Foreigners of every nation are to be found among their professors, and the most learned man in Scotland, Thomas Dempster, sought in a Pisan chair that theatre for his abilities which he could not find at home."

Spain.—To such catholicity of sentiment the Spanish universities of this period offer a complete contrast, their history being strongly modified by political and religious movements Valencia, founded in 1501, and Seville, sanctioned by Julius II in 1505, appear both to have been regarded without mistrust at Rome Julius had approved the foundation of the University of Santiago as early as 1504, but the bull for its creation was not granted by Clement VII until 1526. The design of establishing a university at Granada was deferred until 1531. Little, indeed, is to be learned respecting the new society until the foundation of the liberally endowed College de Sacro Monte by the archbishop of the province in 1605. Under the direction of the Jesuits the scholastic philosophy, together with a certain attention to Greek and Hebrew, became the dominant study. Gregory XIII in 1574 authorized the foundation of the University of Oviedo, but this was not opened until 1608, and then only with a faculty of law. After this time the universities in Spain shared in the general decline of the country, and, even after the expulsion of the Jesuits in 1769, no marked improvement is discernible in their schools until the second half of the 19th century

Mention should be made, however, of the foundations in Spanish America, which went on for more than two centuries. They included the University of Lima, Peru (now Universidad Nacional Mayor de San Marcos and claimed as the oldest university in the new world), set up as a Dominican seminary in 1551 and secularized in 1571 with faculties in philosophy and theology; Mexico City, opened in 1553; Bogotá, Colom (1572), Cuzco, Peru (1696); Havana, Cuba (1728), and Santiago, Chile (1747).

THE REFORMATION

The Reformation represents the first great boundary line in the history of European universities. Even in Roman Catholic countries its effects found expression in connection with the Counter Reformation. The influence of the humanists, and the special character which the Reformation assumed in Germany through the labours of scholars like Erasmus, Reuchlin and Melanchthon, augured well for the future. German university teaching was free from the frivolity, pedantry and scepticism which characterized so much of the corresponding culture in Italy It gave promise of resulting at once in a critical and enlightened study of the masterpieces of classical antiquity, and in a reverent and yet rational interpretation of the Scriptures and the Fathers The bigoted and ceaseless controversies evoked by the promulgation of Lutheran or Calvinistic doctrine dispelled, however, this prospect, and converted the universities into gloomy fortresses of sectarianism. For a century after the Reformation the history of Lutheran theology became almost identified with that of the German universities.

Marburg.—The first Protestant university was that of Marburg, founded by Philip the Magnanimous, landgrave of Hesse, May 30, 1527, and mainly built up out of the confiscation of the property of the religious orders in the Hessian capital. It rapidly became famous and attracted students from remote countries After 1605, when, by the decree of Count Maurice, its formulary of faith was changed from Lutheran to Calvinistic, its numbers greatly declined This dictation by the temporal power now becomes one of the most notable features in academic history in Protestant Germany.

Königsberg.—The Lutheran University of Konigsberg was founded Aug. 17, 1544, by Albert III, margrave of Brandenburg and the first duke of Prussia, and his wife *Dorothea*, a Danish princess. King Sigismund of Poland gave the charter (Sept. 29, 1561), and students who graduated as masters in the faculty of philosophy ranked as nobles of the Polish kingdom. When university Prussia was raised to the rank of a kingdom (1701) the university was made a royal foundation, and the *collegium Fridericianum*, which was then erected, received corresponding privileges. Königsberg will always be remembered as the university of Kant.

Jena.—The Lutheran University of Jena was opened on Feb. 2, 1558. Distinguished for its vehement assertion of Lutheran doctrine, its hostility to the teaching of Wittenberg was hardly less pronounced than that with which both centres regarded Roman Catholicism For a long time it was chiefly noted as a school of medicine, and in the 17th and 18th centuries was in bad repute for the lawlessness of its students, among whom duelling prevailed to a scandalous extent

Helmstedt.—The Lutheran University of Helmstedt, founded by Duke Julius (of the house of Brunswick-Wolfenbüttel), received its charter May 8, 1575, from the emperor Maximilian II It was munificently endowed by the founder and by his son, and its *Convictorium*, or college for poor students, expended in the course of 30 years no less than 100,000 thalers, an extraordinary expenditure for an institution of such a character in those days. Distinguished by its comparatively temperate maintenance of the Lutheran tenets, it attracted a considerable concourse of students, especially from the upper classes. Until suppressed in 1809, Helmstedt enjoyed the special and powerful patronage of the dukes of Saxony.

Altdorf.—The *Gymnasium Aegidianum* of Nuremberg, founded in 1526 and moved in 1575 to Altdorf, represents the origin of the University of Altdorf. Altdorf was about the poorest university in Germany, yet long one of the most eminent. Its whole endowment never rose above £800 a year.

17TH- AND 18TH-CENTURY GERMAN FOUNDATIONS

Giessen.—The conversion of Marburg into a school of Calvinistic doctrine gave occasion to the foundation of the universities of Giessen and of Rinteln. Giessen, founded by the margrave of Hesse-Darmstadt, Louis V, as a kind of refuge for the Lutheran professors from Marburg, received its charter from the emperor Rudolph II (May 19, 1607). In 1625 the university was transferred to Marburg, in 1650 it was moved back again to Giessen.

Strasbourg.—The University of Strasbourg was founded in 1621 on the basis of an already existing academy which, under the direction of John Sturm, had attracted students from all parts of Europe and especially from Portugal, Poland, Denmark, France and England. The method of Sturm's teaching became the basis of that of the Jesuits, and, through them, of the public schools in England In 1621 Ferdinand II conferred on this academy full privileges as a university. In 1681 Strasbourg became French. It was refounded by the emperor William I and before the close of the century numbered more than 1,100 students At the end of the 18th century, after its reversion to Germany, it was distinguished by an intellectual activity with which the name of Goethe is connected.

Kiel.—The royal university of Kiel was founded in 1665 by Duke Christian Albrecht of Holstein (who himself assumed the office of rector), with faculties of theology, law, medicine and philosophy. After the incorporation of Schleswig-Holstein with

the kingdom of Prussia it made a marked advance.

Halle and Pietism.—The year 1693 saw the foundation of the University of Halle, which has been described as the "first real modern university." It originated in a *Ritterschule* for the sons of the nobility Leopold I granted (Oct. 19, 1693) the requisite charter The primary object in founding a university in Halle was to create a centre for the Lutheran party; but its character, under the influence of its two most notable teachers, Christian Thomasius and A. H. Francke, soon expanded beyond the limits of this conception Thomasius and Francke had both been driven from Leipzig because of their liberal and progressive tendencies Thomasius was the first to set the example, soon after followed by all the universities of Germany, of lecturing in the vernacular instead of in the customary Latin Francke, as the founder of that Pietistic school, exercised great influence. Christian Wolff, who followed Thomasius as an assertor of the new culture, was driven from Halle by the accusations of the Pietists. In 1740, however, he was recalled by Frederick II and reinstated. Throughout the whole of the 18th century Halle was the leader of academic thought and advanced theology in Protestant Germany, although sharing that leadership, after the middle of the century, with Göttingen.

Göttingen.—The University of Göttingen (named after its founder, "Georgia Augusta"), was endowed with the amplest privileges as a university by George II of England, elector of Hanover, Dec. 7, 1736. The university included all the faculties, and two of its first professors—J. L. von Mosheim, the eminent theologian from Helmstedt, and G. L Böhmer, the no less distinguished jurist from Halle—together with Johann Gesner, the man of letters, at once established its reputation. Not least among its attractions was also its splendid library, located in an ancient monastery. The Göttingen school of history became famous The labours of the professors at Gottingen, especially J S Putter, J C. Gatterer, A. L von Schlözer and L T. von Spittler, combined with those of J. J. Mascov at Leipzig, did much to promote both a more catholic treatment and a wider scope. The method of appointment of professors was reformed by the chief curator, G A von Munchhausen, on lines similar to those already instituted in the universities of the Netherlands by Janus Dousa.

Erlangen.—The University of Erlangen, a Lutheran centre, was founded by Frederick, margrave of Bayreuth. Its charter was granted by the emperor Charles VII in 1743. In 1791, Ansbach and Bayreuth having passed into the possession of Prussia, Erlangen also became subject to the Prussian government.

NORTHERN EUROPE

The earliest Dutch university, Leyden, founded in 1575, commemorated the successful resistance of the citizens to the Spanish. Throughout the 17th century Leyden was distinguished by its learning, the ability of its professors and the shelter it afforded to the more liberal thought associated at that period with Arminianism. Much of its early success was a result of the wise provisions and the influence of the celebrated Janus Dousa. Dousa, in fact, did for Leyden and the Dutch what Münchhausen afterward did for Göttingen and the German universities. The appointment of the professors at Leyden was vested in three (afterward five) curators, one of whom was selected from the body of the nobles, while the other two were appointed by the states of the province, the office being held for nine years and eventually for life. With these was associated the mayor of Leyden for the time being. Leyden secured and maintained a very high reputation for scientific work. Other Dutch universities with a famous history are Franeker (1585), Harderwyk (1600), Gronngen (1614) and Utrecht (1634), the last being a great resort in the 18th century for English students.

The Royal University of Uppsala, whose foundation as a *studium generale* was sanctioned by Pope Sixtus IV in 1477, despite a checkered history remained the chief centre of higher education in Sweden. In the 18th century lectures began to be delivered in Swedish, but the mediaeval division of the students into "nations" continued, as at Lund (1666), until the second quarter of the 19th.

REFORMATION AND POST-REFORMATION IN BRITAIN

Oxford and Cambridge.—The influence of the Renaissance and the teaching of Erasmus, who resided at both universities, exercised a notable effect alike at Oxford and Cambridge The names of John Colet, William Grocyn and Thomas Linacre illustrate this influence at the former centre; those of Bishop John Fisher, Sir John Cheke and Sir Thomas Smith at the latter. The labours of Erasmus at Cambridge, as the author of a new Latin version of the New Testament, with the design of placing in the hands of students a text free from the errors of the Vulgate, were productive of important effects, and the university became a centre of Reformation doctrine several years before the writings of Luther became known in England The foundation of Christ's college (1505) and St. John's college (1511), through the influence of Fisher with the countess of Richmond, also materially aided the general progress of learning at Cambridge. The Royal Injunctions of 1535, embodying the views and designs of Thomas Cromwell, mark the downfall of the old scholastic methods of study at both universities; and the foundation of Trinity college, Cambridge, in 1547 (partly by an amalgamation of two older societies), represents the earliest conception of such an institution in England in complete independence of Roman Catholic traditions. Trinity (1554) and St John's (1555) at Oxford, on the other hand founded during the reactionary reign of Mary, serve rather as examples of a transitional period

Puritanism at Cambridge.—In the reign of Elizabeth, Cambridge became the centre of another great movement, that of the earlier Puritanism, St John's and Queens' being the strongholds of the party led by Thomas Cartwright, Walter Travers and others The movement continued to gather strength, and Emmanuel college, founded in 1584, owed much of its early prosperity to the fact that it was a known school of Puritan doctrine Most of the Puritans objected to the discipline enforced by the university and ordinary college statutes, especially the wearing of the cap and the surplice and the conferring of degrees in divinity. The Anglican party, headed by such men as archbishops John Whitgift and Richard Bancroft, resorted in defense to a repressive policy, of which subscription to the Acts of Supremacy and Uniformity and the Elizabethan statutes of 1570 (investing the *caput* with larger powers and thereby creating a more oligarchical form of government) were the most notable results. Oxford, although the Puritans were there headed by Leicester, the chancellor, devised at the same time a similar scheme, the rigid discipline of which was further developed in the Laudian or Caroline statutes of 1636. It was under these respective codes—the Elizabethan statutes of 1570 and the Laudian statutes of 1636—that the two universities were governed until the introduction of new codes in 1858. The fidelity with which both universities adhered to the royal cause in the Civil War caused them to be regarded with suspicion by the Puritan party, and under the Commonwealth both Oxford and Cambridge were, for a brief period, in great danger because of the distrust, which reached its highest point among the members of the "nominated parliament" (July-December 1653), of university education generally, as tending to foster contentiousness with respect to religious belief. It was even proposed by William Dell—himself the master of Caius college—to abolish the two universities altogether, as hopelessly pledged to antiquated and obsolete methods, and to establish in their place schools for higher instruction throughout the country. They were saved, however, by the firmness of Cromwell, at that time chancellor of Oxford, and, although Aristotle and the scholastic philosophy no longer held their ground, a marked improvement was observable both in discipline and morality among the students. At Oxford, under the influence and teaching of John Wilkins, Seth Ward and John Wallis, a flourishing school of mathematics was formed.

The Cambridge Platonist Movement.—In the 17th century Cambridge became the centre of a further movement (a reflex of the influence of the Cartesian philosophy), which attracted for a time considerable attention His leaders, known as the Cambridge Platonists, among whom Henry More and Ralph Cudworth were

especially conspicuous, were men of high character and great learning, although much under the influence of an ill-restrained enthusiasm and purely speculative doctrines The spread of the Baconian philosophy, and the example of a succession of eminent scientific thinkers, among whom were Isaac Barrow, master of Trinity (1673–77), the two Lucasian professors Isaac Newton (professor 1669–1702) and his successor William Whiston (professor 1702–11), and Roger Cotes (Plumian professor 1707–16), began to render the exact sciences more and more an object of study, and the institution of the tripos examinations in the course of the first half of the 18th century established the reputation of Cambridge as a school of mathematical science At Oxford, where the study had, in turn, declined, and where the statutable requirements with respect to lectures and exercises were suffered to fall into neglect, academic culture declined.

Edinburgh.—The "College of Edinburgh" was founded by charter of James VI, dated April 14, 1582 This made no mention of a *studium generale* or of any of the privileges associated with a university, and not until 1685 was the college referred to as a university in municipal records. But the charter gave the town council the right to provide for the teaching of all the subjects usual in a university, and from 1587 the college conferred degrees.

Trinity College, Dublin.—Trinity college, Dublin, was founded in 1591 A royal charter nominated a provost and a minimum number of three fellows and three scholars as a body corporate. The first five provosts of Trinity college were all Cambridge men, and under the influence of Archbishop Adam Loftus, the first provost, and his successors, the foundation received a strongly Puritan bias, but the policy of Laud and Wentworth was to make the college more distinctly Anglican as regards its tone and belief. At the Restoration its condition was found to be that of a well-ordered home of learning and piety, with its estates well secured and its privileges unimpaired. Under Bishop Jeremy Taylor, who succeeded to the vice-chancellorship, its progress in learning was considerable

THE COUNTER REFORMATION

Bamberg.—The earliest university whose charter represented the Counter Reformation was that of Bamberg, founded by the prince-bishop and opened Sept 1, 1648. At first, however, it comprised only the faculties of arts and of theology, to these were added in 1729 that of jurisprudence and in 1764 that of medicine. The university library was enriched by a collection of manuscripts from about 30 suppressed monasteries, convents and religious institutions at the time of the "secularization."

Innsbruck.—The University of Innsbruck was founded in 1672 by the emperor Leopold I. In the following century, under the patronage of the empress Maria Theresa, it made considerable progress, and received from her its ancient library and bookshelves in 1745. In 1782 the university was reduced by the emperor Joseph II from the status of a university to that of a lyceum, although retaining in the theological faculty the right of conferring degrees In 1791 it was restored to its privileges by the emperor Leopold II.

Breslau.—The University of Breslau was founded by the emperor Leopold I in 1702. When Frederick the Great conquered Silesia in 1741, he took both the university and the Jesuits in Breslau under his protection, and when, in 1774, the order was suppressed by Clement XIV he established them as priests in the Royal Scholastic institute, at the same time giving new statutes to the university.

Jesuit Influence in France.—In no country was the influence of the Jesuits on the universities more marked than in France. The civil wars in that country during the 30 years which preceded the close of the 16th century told with disastrous effects upon the condition of the University of Paris, and with the commencement of the 17th century its collegiate life seemed at an end and its 40 colleges stood absolutely deserted. To this state of affairs the obstinate conservatism of the academic authorities contributed not a little. The Jesuits did not fail to profit by this excessive conservatism on the part of the university, and during the second half of the 16th century and the whole of the 17th they contrived to gain almost a complete monopoly of both the higher and the lower education of provincial France. Their schools rose at Toulouse and Bordeaux, at Auch, Agen, Rhodez, Périgueux, Limoges, Le Puy, Aubenas, Béziers, Tournon, in the colleges of Flanders and Lorraine, Douai and Pont-à-Mousson—places beyond the jurisdiction of the *parlement* of Paris or even of the crown of France. Their banishment from Paris itself had been by the decree of the *parlement* alone and had never been confirmed by the crown. "Lyons," says Mark Pattison, "loudly demanded a Jesuit college," and even the Huguenot duke of Lesdiguières, almost king in Dauphiné, was prepared to erect one at Grenoble. The university was rescued from the fate which seemed to threaten it only by the excellent statutes given by Edmond Richer in 1598 and by the discerning protection extended by Henry IV

Nevertheless, the University of Paris remained distracted throughout the 17th century by theological dissensions—in the first instance as a result of the struggle that ensued after the Jesuits had effected a footing at the Collège de Clermont, and subsequently by the strife occasioned by the teaching of the Jansenists. Toward the close of the century a certain revival took place, and a succession of illustrious names—E. Pourchot, Charles Rollin, Bénigne Grenan, Charles Coffin, Jean-Gabriel Demontempuis, J. B L. Crevier, Charles Le Beau—appear on the roll of its teachers. But this improvement was soon interrupted by the controversies excited by the promulgation of the bull *Unigenitus* in 1713, condemning the tenets of Pasquier Quesnel. At last, in 1762, the *parlement* of Paris issued a decree (Aug 6) placing the colleges of the Jesuits at the disposal of the university, and this was immediately followed by another for the expulsion of the order from Paris, the university being installed in possession of its vacated premises. Concurrently with this measure, both history and natural science began to be cultivated with a certain success. Then came the French Revolution.

MODERN TIMES

The United Kingdom.—The Reformation marked the first great turning point in the history of the universities; the 19th century can lay good claim to having marked the second It saw the foundation of numerous new universities, many in parts of the world previously unprovided with facilities for higher education; it saw also the reconstitution of numerous ancient universities Neither process was the result of chance; new and reconstituted universities alike arose to meet new needs, the needs of an expanding world and an increasingly industrialized age. Neither left, nor could leave, the idea of the university completely unchanged.

Oxford and Cambridge.—In the United Kingdom of Great Britain and Ireland both processes took place. At the beginning of the 19th century Oxford and Cambridge were "the endowed preserve of a class" (Sir Charles Grant Robertson, *The British Universities*); by the end of it the "privileges and monopoly" of this class had been almost completely swept away. Much of the reform came from within, but two royal commissions, in 1858 and 1877, investigated the affairs of the universities and recommended drastic and far-reaching changes. During the century the range of studies was enormously extended. Exacting written examinations took the place of the often merely formal *viva voce* ceremonies. The professoriate was increased, reorganized and re-endowed, so that it became a resident, university body. General and uniform regulations were enforced for the selection, duties and salaries of professors, lecturers and examiners. Fellowships were thrown open to merit. The colleges were emancipated from their mediaeval statutes, invested with new constitutions and granted new legislative powers, while at the same time a proportion of their revenues was diverted to the uses of the university. A great mass of vexatious and obsolete oaths was swept away; in 1858 dissenters were admitted to matriculation and the B.A., and in 1871 all religious tests were abolished.

In 1863 noncollegiate students were admitted to Oxford and in 1869 to Cambridge. Women's colleges were also established. Girton (1869) and Newnham (1871–75) at Cambridge, Somerville

(1879) and Lady Margaret Hall (1878) at Oxford, the latter being followed by St. Hugh's (1886), St. Hilda's (1893) and St. Anne's (1952) Women had to wait, however, until the 20th century before the ancient English universities would admit them to degrees

Scotland.—In the 19th century three royal commissions wrestled with the affairs of the Scottish universities The first, which reported in 1830, produced no tangible results, the opposition to its proposals proving too strong But it stimulated thought about reform and paved the way for the commission of 1858, whose recommendations, embodied in the Universities (Scotland) act, 1858, remodelled the Scottish universities and assimilated their constitutions and conditions of graduation. The teaching and administrative functions were differentiated by the setting up at each university of a university court whose duty was to review all decisions taken by the *Senatus Academicus*. In addition, each university was given a general council, which was to meet twice yearly to consider "all questions affecting the well-being and prosperity of the university" The two independent degree-conferring colleges at Aberdeen, King's and Marischal, were amalgamated.

The Universities (Scotland) act, 1889, introduced further *drastic changes* It set up a Scottish universities committee of the privy council, to which all ordinances and petitions from the universities had to be referred. (This procedure was abandoned 20 years later because of the delays and difficulties it caused.) It increased the membership and powers of the university courts, adding to them representatives of the senate, the general council and the municipality within which the university was situated, and vesting in them responsibility for the business management of the university property and finances, leaving the control of education and discipline only to the *senatus*. It gave statutory recognition to the Students' Representative council (which had come into being in 1884) and empowered it to petition the *senatus* or the university court about any matter affecting the students' interests. It reorganized the curriculums of all the faculties except divinity, greatly broadening them and ending the compulsion to take the "sacred six" subjects in arts (Latin, Greek, mathematics, natural philosophy, logic and moral philosophy). It reduced the period of required residence from four to three years, established a new system of honours degrees and empowered the courts to admit women to lectures and degrees in all faculties. Most of these changes were effected by the executive commission set up under the act; they took eight years to complete.

Ireland.—Religious difficulties gravely impeded university education In 1845 three state-endowed university colleges were set up by act of parliament at Belfast, Cork and Galway, and in 1850 they were federated as the Queen's university. As no provision was made for theological teaching they were boycotted by Roman Catholics. In 1850 John Henry (later Cardinal) Newman founded a Roman Catholic university at Dublin, but this was refused the right to grant degrees. In 1879 the Queen's university was displaced by the Royal university, a nonteaching body empowered to hold examinations and grant degrees, which Roman Catholics could take.

In 1909 university education in Ireland was reorganized. Two new universities were created. the National University of Ireland at Dublin which incorporated the Queen's colleges at Cork and Galway and set up a third college in Dublin; and the Queen's university at Belfast (formerly the Queen's college). Both universities were given nominated senates, with a Roman Catholic majority in Dublin and a Protestant one in Belfast. Trinity college, Dublin, was left intact, . In all three universities there were to be no religious tests for teachers or students.

New British Universities.—*London.*—London, the first of Britain's modern universities, was born out of religious differences, which gave it a unique and unhappy start. It originated in a movement begun in 1825 by the poet Thomas Campbell, Henry (later Lord) Brougham and influential dissenters, whose aim was to set up an institution of university status for students excluded from Oxford and Cambridge by religious belief or lack of means. In 1828 the "University of London" was opened. But the project brought into being a rival group, equally influential, which in 1831 opened King's college, London, whose curriculum was similar except that it included instruction in "the doctrines and duties of Christianity, as the same are inculcated by the United Church of England and Ireland" The result was that neither college received a university charter In 1836 a nonteaching body, called London university, was created, authorized to hold examinations and confer degrees, not only, it is important to note, upon students of its two incorporated colleges, University and King's, but also upon students of such other institutions in the United Kingdom and the British colonies as it might affiliate. In 1858 the degrees of London university (except in medicine) were made available to all. Since that date London has awarded two kinds of degrees, *internal* to members of the university and *external* to anyone else passing its examinations, whether members of an educational institution or private students. This extraordinary constitution caused the University of London endless embarrassment for many years, but proved of the utmost value in assisting colleges throughout the British Commonwealth to rise to university status. They prepare for London degrees until in a position to award their own.

Attempt after attempt was made to reorganize the university, until in 1898 it was reconstituted so that only institutions within the county of London could become recognized as "schools of the university."

Durham.—The London colleges were designed for students of limited means. So was the University of Durham A residential, collegiate university, modelled on Oxford, it was founded by act of parliament in 1832 and received its charter in 1837. It was endowed from the revenues of Durham cathedral and diocese With it was associated in 1852, and more closely in 1870, the Newcastle College of Medicine In 1871 the Durham College of Physical Science was founded (in Newcastle; later called Armstrong college) and incorporated into the university. In 1908 the university was reconstituted in two divisions—Durham and Newcastle—under a single vice-chancellor but with separate teaching staffs. A further reconstitution in 1937 established a central financial control and merged the two Newcastle colleges into King's college, Newcastle-upon-Tyne.

Manchester.—Forty-four years were to elapse before another English university was founded, but within that period the progenitors of at least three others were born, and before the end of the century an additional five. In 1851 Owens college, Manchester, was established to teach "such branches of learning and science as were then or might hereafter be usually taught in English universities." In 1874, at Leeds, arose the Yorkshire College of Science; in 1876 the University college, Bristol, both absorbed earlier medical schools. Within the next 20 years there were similar colleges at Birmingham, Liverpool, Nottingham, Reading and Sheffield. In 1880 Owens college became the Victoria University of Manchester, in which were shortly federated the university colleges of Leeds and Liverpool.

Wales.—The principality of Wales played a notable part in the university college movement and, thanks to strong national feeling and an earlier development of secondary education than in England, secured its university in 1893, when the university colleges of Aberystwyth (1872), Cardiff (1883) and Bangor (1885) were federated St. David's college, Lampeter (1827), a theological college, obtained and retained the right to confer the degrees of bachelor of arts and of divinity.

"Redbrick" Universities.—The university college movement produced a rich harvest in the first decade of the 20th century. Mason college became Birmingham university in 1900. Liverpool and Leeds broke away from Manchester to obtain their own charters in 1903 and 1904. respectively. The University of Sheffield followed in 1905 and that of Bristol in 1909. These five, with Manchester, established a new tradition in English university education. Each was the product of a large industrial city, endowed by its citizens (who justly claimed a share in its government) and linked closely with its occupations. Each had a strong scientific and technological side. Each catered mainly,

though never exclusively, for local students and was consequently nonresidential All were completely free of religious tests, in some the teaching of religion was forbidden In all the fees and other expenses were low. The sobriquet "redbrick" given them later by an English writer referred primarily to their buildings but also characterized them as a homogeneous group.

COMMONWEALTH OF NATIONS

India.—Though there were previously institutions of university status, the foundation of universities as such in India was the outcome of the parliamentary inquiry which preceded the confirmation of the East India company's charter in 1853, and of Sir Charles Wood's dispatch to its court of directors in 1854. In 1857 three universities—Calcutta (Jan. 24), Bombay (July 18) and Madras (Sept. 5)—were founded on the London model as examining bodies with power to affiliate. The framers of this policy did not intend the universities to have no teaching functions, but not until the 20th century did they become fully teaching institutions. Proposals made in 1865–67 for an oriental university in the Punjab resulted in the foundation of a university college at Lahore which became a university in 1882, and in 1887 Allahabad university followed Both of these were London-model examining and affiliating bodies, though the University of the Punjab was also authorized to appoint teachers.

In 1902 a universities' commission recommended, and in 1904 an act provided, that the older universities should become teaching bodies. The conditions for affiliation were stiffened In 1913 a government resolution proposed the establishment of residential universities at Dacca, Aligarh and Benares and the creation of new universities at Rangoon, Patna and Nagpur, but the outbreak of World War I delayed these developments.

Canada.—The history of the universities of Canada is highly complex, reflecting the varied religious and political influences in the making of the nation. All the older universities except two were founded by religious bodies, among whom the Roman Catholics, Anglicans, Presbyterians, Methodists and Baptists were prominent Broadly speaking, these copied three models, Paris, Oxford and Edinburgh, according to the nationality of the founders. Later, after efforts, largely unsuccessful, to overcome the denominational problem by founding universities on the London style, there came the evolution of a distinctively Canadian type of federated university. Finally, the 20th century saw, in the western provinces, the foundation of fully state-provided universities.

The French Laval university, Quebec, was founded as late as 1852, but the Seminary of Quebec, from which it sprang, dates from 1633. The University of Montreal was founded in 1878 as a branch of Laval, from which it was finally separated in 1920. Other Roman Catholic foundations were Ottawa (1849) and St. Francis Xavier, Antigonish, N.S. (1853), the latter with no religious tests for entrance or degrees. Three colleges, each called King's college and each a Church of England establishment, were early founded by the immigrant American loyalists and received royal charters: at Windsor, N.S. (1802, later moved to Halifax), Toronto (1827)—later the University of Toronto—and Fredericton, N.B. (1828), which in 1859 was secularized as the University of New Brunswick. All three were modelled upon Oxford. Later Anglican foundations included the University of Bishop's College, Lennoxville, Que. (1853), and Western university (1878); the latter became nondenominational in 1908 and later changed its name to Western Ontario The Baptists founded Acadia, Wolfville, N.S. (1838), and in 1887 amalgamated two colleges to form McMaster, now located in Hamilton, Ont. The Presbyterians founded Queen's, Kingston, Ont. (1841), modelling it on Edinburgh, it became nondenominational in 1912. The Methodists founded Mount Allison academy at Sackville, N.S., which was given a university charter in 1858 and later also became nondenominational.

The two private foundations, Dalhousie (Halifax, N.S.) and McGill (Montreal, Que.), were both from the start nonsectarian. Both were Scottish-type universities. Each had a precarious early existence; Dalhousie, though founded in 1818, did not open until 1838, and was closed again between 1843 and 1863. The reopening was made possible by the closing of various Presbyterian and Congregational colleges In 1868 the government withdrew grants from denominational colleges, and thus, with the increasing cost of maintenance, compelled them to think seriously about federation. In 1887 a scheme was approved for a university of Toronto consisting essentially of "a group of arts or divinity colleges gathered about a central university, supported and controlled by the State, the University conducting examinations, conferring degrees (except in Divinity), and giving the instruction in those branches of learning which are costly to conduct, or are taken by only a few students, or are professional in character." (*Yearbook of the Universities of the Commonwealth, 1949–50*, p. 547). This scheme became archetypal.

For nearly 20 years Toronto university was administered by a government department. In 1906 it was granted an independent board of governors, nominated by the lieutenant governor in council, and the right of nominating to academic appointments was vested in the president of the university. In 1907 Manitoba university was reconstituted on the same lines. In 1906 and 1907 provincial universities, modelled on Toronto, were founded in Alberta at Edmonton and in Saskatchewan at Saskatoon.

Australia.—The earliest Australian universities successfully combined mediaeval and modern features Each was established by the state legislature, yet constituted a self-governing corporation. Each relied for support upon both public money and private benefactions. Each was nonresidential, nondenominational and secular, yet each made provision for including residential denominational colleges on religious foundations. Geography dictated their location in capital cities. The first to be founded was Sydney (1850), closely followed by Melbourne (1853) Each of these had, before the end of the 19th century, three colleges for men and residential accommodation for women Adelaide was similarly established in 1874 but did not incorporate any colleges until the 20th century When the University of Queensland was founded in 1909 it was made wholly residential, and four colleges, including one for women, were established within four years Living at home was recognized as residence. The universities of Tasmania, Hobart (founded 1890, charter 1913), and Western Australia, Nedlands (1911), had no such provision.

New Zealand.—In 1869 the University of Otago, Dunedin, was founded by provincial ordinance, with power to grant degrees in arts, law and medicine. But the next year the University of New Zealand, Wellington, a purely examining body, was established, and in 1874 Otago agreed to affiliate with it and to hold in abeyance its own right to grant degrees. Canterbury University college, Christchurch (founded 1873), also affiliated, as did later Auckland (1882) and Victoria (1897) In the early days New Zealand maintained academic standards by appointing external examiners from England.

Union of South Africa.—The development of university education in South Africa aptly illustrates the truth that universities are born to meet new needs. Higher education began with the founding in 1829 of South African college, Capetown, a proprietary institution which for 20 years had no competitors. Then within six years appeared the Diocesan college, Capetown (1849), St. Andrew's, Grahamstown (1855), and Grey college, Bloemfontein (1855). In 1858 there was established, primarily to examine candidates for public appointments, a board of examiners in literature and science, which shortly began to conduct examinations not unlike those for university degrees This greatly stimulated the work of the colleges, and by a natural sequence the University of the Cape of Good Hope, an examining and degree-granting body, took the place of the board in 1873. Almost simultaneously the Cape parliament passed a higher education act providing for salary grants to professors at recognized colleges. This further stimulated progress and incited other college foundations, including Stellenbosch (1874), which was raised to university status in 1916. Later came the Kimberley School of Mines (1896), Pretoria University college (1908) and Natal University college (1909), all destined eventually to graduate into universities.

CONTINENTAL EUROPE

France.—On Sept. 15, 1793, the universities and colleges throughout France, together with the faculties of theology, medicine, jurisprudence and arts, had been abolished by a decree of the convention, and the whole system of national education may be said to have remained in abeyance until 1808, when Napoleon I promulgated the scheme which in many essential features obtains today The whole system of education, primary, secondary and higher, was made subject to the control and direction of the state France was divided into 17 districts, designated "academies," each administered by its own rector and council, but subject to the supreme authority of the minister of public instruction, and representing certain faculties which varied at different centres, in conformity with the new scheme of distribution for the entire country The "University of France," as it was styled, became little more than an abstract term signifying collectively the various centres of professional education in their new relations to the state While three new "academies"—those of Lille, Lyons and Rennes—were formed in 1808, many of the pre-existing centres were completely suppressed. In some cases, however, the effacement of an ancient institution was avoided by investing it with new importance, as at Grenoble; in others, the vacated premises were appropriated to new uses connected with the department, as at Avignon, Cahors and Perpignan. Each rector of an "academy" was also constituted president of a local *conseil d'enseignement*, in conjunction with which he nominated the teachers in elementary and secondary schools. The appointments were ratified by a promotion committee in Paris

"Free Faculties"—In 1895 the government was prevailed upon to sanction the institution of certain "free faculties," as they were termed, to be placed under the direction of the bishop, depending for support upon voluntary contributions and each including a faculty of theology, the best known being those of Paris and Lille The faculty at Marseilles was called upon to unite with the academy of Aix, its faculties being restricted to mathematics and natural science (including a medical school), while faculties of law and philosophy were fixed at Aix, which possessed also the university library In the capital itself, the University of Paris and the École Pratique des Hautes Études carried on the work of higher instruction independently of each other—the former with faculties of Protestant theology, law, medicine, science, letters and chemistry, distributed over the Quartier Latin; the latter with schools of mathematics, natural science, history, philology and history of religions centred at the Sorbonne

In 1896 the higher education of France was decentralized and the existing academies, consisting of isolated faculties, were converted into regional universities, while the Sorbonne, from being the University of France, became the University of Paris. The total number of universities, including that of Algiers, was 16.

Germany.—The political storms which marked the close of the 18th and the beginning of the 19th century gave the deathblow to not a few of the ancient universities of Germany. Mainz and Cologne ceased to exist in 1798, Bamberg, Dillingen and Duisburg in 1804, Rinteln and Helmstedt in 1809, Salzburg in 1810 and Erfurt in 1816. Altdorf was united to Erlangen in 1807, Frankfurt-on-Oder to Breslau in 1809 and Wittenberg to Halle in 1815 The University of Ingolstadt was first moved in 1802 to Landshut and from there, in 1826, to Munich, where it was united to the academy of sciences which had been founded in the Bavarian capital in 1759. Munster, in Prussia, which had been constituted a university by Maximilian Frederick (elector and archbishop) in 1772, was abolished in the year 1818; but two faculties, those of theology and philosophy, continued to exist, and in 1843 it received the full privileges of a Prussian university, together with the designation of a royal foundation. Of those of the above centres which altogether ceased to exist, few were much missed or regretted, that at Mainz, which had numbered about 600 students, being the one notable exception. The others had, for the most part, fallen into a perfunctory and lifeless mode of teaching, and, with wasted or diminished revenues and declining numbers, had long ceased worthily to represent the functions of a university. Whatever loss may have attended their suppression was more than compensated by the activity and influence of the three great German universities which were born in the 19th century

Munich after having been completely reorganized, soon became a distinguished centre of study in all the faculties, and its numbers, allowing for the wars of 1866 and 1870, continuously increased The eminence of its professoriate, among whom were J J I von Döllinger, Justus von Liebig, Friedrich von Schelling, K. Zeuss and W von Giesebrecht, attracted students from all parts of Europe.

The University of Berlin, known as the *Royal* Friedrich Wilhelm university, was founded in 1809, immediately after the peace of Tilsit, when Prussia had been reduced to the level of a third-rate power. It incorporated the famous academy of sciences Wilhelm von Humboldt, supported by Frederick William III, adopted for it principles which not only raised it to a foremost place among the universities of Europe but also largely conduced to the regeneration of Germany. Attachment to any particular creed or school of thought was expressly repudiated in favour of complete *Lehrfreiheit* Each teacher presented freely his own views The growth of the university was astonishing; before the end of the 19th century it had more matriculated students than any university except Vienna

The University of Bonn, founded in 1818, also by Frederick William III, became known as the *Rhenish* Friedrich Wilhelm university. It was the king's design to introduce into the Rhine provinces the classic literature and the newly developed scientific knowledge of Germany proper. Accordingly, he summoned to his aid the best available talent, including B G Niebuhr and A W. von Schlegel, with C. F. Nasse in medicine and Georg Hermes in theology. In the last-named faculty Bonn combined the opposed schools of theological doctrine of the Evangelical (or Lutheran) and of the Roman Catholic churches

The German universities underwent considerable changes as a result of the compulsory military service required by the law of 1867, and the events of 1870 were not unconnected with the martial spirit that had been evoked in the student world

The Low Countries.—The settlement of Europe in 1814–15 created the "Kingdom of the Netherlands" comprising Holland and Belgium. The universities of Franeker and Harderwijk were suppressed and those of Ghent and Liège created in 1815, and a uniform constitution was given to Dutch and Belgian universities. It was provided that there should be attached to each a board of curators, consisting of five persons "distinguished by their love of literature and science and by their rank in society," to be nominated by the king. At least three had to come from the province in which the university was situated. When in 1830 Belgium was created as a separate kingdom, further changes took place there. From Louvain, the chief Catholic centre, the faculties of law, medicine and philosophy had already, in 1788, been moved to Brussels; in 1834 Brussels was constituted a free and independent university with a new fourth faculty of natural science. Having, however, no charter, it continued incapable by law of possessing property. Louvain and Brussels came to represent the two chief political parties in the realm, while the universities of Ghent and Liège recruited their students mainly from the two chief language groups, the Flemish and the Walloon. In Holland, where no such marked differences existed, the universities of Groningen, Leyden and Utrecht were in 1876 assimilated in constitution, each being administered by a consistory of five rectors with a senate composed of the professors in the respective faculties. The opening of the Free University of Amsterdam in 1880 more than repaired the loss of Franeker and Harderwijk, particularly as the progress of this new centre during its first ten years was remarkably rapid.

Scandinavia and Iceland.—The University of Christiania (now Oslo) in Norway was founded in 1811 as a state institution yet given self-government by a *collegium academicum* It had at first four faculties, theology, law, medicine and philosophy; in 1860 the last was divided into the faculties of letters and science. Women gained admittance in 1882, and the first woman professor

was appointed in 1912. In 1910 the Norwegian Institute of Technology was opened at Trondheim. No new universities were founded in Sweden, though institutions at Göteborg (1887) and Stockholm (1877) achieved something of university status In Finland, the University of Abo was moved to Helsingfors (Helsinki) in 1828. In 1911 the University of Iceland was created by bringing together schools of theology (1847), medicine (1876) and law (1908). The university is probably unique in having been conducted for the first 29 years of its life in the parliament building (*Althingishus*).

Switzerland.—In Switzerland the universities shared in the conflicts handed down from the days when the Helvetic republic was first created. In 1832, Basle having joined the League of the Catholic Cantons, the Confederates divided the canton into two and agreed to raise the flourishing *Hochschule*, which already existed at Zürich, to the rank of a university—a measure which may be said to mark a turning point and a new epoch in the history of higher education in the republic. The gymnasium of Berne, originally established under the teaching of Ulrich Zwingli, developed, in 1834, into a university with all the faculties As early as 1586 Lausanne had been a noted school for the education of Protestant ministers, but it was not until 1806 that chairs of philosophy and law were established, to which those of natural science and literature were added in 1836 and, somewhat later, that of medicine. Not, however, until 1891 was Lausanne formally constituted a university. At Geneva the famous academy of the 16th and 17th centuries, long distinguished as a centre of Calvinistic teaching, became merged in 1876 in a university, where the instruction was given mainly in the French language. With this was also incorporated an earlier school of science in which H B. de Saussure and A. P. de Candolle had once been teachers. Fribourg, founded in 1889, began with only two faculties, those of law and philosophy, to which one of theology was added in the following year. At Zurich in 1872, and later at Geneva and Berne, women were admitted to lectures, and in 1892 were permitted to lecture.

Austria-Hungary.—The Austrian universities declined rather than advanced during the 19th century. Salzburg, founded in 1623, was suppressed in 1810. Throughout the first half of the century Vienna was in an extremely depressed state; though its medical school attained an unrivalled reputation, its other faculties were allowed to languish. Olmutz (Olomouc), founded 1581, was closed in 1853. Lemberg, founded in 1774 by the emperor Joseph II, was in 1805 moved to Cracow, but in 1816 opened on an independent basis. In 1848 it lost by bombardment its buildings, library and natural history museum. Graz (1586) alone flourished. In 1875 Czernowitz university was founded, three years after that of Klausenburg (Cluj), the chief Magyar centre in Hungary. Zagreb, in Croatia, originally founded in 1669, was reopened in 1874.

Russia.—At the beginning of the 19th century Russia possessed only three universities: Moscow (1755), founded by the empress Elizabeth; Vilnius (1573), which was Polish, and Dorpat (Tartu) (1632), which was virtually German Under the enlightened policy of Alexander I were founded the universities of Kharkov (1804) for New Russia, Kazan (1804) for the countries about the Volga but designed also for the populations of Finland and Siberia, and St. Petersburg (1819). Each of the foregoing six universities had a definite district assigned to it, and, as a further incentive to the pursuit of academic studies, a ukase promulgated in 1809 proclaimed that in all appointments to official posts throughout the empire the holders of university degrees would receive the first consideration. In 1835 the foundation of the St. Vladimir university of Kiev absorbed the university at Vilnius. Odessa, founded in 1865, was designed to be the university of New Russia. Although at St. Petersburg considerable attention was regularly given to the teaching of languages, especially those of Armenia, Georgia and Tartary, the general status of the Russian universities continued, throughout the greater part of the century, exceptionally low In 1884 they were all reconstituted by the promulgation of a "universal code", with this the statutes of the universities at Dorpat (1632) and Warsaw (1816) were essentially in agreement. The study of the Slavonic languages received a considerable stimulus, especially when, by a decree in May 1887, the use of the Russian language was made obligatory in all places of instruction throughout the Baltic provinces. During the ensuing 20 years the general influence of Dorpat rapidly spread far beyond the Baltic provinces. In 1889 the Russification of the university went far to deprive it of its claim to be considered German.

The University of Tomsk in western Siberia, founded in 1888, depended chiefly on a grant from the state, aided by private liberality.

Greece.—The University of Otho at Athens, founded by King Otho (Otto) in 1837, was modelled on the university systems of northern Germany It originally included only four faculties, theology, jurisprudence, medicine and philosophy, to which one of applied mathematics was subsequently added. It was later renamed the National University of Athens.

Rumania, Bulgaria and Turkey.—The University of Jassy (1860) was founded by Prince Cuza of Rumania, and together with the newly founded University of Bucharest received its completed organization in 1864 Both were constituted state institutions and were represented in the senate, although not receiving any fixed revenues from the government In the Kliment Ochridski university of Sofia (1888) in Bulgaria, faculties were established of history, philology, physics, mathematics and jurisprudence, the main object in view being the training of competent schoolteachers and lawyers and affording them the means of gaining an intelligent insight into the real wants of the native population The University of Istanbul, founded 1453, was until the 19th century a religious school.

Mediterranean Lands.—The distracted state of Italy long prevented advance. In 1875, when the educational system was reformed, an attempt was made to assimilate the universities to the German pattern, but this policy was quickly reversed. In 1890 four "free universities," Camerino, Ferrara, Perugia and Urbino, were created, and women were admitted In Sicily the University of Palermo, founded 1779, was closed in 1805 but reopened in 1850 and became of considerable importance and size. The Sardinian universities, Cagliari (1596) and Sassari (1617) were similarly closed and reopened, but attained little eminence

Spain.—Lifeless routine and unreasoning tradition characterized the Spanish universities until the second half of the 19th century. In 1857 the entire system of education was placed, as in France, under the control of the minister for public instruction The kingdom was divided into ten university districts, each in the charge of a rector, and a precise plan of instruction was prescribed in which every hour had its appointed lecturer and subject. At every university philosophy, natural science, law and medicine were to be studied, but no provision was made for theology, this being transferred to the seminaries in the episcopal cities. In the same year the University of Manila in the Philippines was formally founded; it had been in existence for 250 years.

(J B. Mu.; C. Br.; H. C. D.)

THE UNITED STATES

The origins of the universities in the U.S. are to be found in the colleges established in the colonies before the nation was formed. Nine such colleges were founded: Harvard college, 1636; College of William and Mary, 1693, Yale college, 1701, College of New Jersey, 1746, King's college, 1754; College and Academy of Philadelphia, 1755 (originated in a charity school trust created in 1740); Rhode Island college, 1764, Queen's college, 1766; and Dartmouth college, 1770. In general, these institutions represented the arts course provided in the colleges of the universities of England, particularly at Cambridge and Oxford.

The principal purpose of the colonial colleges was to train a class of learned men specifically for the Christian ministry, although some of them aimed also at training a body of men in culture and knowledge for service in the state. The College and Academy of Philadelphia, in contrast with the other colleges, was founded on a broad plan of education, which included a considerable amount of mathematics, science, government and law. It established a medical department in 1765—the first in the country. Two years later King's college also opened a medical department.

From the American Revolution to the Civil War there was a

spectacular increase in the number of new colleges established During this period some of the older colleges came to be known as universities, and new institutions bearing the name were founded. The constitution of Massachusetts adopted in 1780 refers to Harvard college as the "University at Cambridge." The College and Academy of Philadelphia, through legislative action, became the University of Pennsylvania in 1791, and in 1804 Rhode Island College was named Brown university. The names of three other colonial colleges were officially changed at later dates—Yale college to Yale university, 1887; the College of New Jersey to Princeton university, 1896; King's college to Columbia college, 1784, and to Columbia university, 1912—although all three operated as universities before these dates Queen's college became Rutgers college in 1825 and Rutgers university in 1924. The legislature of New Hampshire attempted in 1816 to take over Dartmouth college and make of it a state university, but a decision of the United States supreme court in 1819 stopped this action.

The state university, destined to become one of the important and characteristic types of U S. higher education institutions, had its origin in the latter part of the 18th century: the University of North Carolina was provided for in the state constitution of 1776, chartered in 1789 and opened in 1795, the University of Georgia was chartered in 1875 and opened in 1801. The Indiana constitution of 1816 made it the duty of the general assembly "to provide by law for a general system of education, ascending in a regular gradation from township schools to a State university, wherein tuition shall be gratis, and equally open to all." This statement represents the ideal of the state university—the capstone of the system of public education.

The most notable early example of the state university was the University of Virginia, which, through the influence of Thomas Jefferson, was established by legislative act in 1819 and opened in 1825. The model for the state universities, however, particularly those in the western states, was the University of Michigan, opened in 1841 and reorganized in 1850. The establishment of the state-universities in the states carved out of the public lands in the west was greatly aided by grants of land from the federal government, beginning with the admission of Ohio into the union in 1803 The State University of New York, created by the legislature in 1948, was, at mid-20th century, the most recently established state university. It consists of a number of state-owned institutions of higher education located at various places and of such new ones as may be established

By 1952, 45 states each maintained one or more state universities. In two others there were "semipublic" universities. (1) the University of Vermont, privately supported to a large extent, but receiving state aid, and with some of the trustees appointed by the legislature; (2) Rutgers university, designated in 1945 as the State University of New Jersey, largely under private control, but with 9 of the 58 members of the board of trustees state officials serving in an ex officio capacity and 5 appointed with advice and consent of the state senate. The state of Pennsylvania supports Pennsylvania State college, a privately controlled institution, and it gives also some financial assistance to several privately controlled universities, including the University of Pennsylvania. Alaska, Hawaii and Puerto Rico maintain territorial universities Distinguishing characteristics of the typical state university are: (1) creation and direct support by the state government; (2) control by a publicly appointed or elected board; (3) free or low tuition to students who reside in the state, and (4) provision for numerous educational services to the state in addition to instruction on the campus.

Fourteen municipal colleges and universities had been established by mid-20th century. College of Charleston (S.C.); College of the City of New York, comprising four colleges; the universities of Akron, Cincinnati, Houston (district), Louisville, Omaha, Toledo and Wichita; Washburn Municipal university of Topeka, Kan., and Wayne university, Detroit, Mich. These institutions are controlled and supported by the municipalities in which they are located.

A group of institutions which became a prominent feature of higher education in the United States are the land-grant colleges and universities, which numbered 69 in 1950. About 200 colleges for women had also been established by mid-century. (*See* WOMEN, EDUCATION OF.)

As large personal fortunes were amassed in the United States another type of university was established—that endowed by individual munificence. Among these universities (with date of original founding) were: Tulane (1834), Emory (1836), Duke (1838), Cornell (1865), Vanderbilt (1873), Johns Hopkins (1876), Stanford (1885) and Chicago (1890). Other highly endowed institutions were the Massachusetts Institute of Technology, founded in 1861 and opened in 1865; Rice institute, 1912; Carnegie Institute of Technology, 1900; and California Institute of Technology, 1891. A number of the older universities also became the recipients of large endowments, among them Columbia, Brown, Dartmouth (college), Harvard, New York, Northwestern, Pennsylvania, Princeton, Rochester, Washington, Western Reserve and Yale. A few state universities likewise acquired large endowments, some from private and some from public sources, among them California, Michigan, Minnesota, Texas, Virginia and Washington. The endowments of these 30 institutions at mid-century ranged from $13,217,000 (Tulane) to $241,185,000 (Harvard), the average being $51,091,000. When the federal government was organized, some leaders of the nation desired the establishment of a national university, and subsequently numerous proposals for such an institution were placed before congress, but none was enacted into law. Some of the federal interests are served through institutions maintained by the federal government, such as the United States Military academy; other federal interests are served through certain relationships established with higher education institutions through grants-in-aid, payment for contracted services and loans for the construction of housing for students and faculty members.

Control and Organization.—Some universities are publicly controlled—by a state, a municipality or a district. Others are controlled by private organizations, which usually receive their charters from the states in which they are located. In general, each university is under direct control of a lay board, usually known as a board of trustees, although other titles, such as board of regents and board of directors, are also used. Boards of publicly controlled universities are elected by the voters of the state or the municipality which maintains the institution, or they are chosen by a governmental official or agency. In a few states all the state institutions of higher education are controlled by one board, as in Georgia and Oregon. The members of the boards of privately controlled universities elect persons to fill vacancies; such boards are known as self-perpetuating. The members of the boards that control church-related universities are, in many instances, elected by the religious organizations which maintain the institutions. For many universities the alumni elect some members of the boards of trustees. Most of the Roman Catholic institutions are controlled by the religious orders, though some are under diocesan control

The actual administration of a university is assigned to administrative officers employed by the board of trustees. Usually the principal officer is called president or sometimes chancellor. He has a heavy responsibility and large authority in the direction and management of the institution. Among his principal assistants are vice-presidents, directors, deans and business managers. The various colleges and schools of the university are in charge of deans, who have large responsibility for such matters as selection of faculty members, leadership in development of the curriculum and improvement of the quality of instruction. Each college or school is organized in departments or divisions. In most universities the faculties have considerable control over educational policy, especially matters relating to admission requirements, organization of the curriculum and requirements for degrees; in the larger universities this control is usually delegated to a smaller group selected entirely or partly by the faculty or by instructional staff members holding certain positions.

Educational Programs.—At the centre of the typical university in the United States is the college of arts and sciences. Students enter it upon completion of secondary education. The cur-

riculum, which is four years long, leads to the bachelor's degree—bachelor of arts or bachelor of science. The college of arts and sciences offers a program of education for students who take all their work in the arts and sciences, and provides a considerable amount of instruction to students who are registered in the professional schools of the university. The curriculum is usually so arranged as to require the student to obtain a general knowledge of a number of fields and more highly specialized and advanced knowledge in one or two fields.

The college in The University of Chicago provides a program of education which is different from that in the usual college of arts and sciences. It begins at the end of the sophomore year of high school and is normally completed at the end of four academic years. Students who complete this program are awarded the degree of bachelor of arts.

Most of the formal professional education in the United States is acquired in the universities, where it is organized in various patterns. Much of it consists of four-year programs which students enter upon completion of secondary education and which end with attainment of the bachelor's degree Examples are agriculture, business administration, education (preparation of teachers of elementary and secondary schools), engineering, fine arts, forestry, journalism and pharmacy The degrees conferred for the completion of study in special fields frequently carry designation of those fields, as bachelor of education, bachelor of fine arts and bachelor of business administration; or as bachelor of science in education, bachelor of science in engineering, bachelor of science in pharmacy; or as bachelor of arts in education, bachelor of arts in business administration

There is a tendency to lengthen programs of education for the professions. This is usually done by including, as an entrance requirement of the professional college or school, the completion of a specified amount of study in a college of liberal arts or a college of arts and sciences. As an example, three years of college work constitute a minimum for admission to the study of medicine. The medical curriculum is four years long The educational patterns in some other fields are: dentistry, two years in college and four years in the school of dentistry; veterinary medicine, two and four; law, three and three or three and four. For admission to professional training in several fields, possession of a bachelor's degree is a prerequisite, and the professional curriculums range in length from one to three years; examples are hospital administration, public health, social work and theology The first degrees conferred for the completion of curriculums in these professional fields are doctor of medicine, doctor of dental surgery or doctor of dental medicine, bachelor of laws, doctor of veterinary medicine, master of hospital administration (master of business administration, master of science in some schools), master of public health and doctor of public health, master of social work and bachelor of divinity.

All universities, except those that are universities in name only, provide programs of advanced study leading to graduate degrees. Such study is usually supervised by an administrative division known as a graduate school, which establishes and enforces policies and standards for advanced work. The instruction, however, is usually carried on by the regular departments of the university. In some universities the graduate work in professional studies is carried on by the professional schools independent of the graduate school. As a prerequisite for admission to graduate study a student must present a bachelor's or a first professional degree or the equivalent.

The principal purposes of graduate education are: to prepare college and university teachers; to prepare specialists in the various professions; and to prepare students to carry on research. Graduate study also prepares teachers of elementary and secondary schools for better service. Programs of graduate study consist of (1) specialized and advanced courses aimed at broadening and deepening the student's knowledge in one or a few fields and (2) independent study and research, largely original in character, intended to develop ability to do research in a particular field. The degrees conferred for graduate study are the master's degree, usually master of arts or master of science, and the degree of doctor of philosophy The master's degree is usually obtained for one academic year of graduate work as a minimum, three or more years of study are required for the doctor of philosophy degree Other types of doctoral degrees comparable with the doctor of philosophy are the doctor of science and the doctor of education These degrees should not be confused with the doctor of laws (LL D.), doctor of humane letters (L H D), doctor of letters or doctor of literature (Litt D), doctor of divinity (D D.) and other doctoral degrees which are conferred by colleges and universities as purely honorary distinctions.

Other Services.—Research is an important part of the work of the universities Some of it is carried on by individual faculty members as a part of their effort to improve themselves and gain professional recognition and advancement A considerable part of the research, however, is organized in projects for which funds are appropriated to pay the costs The land-grant colleges and universities maintain agricultural experiment stations, and many colleges of engineering carry on research through their engineering experiment stations. Within a number of universities research institutes have been organized to promote specific types of investigations.

Research in universities is supported from university funds and from funds supplied by foundations, scholarly and professional societies, commercial concerns, state agencies, the federal government and individual donors. The financial assistance takes the form of fellowships and grants-in-aid to mature students and faculty members, and grants and contract payments to the universities. During the year 1949–50 (as an example), $225,341,000 was spent in organized research by higher education institutions

Research in universities results in the preparation of many scholarly and scientific articles, monographs and books. To facilitate publication of such materials a number of institutions, beginning with Cornell university in 1869, established university presses In addition to books, these presses publish a number of scholarly periodicals.

Many universities extend their educational services to persons who cannot go to the institution for regular residence instruction These services are usually grouped under the category of extension work (see UNIVERSITY EXTENSION), which includes home-study or correspondence courses, extension classes, short courses and various minor activities The co-operative agricultural and home economics extension work carried on by the land-grant colleges and universities is supported partly by the federal government

Statistical Data.—The *Education Directory* for 1951–52, published by the United States office of education of the Federal Security agency, listed 1,859 institutions of higher education in the United States Of this number, 209 bore the name university, but perhaps one-third of these were universities in name only and should more appropriately be called colleges

In the fall of 1951 the enrolment in institutions of higher education was 2,116,440. Of this number, 1,017,812 students were enrolled in 130 universities. (Universities, as defined by the office of education for statistical purposes, are "those institutions of large and complex organization in which several professional schools and colleges, not exclusively technical, are incorporated within the administrative framework of the institution.") The other 1,098,628 students were enrolled in smaller universities and liberal arts colleges, teachers colleges, institutes of technology, technical institutes and other institutions. The largest enrolment in one institution was 45,186, 30 universities and colleges enrolled more than 10,000 each. Graduate students comprised approximately 9% of the enrolment. The numbers of earned degrees conferred by all higher education institutions during the academic year 1950–51 were· bachelor's and first professional, 384,352; master's and second professional, 65,132; doctor's, 7,338.

The amount expended in 1949–50 by all higher education institutions for educational and general purposes, including research but not including expenditures for plant expansion and for non-educational purposes, was $1,706,444,000. At many of the institutions the expenditures ran into millions of dollars; as examples: the University of Illinois, $41,784,000, The University of Chi-

cago, $42,542,000; the University of Minnesota, $35,040,000.
(L. E Bit)

SOUTH AND CENTRAL AMERICA

The achievement of independence by the Latin-American states was, in some instances at least, accompanied by measures of educational reform. Between 1821 and 1832 nine universities were founded or refounded and survived the many and grievous troubles which wracked the continent throughout the 19th century.

In Peru, Trujillo (1824), founded by Simón Bolívar; Arequipa, raised in 1827 from academy to university status; and Cuzco (founded 1696), which was in the same year transformed from an ecclesiastical to a lay foundation and made open to all, became centres of considerable intellectual activity. In Colombia the foundation of the University of Antioquia at Medellín in 1822 was followed by those of Cartagena (1824) and Popayán (1827). In Argentina arose Buenos Aires (1821), and in Bolivia, La Paz (1831) and Cochabamba (1832). Round the mid-19th century there was a second cluster of foundations The University of Montevideo in Uruguay dates from 1849, though it became important only when a medical school was added in 1876. In 1843 the University of Costa Rica was founded at San José, and in 1867 the University of Cuenca in Ecuador. In 1842 the century-old University of Havana was reorganized; its subsequent history for 60 years was unhappy, until in 1900 it was refounded with U.S. aid In 1843 the University of Santiago in Chile (1738) was nationalized, as was also in 1856 that of Córdoba in Argentina (1613). The closing years of the century were also marked by new foundations. La Plata (1890) in Argentina (to be reopened in 1905–08 under the auspices of the University of Philadelphia), the Catholic University of Chile in Santiago (1888), the National University of Paraguay at Asunción (1889) and the University of Guayaquil in Ecuador (1867) among others.

THE FAR EAST

China.—Until nearly the end of the 19th century public education in China consisted almost entirely of study of the classical texts. But some education on western lines had been introduced nearly half a century previously. In 1852 Roman Catholic missionaries founded a college to train Chinese as priests Protestant missions followed suit, and Americans in particular began to found institutions of university status which were open to all Meanwhile, in 1861, the government opened two colleges, at Peking and Canton, for the study of foreign languages, and about 25 years later began to send young Chinese abroad to foreign universities. In 1902, after the Boxer rising, the government embarked on *thoroughgoing educational reform* and in the same year founded the National University of Peking, incorporating in it the foreign-language colleges. By 1910 an imperial university had been established, in name at least, in every one of the 18 provinces.

Japan.—On the reopening of communication with the west Japan began eagerly to absorb western learning. In 1857 the government founded "a place for studying foreign books" and a "school for acquiring foreign medical art." To these in 1862 a college for the study of European science was added In 1871 a system of compulsory education was introduced, and in 1877 the Imperial University of Tokyo was founded. By 1910 three other universities (all much smaller) had been established· Kyoto (1897), Tohoku (1907) and Kyushu (1910).

WORLD WARS I AND II AND AFTER

The years following 1914 saw a huge increase in the number of universities. Excluding the U.S, about 250 new foundations had been recorded by 1952, or rather more than one for every two universities functioning in 1914. During the same period new faculties, schools and research institutes were added in profusion at both old and modern universities, and the numbers of students and staff multiplied at an unprecedented rate. Yet by 1950 the demand for admission was hardly anywhere satisfied, and in many countries vastly exceeded the available places.

It would be wrong to attribute this amazing growth solely, or even largely, to the effect of two world wars, though each of these undoubtedly proved a powerful stimulant. The growth derived from forces set in motion long before the outbreak of World War I, forces which were working themselves out in a world-wide social and economic revolution.

China.—By far the largest increase in the number of universities took place in Asia Including those in the U.S S.R., there were about 150 new foundations. Of these, a quarter or more took place in China. There, in 1912, a universities law was passed making the college of liberal arts and sciences the nucleus of the university, whose purpose was declared to be "to cultivate scholars and prepare men for the service of the state." By 1925 there were said to be 47 institutions of university status in China, and by 1937 (when Japan attacked China), 108. Probably fewer than half of these, however, would have qualified as universities in the ordinarily accepted sense of that term. An estimate made in 1938 spoke of China's 47 universities.

Between 1937 and 1945 China wrote an immortal chapter in the history of the university Many of the major institutions were situated in coastal areas that were early exposed to the full blast of invasion. Their buildings destroyed, damaged or occupied, staffs and students migrated westward, carrying with them what they could of books and equipment. More than 80 institutions are said to have thus sought security during the first year of the war, during the following seven, many universities were compelled to move again and again, usually on foot and often across mountainous territory. They suffered terrible privations and had to pursue their studies with little or nothing even of essential materials; but they held on. Academic standards inevitably deteriorated When hostilities ended, arrangements were made by the government for the universities to return to their original homes, and between May and October 1946 about 60 institutions, with more than 60,000 students, were moved back. Scarcely had this happened before the tide of war began to flow over them again, to culminate in 1949 in the complete occupation of continental China by the Communists Within the following three years all universities and colleges owned or administered by foreigners had been closed or absorbed into a nationalized system of higher education.

Japan.—Between 1920 and 1945 about 35 universities were founded in Japan These were of three kinds imperial, other state universities and private. The imperial universities had several faculties, the "government" universities one only. The private universities, about 25 in all, were about half and half multiple- and single-faculty institutions; most of them maintained their own preparatory schools to ensure a steady flow of entrants

During World War II the buildings of two-thirds of the universities were destroyed or badly damaged In 1947, following advice from a U.S education mission, the diet passed a school education law which provided for a four-year university system after the U.S. pattern. Under this all institutions for higher education which could satisfy the standards prescribed by the University Accreditation association (founded for the purpose) were to be organized into about 220 "new-type" universities—70 government, 20 public and 130 private

India.—In India, following the government's 1913 resolution, universities were founded at Benares (1916) and Patna (1917), the former specifically to develop Hindu culture. Almost simultaneously two universities were started in Indian states, at Mysore (1916) and Hyderabad (1918), the latter, Osmania university, adopting Urdu, the official language of the state, as the medium of instruction. Between 1917 and 1919 the whole organization of higher education in India was exhaustively examined by the government's Calcutta University commission Little change ensued at Calcutta, but from the recommendations sprang eight new universities in ten years. the Moslem university of Aligarh (1920), Lucknow (1920), Rangoon (1920), Delhi (1922), Nagpur (1923), Andhra (1926), Agra (1927) and Annamalai (1929). During these years Bombay, Madras and Allahabad were reconstituted. During the 1930s only one university was founded, at Travancore (1937), but in 1943 another succession began which resulted in Utkal (1943), Saugar (1946), Rajputana (1947), Gauhati (1947), Poona (1948), Roorkee (1948), Kashmir (1948) and Baroda (1949).

Pakistan.—On the creation in 1947 of the dominions of India and Pakistan, the University of the Punjab (1882) became two universities. West Punjab in Pakistan and East Punjab in India. The former became the University of the Punjab. The University of Dacca (1921), previously unitary, became affiliating. The University of Sind (1947) was founded just before partition, and universities were later established at Peshawar (1950) and at Karachi (1952).

Ceylon.—In Ceylon the University college (1921) and the Medical college (1870) amalgamated to become in 1942 the University of Ceylon, which in 1952 moved into new buildings near Kandy.

Others.—In 1949, following the report of a commission sent from England, the University of Malaya was founded by the amalgamation of Raffles college (1928) and the King Edward VII College of Medicine (1905). During the years after 1914 universities were also founded in Afghanistan (1946), Java (1947), Iran (1934), the Philippines (seven between 1921 and 1948), Siam (four between 1917 and 1943) and Turkey, at Ankara (1946) and Istanbul (1944), the latter a technical university. Special mention must be made of the Hebrew University of Jerusalem, begun in 1918 and formally opened by Lord Balfour in 1925, which became the world centre of Jewish culture.

U.S.S.R.—Detailed information about the U.S.S.R., especially about later developments, has to be derived largely from secondary sources. During the revolutionary period (1917–20), many of the republics founded national universities. Between 1922 and 1932 the Russian S.F.S.R. and other republics broke up their universities into separate specialist institutes, but the sharp lowering of standards of general culture led in 1932 to a reversal of this policy. The universities were reconstituted, at first with scientific faculties only, to which between 1934 and 1948 the humanities and law were added. During World War II many universities in the west were destroyed or seriously damaged, as they were freed from German occupation they were restored. In 1950 there were said to be about 30 universities in the U.S.S.R. All were state-owned and controlled and all similarly governed and organized.

EUROPE

Both World Wars I and II temporarily checked university studies and development, World War II far more disastrously than World War I. Apart from widespread material damage—worst of all perhaps in Germany—it was German policy in all the countries which were occupied to transform the universities into purely nazi institutions. Everywhere the policy, however savagely applied, met with determined resistance, overt or underground. In Poland, where the execution and internment in concentration camps of teachers and students probably reached the limit of ferocity, the Poles formed a secret department of education and culture and organized in Warsaw a "free Polish university" which enabled students to study and sit for degrees. By 1943–44 this had 2,000 registered students and was providing instruction in a score of subjects. In the Netherlands, where the universities of Leyden, Amsterdam and Nijmegen were closed, 80% of students refused to sign a declaration of compliance with nazi desires, and went underground. In Norway the University of Oslo was closed in 1942, when 700 students were arrested and deported. Many students escaped into Sweden, which received refugees also from Denmark, Finland and the Baltic states and organized courses and examinations for them. An international university students' committee formed in Sweden helped to keep prisoner of war camps in Germany—some of which organized "universities"—supplied with books, paper and other materials essential for study.

There was a remarkable similarity between processes of recovery after World Wars I and II, though that after the latter, having to rise from far greater depths of desolation, was on a much larger and more heroic scale. First, both wars, especially the second, stimulated the desire for increased facilities for secondary and higher education. As a result, universities everywhere were overwhelmed with applicants and overcrowded to the breaking point. Second, both wars, but again especially the second, impressed upon the nations the necessity for widespread technological and administrative proficiency; consequently there was a rapid development of specialist institutes, for both teaching and research, mainly within or attached to universities. New faculties and schools arose in equal profusion: in the applied and social sciences, agriculture, commerce and the fine arts. Third, the wars emphasized—unsuccessfully after World War I—the urgent need for international co-operation at the university level. Cultural conventions between nations facilitated the exchange of teachers and students for shorter or longer periods. This development was particularly widespread after World War II, being stimulated not least by the Fulbright agreements. International conferences, courses and summer schools proliferated, being encouraged after World War I by the League of Nations and organized by such bodies as the Institute of International Education in New York city, and after World War II by the United Nations Educational, Scientific and Cultural organization and, for example, the Association of Universities of the British Commonwealth and the British council.

Curiously, neither war led to much foundation of new universities, except in eastern Europe. After World War I, several were set up in the newly established states of Czechoslovakia, Finland, Poland, Rumania, Yugoslavia and the Baltic republics; elsewhere, except in Italy under the Mussolini regime, only an evolutionary development took place, illustrated, for example, by the promotion of Reading (1926) in England and the foundation of Hamburg (1919) in Germany. After World War II there was a similar but smaller outcrop in the east, chiefly in Poland and Rumania. For political reasons Berlin acquired three new universities. The British raised the famous Charlottenberg Institute of Technology to university rank (1946), the Americans founded the Free University of Berlin (1948) and the Russians the University of Potsdam (1948). The French reopened the ancient University of Mainz (1946), which had been closed for a century and a half. The only other foundations in western Europe were Nottingham (1948) and Southampton (1952) in England and Bergen (1948) in Norway, all three elevations of long-established institutions.

LATIN AMERICA

Brazil.—Brazil and Mexico contributed almost half of the new universities, about 50 in number, founded in South and Central America between 1914 and 1952. Brazil's first university, at Rio de Janeiro, was set up in 1920; 30 years later the country had three national, five state and three Roman Catholic universities. By a law passed in 1931, every university must have a law school, a medical school and either a school of engineering or philosophy.

Mexico.—The rapid growth of universities in Mexico reflected the intensive attention given to public education after the 1910 revolution. In May of that year the ancient Royal and Pontifical University of Mexico (founded 1551) was reorganized as the National University of Mexico. In 1929 it was granted virtual autonomy and became the model for all the state universities, of which there were 11 in 1952. In 1933, students at the state university of Guadalajara went on strike in protest against state control and after a struggle lasting several months forced the government to agree to the foundation of autonomous universities. Thereupon they organized the Autonomous University of Guadalajara, inducing teachers to serve without pay, until the university was recognized in May 1935. In 1943 a women's university was founded in Mexico City as a private institution providing courses in letters, law, science and a long list of special subjects ranging from journalism to nursing.

Colombia.—In Colombia as in Mexico there was a determined effort to raise the general standard of education. A law passed in 1934 decreed that not less than 10% of the government's revenue was to be expended on education. Within the next six years four new universities had been set up, and by 1950 there were altogether ten in the country, one national, five departmental and four private. All enjoy considerable autonomy, though all must conform to the statutes of the National university at Bogotá.

Other Nations.—Universities were also founded after 1914 in Argentina, Bolivia, Chile, Costa Rica, Ecuador, Haiti, Nicaragua,

Panamá and Peru.

Cuba and West Indies.—Between 1946 and 1948 Cuba increased the number of its universities from one to five in 1946 the Catholic university, Havana, the first private university in the republic, was approved by the church; in 1947 and 1948, respectively, the universities of Oriente and Santa Clara were founded, and in 1947 the Junior college of the Havana Business academy, a privately owned institution, became a university and independent of the parent body.

Following the passing of the Colonial Development and Welfare act, 1940, the British secretary of state for the colonies appointed in 1943 a commission to consider the principles which should guide the promotion of higher education, learning and research and the development of universities throughout the British colonies A delegation sent by this commission to the West Indies recommended that a university be established there at the earliest possible date The British government undertook to provide the capital funds for its establishment and the West Indian colonies the income for maintenance A principal was appointed in 1946, and in 1948 the medical faculty of a university college of the West Indies opened, working under the aegis of the University of London In 1949 the science faculty was added, in 1950 that of arts. The site of the college, near Kingston in Jamaica, was donated by the Jamaican government. Construction of permanent buildings began in 1949.

AFRICA

Union of South Africa.—After long discussions on the replacement of examining by teaching universities, the South African parliament in 1916 passed three acts whereby the University of the Cape of Good Hope became the University of South Africa, with headquarters at Pretoria; the South African college became the University of Capetown; and the Victoria college, Stellenbosch, became the University of Stellenbosch. In 1922 the University college, Johannesburg (formerly the Kimberley School of Mines), became the University of the Witwatersrand; in 1930 Transvaal University college became the University of Pretoria; and in 1948 Natal University college the University of Natal. In 1945 the Pius XII Catholic University college at Roma in Basutoland was founded, the first Roman Catholic university establishment for Negroes in the world.

Development in Tropical Africa.—In 1945 the Commission on Higher Education in the British Colonies urged that university colleges should be established as soon as possible in British West Africa and that Makerere college, Uganda, be developed to full university status. In accordance with these recommendations, university colleges were established in Nigeria and the Gold Coast in 1948, and Makerere college was upgraded to university college status in 1950.

AUSTRALASIA

Australia.—In 1930 Canberra University college was constituted, "pending the establishment of a teaching university in Canberra" Its function was to provide courses for degrees in cooperation with one or more of the existing universities In 1946 the commonwealth parliament passed the Australian National University act to establish at Canberra a university providing especially for postgraduate study and research. Building began in 1949. By 1952 all its four research schools (medicine, physical sciences, social sciences and Pacific studies) were at work.

In 1947 the New South Wales government set up a development council to create a university providing facilities for undergraduate, graduate and research study in technical subjects. The New South Wales University of Technology began work in March 1948 and was incorporated by the state parliament in April 1949.

New Zealand.—In 1926 the University of New Zealand became a federal body including four constituent colleges (Otago, Canterbury, Auckland, Victoria) and two associated agricultural colleges. (J. B. Mu.; C. Br., H. C. D.)

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UNIVERSITY ARCHITECTURE. The earliest universities, such as Paris, Bologna, Prague, Salamanca and others, were established in towns, and it is with the buildings of the towns that the universities grew and became mingled. They were often housed under the protection of religious establishments in monastic and church buildings, and, if under secular control, in old palaces or other structures hired or lent by the civil authorities and not always planned for the purposes of the university.

Continental European Universities.—Nearly all univer-

sity structures on the Continent of Europe are Renaissance; the remainder are classic in style. Exigencies of the site, such as land values and density of the surroundings, have in many cases imposed a form of building with a closely knit plan entirely occupying a city block Uninterrupted exterior walls correspond with the street building lines Within are one or more courts providing light and air. These courts are usually surrounded by a colonnade which gives access to the various rooms. An example of this type is the Sorbonne (Nerot, architect; 1885–1900) Where the site is sufficiently open the U- and H-shaped plans or a combination of these are found. An imposing group of university buildings laid out in modern style is at Strasbourg Other universities of a modern type are to be found at Vienna (Ferstel, architect; 1885), Uppsala, Munich, Bucharest, Budapest.

Oriental Universities.—The University of Cairo resembles a mosque (*q.v.*). At the imperial University of Peking new buildings influenced by western design are taking the place of the native one or two-storey structures of gray brick, built about small square courts, opening into each other through broad gateways, and said to have been originally palaces. The 50 buildings of the modern University of Tokyo indicate the influence of German universities, and like them provide for education in the sciences

South American Universities.—University buildings in South America invariably contain one or more courts or patios, from the galleries of which the surrounding rooms are entered The exteriors are in the Renaissance style as taught at European architectural schools—notably those of France—and found in modern buildings of that country and of Spain. Mansard roofs are much in favour for buildings upon a large and pretentious scale, and abundant ornament characterizes both interiors and exteriors Of this order are the National University of Mexico at Mexico City, the university buildings at La Plata, Argentina, the University of Montevideo, Uruguay, and the Catholic university at Santiago, Chile.

English Traditional Type.—Oxford and Cambridge typify the English university system, and are so singularly venerable and traditional that, in the English-speaking world, their names are almost synonymous with the word university The congeries of buildings that grew up at Oxford round the University Church of St. Mary and the Schools, consisted first of halls, which were scarcely more than inns or hostels for the students, that is to say, rows of separate dwellings, each with its entrance on the side away from the street and each independent of its neighbour. Later the colleges were erected, each sufficient unto itself, with its own chapel and antechapel, library, masters' lodge and hall, common room, student lodging, dining hall (commons), kitchen, buttery, bake-house, brew-house, cellars and other offices. Additional rooms were contrived later in the attics, by means of roof and wall dormers, additional storeys and by additional colleges. The early colleges were so constructed as nearly to enclose a quadrangular sequestered space.

These establishments epitomize the history and development of the national styles ranging from the monastic period through the centuries marked by the Perpendicular, Tudor, Elizabethan, Jacobean and Modern styles. In spite of their variations, the oldest of the colleges have in common an architectural character that has been designated the English Collegiate Gothic style. The old English universities dominate the town and yet defer to it in so far as the architectural boundary lines conform to the streets, none of which are rectilinear. Instead of rigidly formal lay-outs or grouping of buildings, there is a happy picturesqueness Modern buildings have, however, made their appearance

The modern Universities of London, Manchester, Liverpool and Birmingham differ radically from Oxford and Cambridge, and being urban, student lodgings play little or no part in their design.

American Universities.—The influence of both English and Continental university architecture is seen in the building for educational institutions which has taken place on a prodigious scale in America during the past 50 years. The earliest foundations to develop with the towns in which they were situated were Harvard and Yale The typical American university, however, differs from these in having, often isolated in rural districts, its own separate domain, the heart of which is the campus (*q.v.*) or college yard The University of Virginia, designed by Thomas Jefferson and dominated by the classic library, is believed to be the first general scheme realized After the period of stagnation of the arts, and following the awakening caused by the Centennial at Philadelphia and the work of Richardson and other pioneers (*see* MODERN ARCHITECTURE: 18th AND 19th CENTURIES), the first university to attempt a comprehensively developed plan was that of Stanford, Cal. (C. A. Coolidge, architect; 1886) Developments on a comprehensive pre-arranged plan are at the University of Illinois, Louisiana State university, University of Rochester, Duke university, Johns Hopkins, Washington university (St. Louis), and the University of Minnesota

The earliest university buildings were designed in the style brought from England by the colonists. New buildings of this character are also found at Harvard, Franklin and Marshall, Rutgers, Delaware, Johns Hopkins and Brown universities At the end of the 19th century, however, a counter-current set in College buildings in English collegiate style having been carried out with measurable success by Cobb at Chicago, Haight at Yale and Cope and Stewardson at the University of Pennsylvania, a predilection for this style arose Curiously enough, this was more pronounced at the American universities where the Colonial tradition was formerly strong, so at Yale and Princeton, for example, Gothic is seen side by side with the traditional colonial

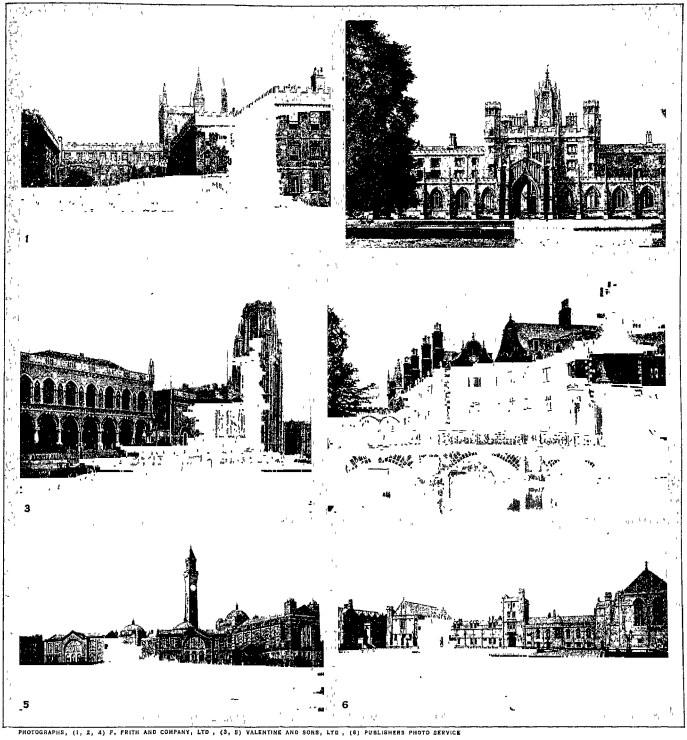
Yet another aspect of the development of university architecture in America is the so-called "sky-scraper" type of building at the University of Pittsburgh (Klauder, architect). That the universities of the U.S. are ready to progress beyond mere eclecticism in the design of their buildings is evinced by the competitions for the Fine Arts building group at Wheaton college (1938), and the Festival Theatre at William and Mary in Williamsburg (1939)

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UNIVERSITY COLLEGES. The so-called university colleges in England owe their rise to the desire, in the 19th century, to bring higher education within the reach of the population of certain regions to whom the existing universities were, for reasons of cost or distance, inaccessible. The earliest of such colleges, Owens college, Manchester (opened in 1851), was specifically founded for that purpose, and many of its students were long prepared for the external examinations of London university Subsequently, in Manchester and elsewhere, the technical side was developed. Other similar foundations were the Yorkshire college, Leeds, the New University college, Liverpool, the Mason college, Birmingham, the Firth college, Sheffield. Later on certain of these colleges became affiliated colleges of a single university (*see* UNIVERSITIES), but such colleges, and even others which did not go through the intermediate stage, have now become independent universities, with the exception of Armstrong college, Newcastle, which is still part of Durham university In fact, a university college to-day is regarded as a university in the making The most recent to attain that dignity is Reading, while University college, Nottingham (*see* below) should soon win its charter. (C. BR.)

Exeter.—When the Royal Albert Memorial building was erected in 1865, part of the premises was set aside for educational purposes Here various extension courses provided by the University of Cambridge were instituted. These were co-ordinated in 1893 and the work placed under the direction of a principal At the beginning of the present century courses were developed to prepare students for the external degrees of the University of London. In 1922, the institution was incorporated as the University college of the south-west of England, and its status was recognized by grants from the University Grants committee. It is hoped in time to develop this institution as a university of the south-west of England. In June 1927 the prince of Wales laid the foundation stone.

Hull.—The University college of Hull opened for the first time



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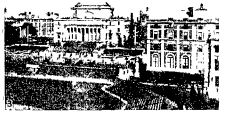
ENGLISH UNIVERSITIES

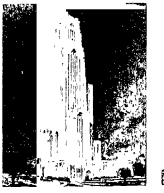
1. New College, Oxford University, Oxford
2. St. John's College, Cambridge
3 Art Gallery, Museum and University, Bristol
4 St John's College, showing the river, Cambridge
5. Birmingham University, Birmingham
6. Mansfield College, Oxford

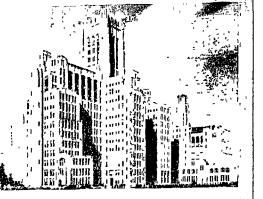
UNIVERSITY ARCHITECTURE


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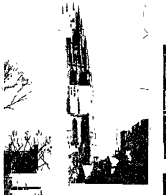

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BY COURTESY OF (4) CHARLES Z KLAUDER, ARCHITECT, (7) JAMES GAMBLE ROGERS, ARCHITECT, PHOTOGRAPHS, (2, 3) EWING GALLOWAY, (5) UNDERWOOD AND UNDERWOOD, (6) PAUL WEBER, (8) FAY C. LINCOLN, (11) GREEN J TURNER, (12) ROSE

VIEWS OF AMERICAN UNIVERSITIES

1 Massachusetts Institute of Technology, Cambridge, Mass.
2 School of Business Administration, Harvard University, across the Charles river from Cambridge, Mass
3. Columbia University, New York city
4. Cathedral of Learning at University of Pittsburgh, Pittsburgh, Pa.
5. Buildings on the Chicago campus (Lake Shore Drive, Chicago), Northwestern University, Evanston, Ill.
6 Dartmouth Hall at Dartmouth College, Hanover, N H.
7. Harkness Memorial Tower, Yale University, New Haven, Conn.
8. School of Business Administration, Harvard University. Detail of fig 2
9. Alumni Dormitory, Johns Hopkins University, Baltimore, Md.
10. Baker Laboratory of Chemistry, Cornell University, Ithaca, N Y.
11. Cuyler Hall, Princeton University, Princeton, N.J.
12 Graduate College and Cleveland Memorial Tower, at Princeton, N.J.
13. Sorority House group at Northwestern University, Evanston, Ill.

in Oct 1928. The college has been established as a result of gifts by the Rt. Hon. T R. Ferrens, amounting to £272,000. The corporation of Hull has also given £150,000 towards the initial building scheme and has resolved to make an annual maintenance grant of £2,500. The policy of the college is to aim at quality rather than quantity. It has, therefore, been decided to begin as only two faculties, arts and science

Leicester.—In 1921 an institution was established to prepare students for the examinations of the University of London under the style of the Leicester, Leicestershire and Rutland college. In 1926 the name was changed to Leicester University college, when the endowment fund had reached a total of £130,000.

Nottingham.—The University college was first opened in 1881, having developed out of courses conducted by the Extension Board of the University of Cambridge. It was housed till 1928 in buildings in the centre of the town, provided by the municipality. Through the generosity of Sir Jesse Boot, an admirable site and a fine building, opened by the King in the year named, have been provided at a cost of over £500,000. An appeal is now being made for an adequate endowment fund The college prepares its students, both in day and evening classes, for the London university examinations in art, science and law. It has a very active University Extension department.

Southampton.—University college was opened as the Hartley institution by Lord Palmerston in 1862. At the outset the work was mostly evening work, by which students were prepared for the examination of the Science and Art department; the day was rather preparatory to university work than of real academic standard. In 1902, under a scheme of the Board of Education, the institution became the Hartley University college, and received a grant from the Treasury. Just before the World War new buildings had been provided at Highfield, but they were not occupied by the college till 1919.

Wales.—*Lampeter.* St David's college, Lampeter, was founded in 1827 to provide a liberal education to persons intended for the Church, especially in Wales. It was subsequently affiliated to Oxford and Cambridge, where its students have special privileges. Under royal charters it has received the right to confer degrees in arts and theology, the examinations being conducted by examiners appointed by Oxford and Cambridge. Residence for a certain number of terms is also essential. (A. E. Tw.)

UNIVERSITY COURTS, in the English universities of Oxford and Cambridge, courts of inferior jurisdiction, administering the form and procedure of the canon law.

At Oxford the chancellor, in 1244, acquired jurisdiction over actions of debt and actions affecting movables in which one party was a clerk; in 1275 over all personal actions in which either party was a member of the university, and in 1290 over all crimes, except homicide and mayhem. The chancellor, vice-chancellor and the vice-chancellor's deputy are justices of the peace for Oxford, Oxfordshire and Berkshire, where scholars are concerned, and so exercise jurisdiction under the Summary Jurisdiction acts By the Oxford University act 1854, the procedure of the common law was substituted for that of the canon law.

At Cambridge the chancellor enjoyed a jurisdiction similar to that of the Oxford chancellor, but limited to cases arising in the town and suburbs of the university Previous to 1891, women of light character, who had been convicted of consorting with or soliciting members of the university *in statu pupillari*, were detained in a house of correction called the "spinning house," but in that year a conviction was held bad (*ex parte Hopkins* [1891]), with the result that the clause in Elizabeth's charter of 1561 giving power to imprison women was repealed. *See* H. Rashdall, *Universities of Europe in the Middle Ages* (1895); D. S. Holdsworth, *Hist. Eng. Law* (1921). (H. H. L. B.)

UNIVERSITY EXTENSION, a term applied to the provision of lectures or other teaching by universities for the general public, not members of the university.

Great Britain.—The idea of extending the range of advanced teaching beyond the walls of the universities was not a wholly new one in the 19th century, but it was not taken up with pertinacity till the early '70s. At that time a young Fellow of Trinity, James Stuart, approached his own university of Cambridge for the recognition of extra-mural work. He had been specially impressed with the needs of two classes who had sought his help—the working men of Crewe and an association for the higher education of ladies in the north of England Cambridge gave its official support in 1873 and Mr. (afterwards Professor) Stuart developed a system, not merely of lectures, but of classes.

Before long Oxford followed suit and a London society was formed which has since been absorbed by the University of London. The old Victoria university (Manchester, Liverpool, Leeds) took its share of the work.

Before the end of the century every large town in England and most small ones had a university extension centre, the subjects studied including history, geography, literature, art, music, science, economics. Since then the older type of extra-mural work, called officially university extension at Oxford and London and university local lectures at Cambridge, has continued to advance. Even during the World War a large number of courses were delivered.

The period since the war has shown a remarkable development of university tutorial classes, begun by Oxford in 1908 and soon taken up by other universities. The system, like the older type, provides for lectures, discussion classes and paper work; but the membership is limited to a small number, formerly 32 and now 24, of students pledged to fulfil the conditions for three years. In 1910–11 the number of classes was 72 and students 1,829; in 1927–28 these had increased to 591 and 10,778 respectively. In addition there were 83 preparatory classes with 1,709 students. Substantial grants in aid are made by the Board of Education and local authorities.

The central joint advisory committee on tutorial classes, formed in 1909, was one of the first bodies to represent all the universities and university colleges in England and Wales. It also has direct representation of the joint committees which manage the work in each case, and which include members nominated by the Workers' Educational Association In 1925 a consultative committee was formed, consisting of all the extra-mural officials It is concerned with all branches of the movement and not only with the tutorial classes. At the congresses of universities of the empire, held in 1912 and 1921, a prominent place was given to teaching work outside the walls The tutorial class movement has flourished in Australia and New Zealand

Every university and university college in England and Wales is now conducting tutorial classes. Several have started university extension work of the older type, a development which has been made possible by the issue in Aug. 1924 of new regulations of the Board of Education in providing for grants in aid

One of the most promising developments is the plan, recommended by the royal commission, of bringing up to the university adult students who have gone through a course of extra-mural instruction. At both Oxford and Cambridge a number of such students are now in residence for at least a year, and experience is already showing that, besides widening their own outlook, they contribute an element of great value to the undergraduate life of the places. All will return to their homes with powers of greater service to the community, and many will become valuable teachers in the adult education movement (*See also* ADULT EDUCATION)

BIBLIOGRAPHY.—W. H. Draper, *University Extension: a Survey of 50 years (1873–1923)* (1923), Albert Mansbridge, *University Tutorial Classes* (1913); R. St. J. Parry, *Cambridge Essays on Adult Education* (1920); *Reports* of the Adult Education Committee appointed by the president of the Board of Education. (D. H. S. C.)

The United States.—To trace the history of university extension in the United States to any definite initial movement is impossible It grew out of the public demand for the extension of the advantages of the university to the community in general. A hint of the desire to broaden the service of higher education may be found in the series of lectures open to the public for a small fee offered by Columbia college at its original site in College Place, New York, in 1830. This was premature and failed to arouse interest. We may refer also to the American National lyceum founded in 1831, the Lowell Institute in Boston (1839), the Peabody Institute in Baltimore (1859), all having features of univer-

sity extension particularly of the lyceum (*see* LYCEUMS AND CHAUTAUQUAS) or short lecture course type Then the summer school (*q.v.*) was organized at *Chautauqua* in 1874 which through its literary and scientific circles developed a form of correspondence study. The next incident in the development centred around the public libraries in such cities as Chicago and St Louis, for it was at the meeting of the American Library Association in Sept 1887, when Prof. Herbert B. Adams of Johns Hopkins university spoke on the university extension of England. Extension work under the auspices of public libraries was endorsed and earnestly advocated by Melvil Dewey, librarian of Columbia university, before the regents of the University of the State of New York in 1888. In 1890, when Mr. Dewey had become the librarian of the State library of New York, the regents following his suggestion, endorsed by 31 colleges of the State, determined to establish a system of university extension and obtained from the legislature an appropriation of $10,000 for administrative expenses.

The University of Chicago and the University of California, 1891–92, were pioneers in the acceptance of extension instruction in their scheme of university study. Thus naturally led to the gradual disbanding of organizations established outside of the universities. The first 20 years of the 20th century witnessed the organization of extension teaching in at least 30 State universities Only a few institutions which rely largely upon private endowment—as Columbia university (1902 and 1910), New York university (1908), University of Rochester (1916), Syracuse university (1920) and University of Pennsylvania (1913)—have included university extension as part of their public service in education.

Early Forms of University Extension.—As in England so in the United States the early form of university extension was that of the lyceum or short lecture course, not too profound, often illustrated, intended to entertain as well as to instruct Although the short lecture course served a useful purpose, yet the lyceum as a means of education, with its difficulty of maintaining a balance between the serious and the entertaining, proved unsatisfactory It became necessary to approximate much more closely the form of instruction followed in the established schools and offered to students in regular attendance. Those who could not attend classes were given courses by correspondence (*see* CORRESPONDENCE SCHOOLS), which assumed a more or less academic form and exactness, and classes were established at convenient centres and in university buildings. The large universities of the West, *e g*, the University of Chicago and the University of Wisconsin, built up great departments of correspondence although using class instruction in a restricted degree.

Credit for Extension Courses.—Certain privately endowed universities and colleges, particularly those in the East, have believed that their special function would be jeopardized if they should supplement their classes by those intended for the irregular student. Thus Princeton gives no indication of a desire to enter this field Yale is cautious in its active interest in adult education. Harvard co-operates with Tufts college, Massachusetts Institute of Technology, Boston university and Wellesley college in offering courses of a collegiate grade to qualified, though not formally matriculated, students. Massachusetts has a well organized department of university extension. As to credit toward degrees for extension students the policy varies in different institutions. The State universities in the West generally grant credit for class and correspondence courses. Columbia gives credit for established class instruction but not for home study. Harvard grants credit in co-operation with other institutions toward a special degree of A.A., associate in arts.

The National Association of University Extension is an organization of universities and colleges which have established departments of extension teaching. This was organized in 1914 and publishes annual reports which contain the records of meetings of the association. The American Association for Adult Education held its first annual meeting at the Hotel Drake in Chicago, on March 26, 1926. The latter organization is a most active agent for the study and extension of adult education. In 1926–27, under the auspices of the Carnegie Corporation, four studies covering the field of adult education were published. One of these entitled *The University Afield*, by Alfred L. Hall-Quest (1926), is a carefully prepared examination of educational opportunities offered by American universities in university extension.

BIBLIOGRAPHY.—The American Society for the Extension of University Teaching, *University Extension—Its Definition, History, System of Teaching and Organization* (1891); Arthur J. Klein, *Correspondence Studying in Universities and Colleges* (1920); W. H. Draper, *University Extension, 1873–1923* (1923), John S Noffsinger, *Correspondence Schools, Lyceums, Chautauquas* (1926); Owen D Evans, *Educational Opportunities for Young Workers* (1926); N. Peffer, *New Schools for Older Students* (1926); A study by the American Library Association, *Libraries and Adult Education* (1926). (J. C. E.)

UNIVERSITY SETTLEMENT: *see* SOCIAL SETTLEMENTS.

UNRUH, FRITZ VON (1885–), German dramatist, novelist and poet, was born in Coblenz of an aristocratic Silesian and Prussian family. He joined the Prussian Guard, but resigned his commission in 1912 when his first play, *Offiziere* (*Officers*) met with great success. His *Opfergang* (1916; English tr. 1928, *Way of Sacrifice*), which is the first written description of the battle of Verdun, expressed his revolt against militarism. His trilogy *Ein Geschlecht* (1918–21) was also impressionist The later *Flugel der Nike* (1924), *Heinrich aus Andernach* (1925), and *Bonaparte* (1926; English tr. 1928) were still expressive of revolt but they had lost some of the wildness, and with it some of the force of *Opfergang*. Other works include *Louis Ferdinand, Prinz von Preussen* (1914), *Rosengarten* (1922), *Politeia* (1933), *Charlotte Corday* (1935) and *Gandha* (1936). Unruh was a member of the Prussian Academy of Letters from 1928 until 1933. He moved to France in 1933 and to America in 1940

UNTERMYER, SAMUEL (1858–1940), American lawyer, was born at Lynchburg (Va), on June 6, 1858. He was educated at the College of the City of New York and at the Columbia law school, and was admitted to the bar in 1879, practising thereafter in New York city. He was counsel in many celebrated cases covering almost every phase of corporate, civil, criminal and international law. As counsel for H. Clay Pierce he prevented the Standard Oil Co., after its dissolution in 1910, from dominating the Water-Pierce Company. In the same year he effected the merger of the Utah Copper Co. with the Boston Consolidated and the Nevada Consolidated Cos., involving more than $100,000,000. In 1903 he undertook the first judicial exposure of "high finance" in connection with the failure of the U.S. Shipbuilding Co., organized as a consolidation of the larger shipbuilding companies in America After this he conducted a number of similar exposures. In 1911 he delivered an address entitled, "Is There a Money Trust?" which led the following year to the so-called Pujo money trust investigation by the committee on banking and currency of the Federal House of Representatives. Mr Untermyer urged measures like the compulsory regulation of stock exchanges, reform of the criminal laws and the regulation of trusts and combinations. He took part in preparing the Federal Reserve Bank law, the Clayton bill, the Federal trade commission bill and other legislation curbing trusts He was a delegate to Democratic conventions and a strong supporter of President Wilson, who appointed him to serve on the commission which sat at Buenos Aires in 1916 to frame uniform laws for the Pan-American countries.

Untermyer acted for Governor Smith in a water-power controversy over the Niagara, St. Lawrence river, Adirondack forest reserve and other hydro-electric power rights, resulting in the defeat of the grant of the water-power rights of the State to private interests. He was counsel for Herman Bernstein in the first suit brought against Henry Ford because of attacks on the Jewish people published in the *Dearborn Independent*. In July 1927, Mr. Ford agreed to destroy the publications.

UNTERWALDEN, a canton of Switzerland, consisting of the basins of two streams, both called Aa, flowing into the Lake of Lucerne and divided into Obwalden and Nidwalden. The area of the canton is 296.4 sq.mi. Forests cover about 85 sq.mi. and glaciers occupy over 5 sq.mi. The highest point is the Titlis—10,627 ft.—south of Engelberg. As Obwalden includes this region, it is generally more mountainous than Nidwalden. The latter in-

cludes much more lake surface than Obwalden. The inhabitants are devoted to pastoral and, in a much less degree, to agricultural pursuits. In 1941 the total population was 20,110 in Obwalden and 17,346 in Nidwalden, and in 1950, 22,125 and 19,389, respectively, mainly German-speaking Catholics. The capital of Obwalden is Sarnen (pop., 1950, 6,199); and of Nidwalden, Stans (3,992).

There are no main line railways; a light railway runs from Lucerne to Brünig pass via the Sarner-Aa valley; an electric railway from Stansstad ascends the other main valley as far as Engelberg, and mountain railways give access to the summits of Pilatus, Stanserhorn, Bürgenstock and Seelisberg Each area forms a single administrative district, with its own independent local institutions, in Obwalden there are 7 communes and in Nidwalden 11 In each "half" canton the legislature is composed of 32 (Obwalden) and 58 (Nidwalden) members respectively, elected for 4 (Obwalden) or 6 (Nidwalden) years by all male citizens of voting age

The people have always been deeply religious. In the church of Sachseln, on the Sarnersee, still lie the bones of the holy hermit, Nicholas Lowenbrugger (1417–87), known as Nicholas von der Flue, or "Bruder Klaus," while at Sarnen, near by, are several convents; the most famous of all the monasteries in the canton is the great and still wealthy Benedictine house of Engelberg (founded about 1120). Another site of historical interest is Stans, the birthplace of Arnold von Winkelried, the real or legendary hero of Sempach (1386).

History.—Historically, both Obwalden (save a small area in the Aargau) and Nidwalden were included in the Zürichgau. In both there were many great landowners (especially the abbey of Murbach and the Habsburgs) and few free men; while the fact that the Habsburgs were counts of the Aargau and the Zurichgau further delayed the development of political freedom. Both took part in the risings of 1245–47, and in 1247 Sarnen was threatened by the pope with excommunication for opposing its hereditary lord, the count of Habsburg. The alleged cruelties committed by the Habsburgs do not, however, appear in history until Justinger's *Chronicle*, 1420. On April 16, 1291, Rudolph, the future emperor, bought from Murbach all its estates in Unterwalden, and thus ruled this district as the chief landowner, as count and as emperor. On Aug. 1, 1291, Nidwalden (Obwalden is not named in the text of the document, though it is named on the seal appended to it) formed the "Everlasting League" with Uri and Schwyz (this being the first known case in which its common seal is used). In 1304 the two valleys were joined together, and in 1309 Henry VII confirmed to them all the liberties granted by his predecessor. This placed Unterwalden on an equal political footing with Uri and Schwyz, and as such it took part (1315) in Morgarten fight, in the renewal of the Everlasting League at Brunnen (1315), at Sempach (1386), and in driving back the Gugler or English free-booters (1375).

For physical reasons, it was difficult for Unterwalden to enlarge its territories Yet in 1368 it acquired Alpnach and in 1378 Hergiswil. Also Obwalden shared with Uri in the conquest of the Val Leventina (1403) and in the purchase of Bellinzona (1419), as well as in the loss of both (1422). It was Nidwalden that, with Schwyz and Uri, finally won (1500) and ruled (until 1798) Bellinzona, the Riviera and the Val Blernio; while both shared in the conquests of the Aargau (1415), the Thurgau (1460) and Locarno, etc. (1512), and in the temporary occupation of the Val d' Ossola. In the Burgundian war Unterwalden, like the other Forest cantons, long hung back through jealousy of Bern but came to the rescue in time of need. In 1481 it was at Stans that the confederates nearly broke up the league for various reasons; and it was only by the intervention of the holy hermit, Nicholas von der Flüe, that peace was restored and the great federal agreement known as the compact of Stans concluded. Like the other Forest cantons, Unterwalden clung to the old faith at the time of the Reformation, being a member of the "Christliche Vereinigung" (1529) and of the Golden league (1586)

In 1798 Unterwalden resisted the Helvetic republic, but, having formed part of the short-lived Tellgau, became a district of the canton of the Waldstätten. Obwalden submitted at an early date, but Nidwalden, refusing to accept the oath of fidelity to the constitution, rose in revolt (Sept. 1798) and was only put down by the arrival of 16,000 armed men. In 1803 its independence as a canton was restored, but in 1815 the refusal of Nidwalden to accept the new constitution resulted in the transfer (1816) to Obwalden of the abbey lands of Engelberg.

UNTON (or **UMPTON**), **SIR HENRY** (*c.* 1557–1596), English diplomatist, was the second son of Sir Edward Unton, or Umpton, of Wadley, Berkshire, his mother, Anne, being a daughter of Edward Seymour, duke of Somerset. Educated at Oriel college, Oxford, Unton became a member of parliament in 1584 and served with the English forces in the Netherlands in 1585 and 1586, being present at the skirmish of Zutphen. In 1586 he was knighted. In 1591, through the good offices of the earl of Essex, he was sent as ambassador to Henry IV of France, he became friendly with the French ruler and accompanied him on a campaign in Normandy before he was recalled to England in June 1592 Again securing a seat in parliament he lost for a short time the favour of Queen Elizabeth, however, in 1593 he went again as ambassador to France He died in the French camp at La Fère on March 23, 1596; a collection of verses published in his memory during the same year was edited by his chaplain, Robert Wright, afterwards bishop of Lichfield and Coventry. An interesting picture of Unton hangs in the National Portrait gallery and many of his official letters are in the British museum and in the Public Record office, London

UNTOUCHABLES, members of certain Indian castes which, though reckoned as Hindus, were excluded from the ordinary social and religious privileges of Hinduism. Under the constitution adopted by the Indian constituent assembly Nov 26, 1949, "untouchability" was outlawed and persecution of untouchables made punishable by law. In Pakistan the constituent assembly accepted a similar statement in 1950.

How this caste came to be pushed out of, or never admitted within, the pale is obscure. Probably in the main they represented Dravidians of the lower orders, relegated to menial or unsavoury occupations; they must not be confused with the non-Hindu animists, the wandering and criminal tribes and the pre-Dravidians of the hills and forests. A mistaken aggregation with these latter sometimes led to their numbers being taken at 60,000,000 The population of untouchables proper seems to have been nearer 40,000,000. They are best defined as Hindus who were not allowed to enter ordinary Hindu temples and who supposedly caused pollution to ordinary Hindus either by touch or by proximity. The Brahman would not officiate at the events in life at which, in the case of other castes, his attendance was essential The untouchables were compelled to live either in hamlets or wards of their own or in separate quarters, generally the unsanitary outskirts, of the villages. They could not use the village well, and there was always opposition to their children attending the village school The indignities they suffered varied in different parts of India, being the worst in the south, where a fantastic code regulated the distance an untouchable must maintain from a high-caste Hindu on the public roads and the warning he must give of his approach.

During their persecution, large numbers of untouchables adopted the religions of Islam or Christianity. (ME.; X.)

UNYAMWEZI, a region in Tanganyika, roughly coinciding with the Tabora district of the Western Province of Tanganyika, is situated on a plateau between 3,500–4,100 ft. above sea level. The average maximum temperature is 83° F. and the minimum 62°.F. The region, which is well-watered, is lightly forested and covered with tall grass. The town of Tabora (*q.v.*), founded by Arabs, is located in Unyamwezi.

Unyamwezi is the Bantu word for the country inhabited by the Wanyamwezi or Nyamwezi, a Bantu group which consists of many tribes such as the Wakimba, Wasumbwa, Wagala. They are skilled agriculturists, growing cassava, rice, maize and beans. During the first half of the 19th century Unyamwezi (visited by R. Burton and J. H. Speke in 1857) was the leading political power in Tanganyika.

Under the leadership of Mirambo, the Nyamwezi conquered

large sections of the country, defeated the Watuta-Zulu of the south (*c.* 1850), and conquered the Arab town of Tabora (1871), the centre of Africa's ivory trade. After Mirambo's death in 1886, his successor Siki failed to retain Unyamwezi's political position, since German troops occupied the country in 1890. The Nyamwezi who resisted were forced to surrender in 1893.

See the works of Burton, Speke, Stanley; G F. Sayers, *Handbook of Tanganyika Territory* (1930); H. Meyer, *Das Deutsche Kolonialreich* (1909). (H. A. WF.)

UNYORO, now officially called BUNYORO, a district in the Northern Province of the British protectorate of Uganda. The district coincides with the native state of Bunyoro-Kitara, over which a British protectorate was declared June 30, 1896. The country, extending toward the west of Lake Albert, is hilly and well-watered in the south (average altitude between 3,500 and 3,800 ft) and has a low, undulating savanna in the north. Bunyoro covers an area of 5,619 sq mi. and in 1948 had 120,926 inhabitants. Masindi, Masindi Port (on Lake Kyoga), Butiaba (on Lake Albert) and Hoima are the major settlements and trade centres; they are connected by all-weather roads.

In 1933, when the Bunyoro agreement went into effect, the native state was reorganized under British control. Although the district commissioner remained in charge of the general administration, the native ruler, whose full title is Rukirabasaija Agutamba Mukama, was associated with the administration of the state. Tito Gafabusa Winyi II, who became mukama in 1924, was assisted by the traditional council called Rukurato and by six chiefs in charge of the six *saza*s or districts into which Bunyoro is divided. The district commissioner and the mukama have their residence in Hoima.

The Banyoro, as the inhabitants of Bunyoro are called, belong to the Bantu population of Africa. The ruling Bahima families belong to the Hamitic people who invaded East Africa about A.D. 1000 and founded several states of which Buganda and Bunyoro are the most prominent. Both states were in permanent struggle for the political supremacy in the East African lake region. Although the Arabs of Zanzibar had visited Bunyoro for many centuries, the first Europeans to enter it were J. H. Speke and J. H. Grant in 1862, to be followed in 1864 by Sir Samuel and Lady Baker. Baker, having been appointed governor of Egyptian Equatoria, annexed Bunyoro to Egypt in 1872 when Kabarega was king of Bunyoro Kabarega did not recognize any foreign authority and opposed first Egyptian and later British forces. Although his country had been occupied and formally annexed by the British in 1896, he was not captured until April 1899; subsequently he was deported to the Seychelles but was permitted to return in 1923. He died upon his return to Uganda. Tito Gafabusa Winyi II, who succeeded his half-brother Andereya Duhaga II, was a son of king Kabarega.

See H. B Thomas and R. Scott, *Uganda* (1935). (H. A. WF.)

UPAS, a Javanese word meaning poison, and specially, the gum of the anchar tree (*Antiaris toxicaria*), of the fig family (Moraceae), and a native of the Sunda Islands, used to envenom the darts of the natives. According to the absurd fable (professedly by one Foersch, who was a surgeon at Samarang in 1773) published in the *London Magazine*, Dec. 1783, and by Erasmus Darwin (*Botanic Garden*, pt. ii), the tree destroys all animal life within a radius of 15 mi. The tree has a straight stem rising without a branch to 60 to 80 ft. It has a whitish bark and yields the juice from which the poison is prepared. The toxic effect is somewhat similar to that of picrotoxin. In addition, there is a digitalislike effect on the heart.

UPDIKE, DANIEL BERKELEY (1860–1941), U.S printer, was born in Providence, R I., on Feb. 24, 1860. In 1893, he began to establish the Merrymount Press. In 1895 he revived the Scotch cut type produced by Alexander Wilson about 1835. He later acquired the 17th century Dutch fonts of Janson and the matrices of the Mountjoy type, and he led in the revival of classical typography in the U.S. Special types, among them the Merrymount type, were designed by Bertram Goodhue and Herbert Horne. From 1910–17 he was lecturer on printing in Harvard university. He was selected to print the *Standard Book of Prayer* in the revision of 1928. His published works include: *On the Dedication of American Churches* (with Harold Brown; Cambridge, 1892); *Printing Types—Their History, Forms, and Use* (Cambridge, 1922), *In the Day's Work* (Cambridge, 1924). Also he edited. *A Dissertation Upon English Typographical Founders and Foundries*, by Edward Rowe Mores, with appendix by John Nichols (1924) and *Notes on the Merrymount Press* (1934). Updike died Dec 28, 1941.

UPHOLSTERY. In modern usage, an upholsterer is one who supplies coverings, cushions, padding and stuffing for chairs, sofas or beds, or who repairs them. The word first appears as "upholder," then as "upholdster" or "upholsterer," that is, a broker who holds goods up to public view The earliest example of upholstery consisted in simply stretching a piece of leather across a seat somewhat on the principle of a hammock. Subsequently, springs were added. These springs, at first shallow, developed in height and assumed the hourglass shape, permitting wide bases and a capacity to compress fully without bending over or rubbing together.

Manufacture.—Across the base of the seat webbing is stretched and tacked to the wood frame. To this the springs are sewn with cord and subsequently lashed or tied together to ensure that they do not get bent over on one side. If the chair is to have what is called a spring edge, a piece of cane is bent round at the front of the seat and also lashed to the springs, so as to form a firm edge and at the same time ensure that the springs work in unison. After this, canvas is stretched over the springs and tacked down to the wooden frame. The chair is then first stuffed with whatever material may be chosen, such as fibre or hair, a light canvas or scrim is placed over the filling and the edge stitched by hand to form a firm portion which determines the outline and form of the chair. The chair is then second stuffed with a further layer of hair or some cheaper material. This hair is then covered with a layer of wadding to prevent it from working through the cover.

The same treatment is applied to the back and arms, which may also be sprung The upholstered articles may now be first covered in calico or the final cover put on.

Perforated spring frames are sometimes employed consisting of helical springs held together by metal links and surrounded by a wire edge bent to the outline of the seat.

Sponge Rubber Cushions.—India rubber in liquid form is converted to a froth, poured into moulds, coagulated and vulcanized in boiling water or steam vapour to form the air-cell rubber cushion, 90% air by volume. Moulded cushions of this type came into general use in 1939 to replace both springs and padding material in buses and railroad cars and was introduced for domestic furniture, mattresses and passenger automobiles, both as full depth cushions and thinner pads over conventional spring frames.

The principal raw materials employed in upholstery are timber for the framework, webbing, springs, hair fibre, flock, woodwool, canvas, wadding, tacks, twine and laid cord; various coverings, such as leather, moquettes, velvets, tapestries, silks and damasks.

BIBLIOGRAPHY.—John W Stephenson, *Practical Upholstering* (1937); Charles W Seager, *Upholstered Furniture* (1936); Emil Johnson, *Upholstering* (1939). (*See* FURNITURE MANUFACTURE.) (W. H. S.; X.)

UPLAND, a town in the southern part of California, U.S., in San Bernardino county. It is situated 38 mi. E. of Los Angeles and about 20 mi. W. of San Bernardino. It is served by the Atchison, Topeka and Santa Fe, the Pacific Electric and the Southern Pacific railroads. The altitude is 1,210 ft. The population was 9,203 in 1950 and 6,316 by the federal census of 1940. Three distinct peaks mark the area just north of Upland; Old Baldy, 10,080 ft., Cucamonga, more than 9,000 ft. and Ontario, 8,750 ft. At Euclid Ave. and 12th St. in Upland, stands the "Madonna of the Trail," marking the Santa Fe trail to the coast and being one of 11 marking the line across the United States. The town has a council-manager form of government and owns its own waterworks and sewage treatment plant.

Upland is in the midst of a lemon- and orange-growing region and the ten fruit-packing plants constitute the town's principal commercial activity. The public library contains 32,000 vol.

and the general hospital, established in 1922, is operated by a non-profit association.

UPPER AIR SOUNDINGS. In meteorology the exploration of the upper air, using instruments carried by balloons, kites or aircraft, is an important part of observational technique. The term "soundings" covers the measurement of temperature and humidity, as well as other geophysical elements such as cosmic rays and the electric field, the pressure being measured at the same time in order to determine heights The term is not usually interpreted to include the measurement of upper winds, this being known as wind-finding or pilot-ballooning This article is limited to the meteorological aspect of the subject—the measurement of temperature, humidity and pressure.

The investigation of the upper air began in 1749 when Alexander Wilson attached a thermometer to a kite. With the invention of the balloon in 1783 began a century of scientific ballooning, some indication of the thermal structure of the lowest 25,000 ft. of the atmosphere being gradually obtained at great cost and serious personal risk The modern period began in 1892, when Gustave Hermite and Besançon began to use small unmanned balloons (*ballons-sondes*) carrying instruments. In 1894 Albert Rotch began the use of large kites tethered by steel wire The advent of aircraft provided a further means of carrying instruments aloft but finally resulted in the virtual abandonment of meteorological kite-flying. In the first two decades of the 20th century there was an immense development of the technique of the sounding balloon, providing a good deal of information about the lowest 60,000 ft. of the atmosphere and leading to the discovery of the stratosphere or isothermal region (*see* METEOROLOGY). The disadvantage of having to recover the instruments in order to read their records prevented a fuller exploitation of the method. In the decade 1927–36 the great advances in radio technique made possible the development of the *radiosonde*, an instrument which, attached to a free balloon, sends down radio signals that can be translated into numerical values of temperature, humidity and pressure. The results, being immediately available, can be used in forecasting; and this immense advantage resulted in the adoption of the radiosonde to the practical exclusion of earlier methods.

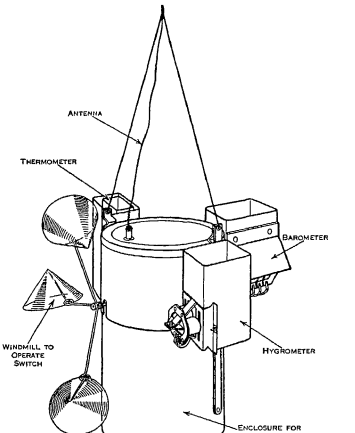
For this reason the rather complicated recording instruments (*meteorographs*) formerly used with sounding balloons will not be described here Aircraft are used to some extent for meteorological reconnaissance flights over long distances, but the very elaborate meteorographs used in the years preceding 1935 were replaced by wet- and dry-bulb thermometers, the pressure being measured by the altimeter of the aircraft. The auxiliary observations of weather phenomena made by the crew are a very important feature of reconnaissance flights.

Radiosondes fall naturally into four classes: (1) those transmitting signals spaced in time, the values of the meteorological elements being deduced from the intervals between signals; (2) those transmitting a carrier wave modulated at various audible frequencies, these being related to the values of the meteorological elements; (3) those making use of changes in carrier frequency in a similar manner; (4) those transmitting signals in Morse or other codes. Instruments of the first two classes seem to have been the most successful.

A complete radiosonde apparatus consists normally of six parts: a rubber balloon, a parachute, the meteorological assembly, the radio transmitter, the batteries and the antenna. At sea or in uninhabited regions the parachute is omitted. The meteorological assembly, the transmitter and the batteries are nearly always contained in, or attached to, one box or carton designed for the proper exposure of the meteorological instruments.

The radiosondes used by the British Meteorological office during the years 1939–46 belong to the second of the above classes, as do those used by the weather bureau and the armed services of the U S. The Canadian Meteorological division has developed an instrument of the first type.

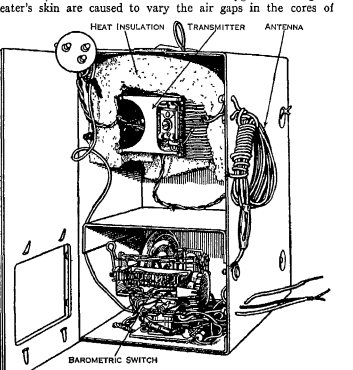
The British and American radiosondes differ greatly in external appearance and also essentially in the means used to produce the variable audio frequency. In the former (fig. 1), an aneroid



FROM "METEOROLOGICAL OFFICE RADIO-SONDE" BY PERMISSION OF HIS BRITANNIC MAJESTY'S STATIONERY OFFICE; BRITISH CROWN COPYRIGHT RESERVED

FIG. 1.—METEOROLOGICAL OFFICE RADIOSONDE
The cylindrical case contains the transmitter and batteries

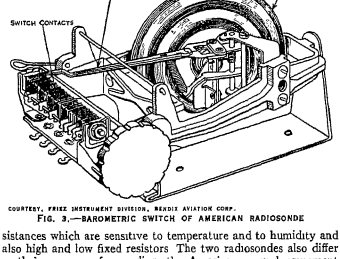
barometer, a bi-metallic thermometer and a hygrometer of gold beater's skin are caused to vary the air gaps in the cores of



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FIG. 2.—RADIOSONDE, AMERICAN TYPE
The batteries go in the upper part, just beneath the transmitter. The heat-insulating material is shown partly cut away

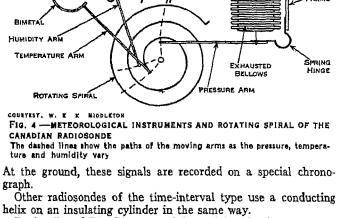
three coils, thus varying their inductance. A switch, operated by a cup wheel exposed to the air stream, connects each coil in turn into the circuit of the radio transmitter. In the American radiosonde (fig. 2) a switch (fig 3) operated by the barometer connects one at a time, into the grid circuit of a relaxation oscillator, re-



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FIG. 3.—BAROMETRIC SWITCH OF AMERICAN RADIOSONDE

sistances which are sensitive to temperature and to humidity and also high and low fixed resistors The two radiosondes also differ in their manner of recording, the American ground equipment recording the frequencies automatically on a chart, the British one requiring the operator to compare each received frequency with that generated by a calibrated oscillator.

The central feature of the Canadian radiosonde is a rotating disk of die-cast metal with a raised spiral on it. This disk is turned at about 4 5 r.p.m. by a special constant-speed electric motor, and in the course of each rotation the spiral makes contact with five arms, as shown in fig. 4 The pressure, temperature and humidity arms traverse the spiral, approximately radially, as the values of these elements vary. When this switching arrangement is connected to a small radio transmitter, the signal emitted consists of 5 short dashes every 13 sec., 2 of these (the reference signals) being separated by constant intervals, the 3 others varying their position in the time cycle according to the current values of pressure, temperature and relative humidity.



COURTESY, W. E. K. MIDDLETON
FIG. 4.—METEOROLOGICAL INSTRUMENTS AND ROTATING SPIRAL OF THE CANADIAN RADIOSONDE
The dashed lines show the paths of the moving arms as the pressure, temperature and humidity vary

At the ground, these signals are recorded on a special chronograph.

Other radiosondes of the time-interval type use a conducting helix on an insulating cylinder in the same way.

During World War II means of determining the direction (azimuth and angular elevation) of the radiosonde from the ground station by radio direction-finding were developed in the United States. The resulting apparatus, known as a *rawinsonde*, made it possible to determine the upper winds at the same time and was rapidly supplanting the ordinary radiosonde for military purposes by 1945. The equipment carried up by the balloon was similar to that described above, but a much higher radio frequency was employed

References: For the early history, *see Wissenschaftliche Luftfahrten*, ed. R Assmann and A Berson (Brunswick 1900), vol. I. In general, *see* E Kleinschmidt, *Handbuch der Meteorologischen Instrumente* (Berlin 1935); W. E. K. Middleton, *Meteorological Instruments*, 2nd. ed. (Toronto 1943). (W. E. K. M.)

UPPER SIND FRONTIER, a district of British India, in the Sind province with administrative headquarters at Jacobabad (*q.v.*) Area, 2,969 sq.mi.; pop. (1941), 304,034. The land is watered by canals from the Indus, of which the chief are the Begari and Desert canals. Principal crops are millets, oilseeds, pulses, wheat and rice, most of which is sent to the sea-board; the trade from central Asia into Sind crosses the district, bringing wool and woollen goods, fruits, carpets and horses. The district is crossed by the Quetta branch of the North-Western railway, and from Jacobabad a 2½ ft. gauge line runs to Kashmor

UPPINGHAM, a market town of Rutland, England. Pop. (1931) 1,703. The Church of SS Peter and Paul has decorated portions in the nave, tower and spire. The pulpit is of the 17th century. Jeremy Taylor was rector there at the outbreak of the Civil War. The principal institution of Uppingham is the school. It is coeval with the grammar school of Oakham (1584) and had the same founder, Robert Johnson, archdeacon of Leicester During the 19th century, the school was developed by Edward Thring into a public school of great educational influence (See *Life and Letters of Edward Thring* by E. R. Parkin, published 1898.) Pop. of rural district (1938) 5,740.

UPPSALA or UPSALA, a city of Sweden, 41 mi. N. of Stockholm. Pop. (1943) 40,053. The name originally belonged to Old Uppsala, nearly 2 mi. N. of the present city This Uppsala, mentioned in the 9th century, was famous for its heathen temple, which gleamed with gold. Three huge grave mounds remain there. In the same place the first cathedral of the bishops of Uppsala was erected (*c.* 1100). But on its destruction by fire, convenience caused removal in 1273 of the archiepiscopal see to the present city, then called Östra Aros, but later Uppsala, which became a kind of ecclesiastical capital. There the kings were crowned, after their election at the Mora Stones, 10 mi. S.E. of Uppsala.

In 1567 Eric XIV murdered in the castle five most eminent men of the kingdom, three of them belonging to the family of Sture. In 1593 was held the great synod which marks the final victory of Protestantism in Sweden; in the same year the university was restored by Charles IX. In the castle, Christina, daughter of Gustavus Adolphus, resigned her crown to Charles X in 1654 In 1702 nearly the whole city burned down.

Uppsala has water communication with Stockholm by the river Fyris and the northward arm of Lake Mälar, into which it flows. The older part of the city lies on its sloping west bank.

The university, the chief and oldest in Sweden, was founded in 1477 by Archbishop Jakob Ulfsson. The main university building, completed in 1887, lies west of the cathedral The library building was erected in 1819–41. It is on the site of the Academia Carolina, founded by Charles IX, and is known in consequence as *Carolina Rediviva*. After 1707 the library had the right of receiving every work printed in Sweden. Among the mss. is the famous *Codex Argenteus* (6th century), a translation of the Gospels in the Gothic of Bishop Ulfilas (4th century). In the old botanic garden, Linnaeus had his residence. The new botanic garden was given by Gustavus III in 1787. The observatory was founded in 1730. The Victoria museum contains Egyptian antiquities. The Royal Society of Sciences, founded in 1710 by Archbishop Erik Benzelius, has a valuable library. Much of the revenue is drawn from the estates granted by Gustavus Adolphus in 1624. Every student must belong to a "nation" (*landskap*), of which there are 13, each representing a particular part of the country and having generally its own clubhouse and fund. The students have a high reputation for singing.

The cathedral stands nobly above the town; its tall western towers with their modern copper-sheathed spires are visible for many miles. It is of simple form and mainly French in style (the first architect was a Frenchman, Étienne de Bonneuil), modified by the use of brick as building material. Ornamentation is

thus slight except at the southern portal. The church was building from 1287 to 1435. It suffered from several fires, and a thorough restoration was completed in 1893. The easternmost chapel is the fine mausoleum of Gustavus Vasa. The castle was founded in 1548 by Gustavus I. It was destroyed by fire in 1702, and only part is restored Uppsala is a book-printing centre.

UR, a very important Sumerian site and the reputed early home of Abraham (Biblical Ur of the Chaldees). Ur lies about 140 miles south of Babylon, and about 6 miles south of the modern bed of the Euphrates, about two miles from the modern Ur junction on the Baghdad–Basra railway, in 31° N, 46° E. In ancient times the Euphrates ran west of Ur, reaching open water near Eridu. The river was diverted so that it passed by Ur in the time of Rimsin. The city also lay near the ancient junction of the Tigris with the Euphrates, when the former flowed along the Shatt al Hai Ur lies close to the low hills which form the edge of the Arabian desert It commanded the communications of both rivers It was close to the sea and at the same time a convenient entrepôt for the commodities of the desert. The gradual change in the coast line and in the course of the rivers has left the ruins in the desert Although most of the ruins of Ur as seen to-day,—and the *ziggurat* is one of the best preserved in Mesopotamia,—belong in their present form to the Neobabylonian period, recent excavations have shown that the site has been occupied from extreme antiquity. Original excavations were undertaken by Taylor in 1854, but a serious examination of the site was not made till after World War I by Hall. His work has since been ably continued by Woolley.

Amid the extensive remains of cemeteries, the most recently found graves, which lie south-east of the sacred enclosure, are the most interesting The graves fall into three periods, and are dated provisionally by Woolley at 3500 B.C., the second series are comparable with Cemetery A at Kish, and are dated by Woolley at about three centuries later, while the third series are some centuries later, but at present are undated.

The richest graves of all belong to the earliest period Their wealth of precious metal shows that there was a very considerable and prosperous civilization, while the settled style of the art shows that this civilization was already an old one. The graves antedate the first dynasty of Ur by 400 years, they come therefore in the period subsequent to "the flood," a period in which Sumerian historians placed two dynasties, those of Kish and Erech. For these periods and for the first dynasty of Ur they record only the names of the kings, often exaggerating the length of their reigns to an absurdly great degree. The excavations at Ur have, however, produced inscriptions of the first dynasty and these early graves show that the occupation of the lower river valley is extremely ancient, while additional confirmatory evidence of an early date has recently been found at Kish.

The great temple area at Ur is both striking and has had many archaeological results. The temenos or sacred enclosure as it exists to-day is the work of Nebuchadrezzar. The outer wall appears to have been pierced by six great gateways. On the north-east side the more northerly had a corner stone with an inscription of Bur-Sin. The southerly was restored by Cyrus, the son of Cambyses. On the south-western side the gateway opposite the ziggurat had an inscription of Nabonidus.

The ziggurat stands in the north-west corner of the sacred area. It consists of three stories. The lowest, which measures 210 × 140 × 20 feet, was built by Ur-Nammu and Dungi and was built so well that further restoration was apparently never needed. The second stage was restored by Nabonidus. A small building crowned the third stage. This was the bedchamber of the god and goddess, not a temple as Herodotus supposed The face of the first stage was blackened, the second and third was of red stone, while the shrine on the top was encased in blue brick, the work of Nabonidus. On the north-east side there were three stairways, leading from the platform to the second stage, two ran along the face of the tower from the north and east angles respectively and met in the middle, from which point there was a third stairway, running towards the face of the tower, at right angles to the other two.

East of the ziggurat lay the great temple of E-num-mah. The ruin is of three periods, prehistoric to Neobabylonian, and of the time of Cyrus. The old Sumerian foundation wall was made of unbaked brick built on a foundation of clay which had been beaten hard On this there were two courses of unbaked bricks of Bur-Sin, 8 ft. 9 in. thick and 8 ft. 5 in high, which had been restored at various times. On either side there are a row of rooms The temple was laid in ruins between the time of Hammurabi and the Kassite dynasty. Nebuchadrezzar II made a complete restoration. The old temple had no great open court, an obvious need in a great temple; for this Nebuchadrezzar made provision

South-east of the ziggurat was a much ruined temple of Ningal. The middle cella and the side chapels lie on the north-west side of the court, and the entrance, through a great recessed doorway is on this side On either side there were two rooms connecting with antechamber and chapels and the plan recalls the temple of Ishtar at Babylon. A roadway led from the south-east of the temple of Ningal, ending in a great double gateway which gave access to the court of a great rectangular building east of the temple. There was communication from the south corner of the temple court to this street through a pair of recessed gates. At the other end of the roadway the excavators found a recess with a door opening on to a building of the Kassite period.

Between the temple of Ningal and E-num-mah lay the shrine of Nannar, E-dub-lal-mah. This is mentioned in an old liturgy as a temple of Ur and buildings of this name occur in other cities, such as Adab, Larsa, Lagash and Isin The town itself was excavated by Woolley. It has been shown that the old town of Ur, as it presented itself to Abraham's view, cannot have differed much from the modern mudbrick towns of Mesopotamia.

See, for earlier excavations, *Cambridge Ancient History*, vol. I, 1923 (bibliography); H R. Hall, *Museum Journal*, XV. Woolley's reports are appearing annually in the *Antiquaries Journal* (Vol. III. onwards). *See* also C Leonard Woolley, *Ur of the Chaldees* (1930); S. Langdon, *Der alte Orient*. 26 (1928). (L. H. D. B.)

URAL-ALTAIC LANGUAGES. The Ural-Altaic languages consist of two groups. The first is the Uralian group (Finno-Ugrian languages [*q.v.*], and the Samoyedic languages), spoken round the Ural mountains; and the second, the Altaic (Turkish [*q.v.*], Mongolian [*q.v.*], and Tungus tongues) in derivation from the mountain ranges of that name.

The Phonetic System.—Almost without exception the Ural-Altaic languages recognize a law of vocalic harmony. Exceptions exist but are explained consistently with the general principle: that in any single word only vowels of the same "timbre" may appear; thus, if the radical vowel of a word be *o* or *u*, the vowels in the other syllables must be *o*, *u* or *a*. In other words, vowels in the same word must harmonize in method of articulation. On the other hand, if the root-vowel is *e* or *i*, the vowels of other syllables of the same word must be pre-palatals or anterior-vowels (*i.e.*, articulated in the forepart of the mouth like *e* and *i*).

We have thus in Finnish the word *kesi* "hand," *kivi*, "stone," *metsä*, "forest," opposed to *kala*, "fish," *sulka*, "feathers," etc. The same applies to Hungarian, *repul*, "to fly," *lélek*, "soul," *segit*, "to help," presenting vocalic contrast to *három*, "three," *olvad*, "to smelt," *savanyu*, "bitter," etc. Turkish is even more observant of detail: *deri*, "skin," *dudak*, "lip," *bajak*, "leg, thigh," *böjük*, "big, tall," etc. (These examples are from Osmanli.)

In actual practice, there are numerous exceptions. Nevertheless, in Mongolian, Turkish, Hungarian and Finnish, vocalic harmony, without being general, tends to establish a balance between the divisions and dispositions of words, and is thus an important factor in the phonetic structure of Ural-Altaic languages

Consonantal Alternation.—In any given word the consonant which ends the root syllable is subject to various mutations according to the nature of the syllable following (open or closed) It is especially characteristic of certain Uralian tongues, like Lapp, Finnish and the Samoyedic languages. In the other languages it has not developed beyond the merest trace. Thus, in Finnish, *hukka*, "flower," but *kukan* (genitive), "of the flower"; *kuto-*, "to weave," but *kudon*, "I weave"; *repo*, "fox," but *revon* (gen.) "of a fox"; *onki*, "fish-hook," but *ongen* (gen.) "of a fish-hook"; *lintu*, "bird," but *linnun* (<*lindun*), "of the bird," etc. In their present form

the consonantal alternations, so numerous and so varied in Finnish and, above all, in Lapp, give no indication of what they once were. In early times, it seems probable that at the end of the root syllable, there was an alternation of degree—a strong one and a weak one, *tt. kk. pp.* and *t k p.* There was also an alternation which produced a contrast between *p. t. k.* and *β. δ. γ*; *m. n* ɔ, and *β. δ. γ.*, etc This alternation extended to groups of consonants opposing a strong *nt* to a weak *nd*, *mp* to *mb*, *ks* to *γz*.

This alternation theory (German *Stufenwechsel*) was formulated by the Finnish linguist, E N. Setalä, who proposed to extend it to Altaic tongues, where Ramstedt had discovered it in part. It is unlikely that consonantal alternation can be demonstrated in Mongolian, Turkish and Tungus except at a very early stage.

Vocalic Alternation.—There exists also an alternation of vowels by which, according to the suffixes which a word may take, the vowel of the root syllable may be modified or changed. Thus, in Finnish, *pala*, to burn (intrans.), and *polttā*, "to burn" (trans.); in Ostyak, *w'ālsm*, "tongue," and *n'ilmom*, "my tongue," etc. These instances are rare in modern Ural-Altaic speech, and the Uralian tongues have best preserved the traces, although examples are also found in Turkish and Mongolian.

The rules which determine the beginning and ending of words are that no word can begin with more than one consonant, and when a foreign word so beginning is borrowed it is simplified accordingly. The Swedish word *stor*, "big," becomes *suuri* in Finnish Elsewhere a vowel is put before the double consonant to facilitate enunciation: the Slav word *stolu* is in Hungarian *asztal* (pron. *ostol*) and the English "steam" is, in Osmanli, *istim*, etc.

The accent varies in position and quality. Finnish and Hungarian stress regularly the first syllable and Turkish the last. In Samoyedic and other idioms such as Ostyak it varies.

Morphology.—In the first place, no language of the group uses prefixes, all the grammatical modifications expressed in English by prepositions (viz, to, on, of, for, etc.) are effected by means of suffixes. "I enter the house," is, in Hungarian, *belépek a ház-ba* (*ház*, "house"—*ba*, suffix meaning "into"). In a tale written in Kazan Turkish we find: *ber keše urmanγa barγan dej*, "a man went into the forest" (*urman*, "forest"—*γa*, "into"). The majority of the grammatical relations affecting words are therefore expressed by suffixes, which differ in form from language to language, but play the same rôle throughout. These suffixes are strengthened by post-positions: thus (Hungarian), *egy fa alatt*, "under a tree" (*egy*, "one, a," *fa*, "tree," *alatt*, "below").

The possessive case is formed by suffixes except in Mongolian and Tungus. Hungarian *szem-e-m*, "my eye" (*szem*, "eye" + *m*, "my," with euphonic *e*) *szemed*, "thine eye" (*-d*, "thy, thine"); *szeme*, "his eye" (*-e*, "his"); *szeminnk*, "our eye" (*-ünk*, "our"), etc. Osmanli Turkish also has this form, *ev-im*, "my house" (*ev* "house," *im*, "my"); *ev-in*, "thy house" (*-in*, "thy"); *ev-i*, "his house" (*i*, "his"); *evimiz*, "our house" (*-imiz*, "our"), etc. This use of the possessive prefix is, however, comparatively modern, since it does not exist in Mongolian and Tungus and, further, since in Hungarian as in Turkish these suffixes are added directly to the root before other suffixes, while in other tongues (Finnish, Lapp, etc.) they follow all other suffixes. Compare Hungarian *a házamban*, "in my house" and Turkish (Osmanli), *evimde* (idem) with Finnish *kodassa-ni* (*-ni*="my").

The Uralian languages, Turkish, Mongolian and Tungus appear to have developed their system of word-building as we know it to-day at a date which, if not recent, was well after the time when the languages were closely related. Only a few suffixes can be restored throughout the family; it may be suggested tentatively that one method of forming the plural was to suffix a *-t* to substantives, as in modern Mongolian, Tungus and Uralian, a process of which Turkish has conserved a few traces The main characteristic of the Ural-Altaic tongues is the difficulty, even in modern speech, of distinguishing between nouns and verbs by their outward forms. The conjugation of the verb is reminiscent of the possessive-suffix system of the noun and many verbal suffixes are identical in form with those which are used to construct new nouns. The adjective has no proper declension.

Vocabulary.—All words dealing with rudimentary civilization are common to all the languages, such as those expressing relationship (father, mother, uncle, aunt, etc), certain elements, animals and plants, primitive occupations and simple movement and gesture words. The comparative philology of these languages demonstrates a neolithic civilization of the type of which traces have been found in different parts of the Urals This primitive vocabulary, the common patrimony of all the tongues, is augmented by words of very diverse origin. Mongolian and Turkish have borrowed much from Chinese and Indian languages Uralian languages have drawn largely on Indo-European stocks and in modern days times many Iranian terms have been admitted In modern days Hungarian, Wogul, Ostyak, Cheremiss and Wotjak have taken many words from Turkish lexicography. Tungus has a large percentage of Mongolian words; Osmanli Turkish has adopted much from Arabic and Persian. Mongolian and Turkish have lent to, and borrowed from, each other, and Palaeo-Asiatic elements have enriched and varied the vocabularies of the Ural-altaic languages spoken in Asia. In Europe, Finnish, Lapp and Estonian have borrowed much from Germanic, Baltic and Slav languages, Hungarian from Ossetian, Slav tongues and German. The vocabularies of the Finno-Ugrian and Turkish languages spoken on Russian territory are rapidly becoming Russianized.

Numerals.—The Ural-Altaic numeral system is decimal throughout. The names of the numbers in the different languages differ widely, because the primitive Ural-Altaic speech had not developed a proper numerical system before the dispersion.

CLASSIFICATION OF URAL-ALTAIC LANGUAGES

A. URALIAN LANGUAGES

Finno-Ugrian Languages (*q.v*)—1. Lapp: Southern Lapp, Ume-Lapp, Swedish-Lapp, Norwegian-Lapp, Enare-Lapp and Kola-Lapp. 2. Finnish: *Suomi* (of Finland), Karelian, Olonetsian, Ingrian, Ludik, Vepse, Wote, Estonian, Livian. 3. Mordvinian, Moksha, Erza. 4. Cheremiss. 5. Permian: Wotjak, Syryene. 6 Ugrian: Wogul, Ostyak, Hungarian (Magyar).

Samoyedic Languages.—Yurak, Tawgy, Yenisseian, Kamass (or Sayan Samoyedic), and Ostyak-Samoyedic.

B. ALTAIC LANGUAGES

Turkish Languages.—1. Turkish of Altai, Uzbeg, Kirghiz, Bashkir. Tatar: Azeri, Turkmen, Osmanli, etc. 2. Yakut. 3. Chuvash.

Mongolian Languages.—1. Eastern Mongol (Khalkha, Tsakhar, etc.). 2. Western Mongol (Kalmuck). 3. Northern Mongol (Buriat).

Tungus Languages.—1. Eastern Tungus: Goldic, Olcha, Lamut, Orochene, etc. 2. Southern Tungus: Dahur, Solonic, etc. 3 Western Tungus (Tungus of Vershoïansk, Yakutsk and of the Yenissei, etc), Manchu.

Many sub-dialects are necessarily annulled, and this brief classification does not imply, so far as Altaic languages are concerned, any definite relationship. The relationships of these different tongues are, as yet, far from being elucidated.

BIBLIOGRAPHY.—There are numerous publications on the Ural-Altaic languages. Apart from special works of interest only to scholars, may be mentioned: A. Sauvageot, "Langues Finno-Quériennes et Samoyèdes" in *Les Langues du Monde* (1924); J Deny (*ibid*) "Langues turk, mongoles, tongous"; Szinnyei, *Finnisch-ugrische Sprachwissenschaft*; J. Németh, *Türkische Grammatik*; P W Schmidt, *Die Sprachstämme des Erdkreises*, E N Setälä (Tetosanakirja X., p. 244 Helsingfors). (*See* bibliographies under TURKISH, HUNGARIAN, FINNISH, MONGOLIAN LANGUAGE AND LITERATURE.) (A SAU)

URAL MOUNTAINS, a mountain system which extends north to south, from the Arctic ocean to the Caspian sea and separates Europe from Asia. The Urals have been affected by a series of separate upheavals, some having a north to west strike and some a north to east. They reach their maximum altitudes along a zone stretching nearly north and south. The composite nature of the Urals is best seen at the extremities of the system, where the upheavals form a distinct chain of mountains.

The Paĕ-khoy or coast ridge (Samoyedic "stony ridge") is independent of the Urals proper It has a distinct north-north-west and north-west trend, and although cut through by the Yugor strait it is continued in Vaigach island and Novaya-Zemlya. Its

dome-shaped summits rise 1,000 ft.

The Obdorsk or Northern Urals begin near the head of Kara bay and extend southwest to the 64th parallel and form a distinct range, stony and craggy, sloping steeply towards the southeast and gently towards the marshes of European Russia Its highest peaks are Khard-yues, 3,715 ft., and Pae-yer, 4,752 ft. Sometimes the main chain has on the west two or three secondary chains, formed by sedimentary rocks, and the highest peaks of the Urals (Sablya, 5,402 ft., and Toll-poz-iz or Murai-chakhl, 5,537 ft.) occur in the south of one of these. Dense forests, chiefly fir, pine and larch, clothe the mountain slopes, but every species, except the larch, gradually disappears in the north, and the upper limit of vegetation (2,400 ft. in the south) rapidly descends to the base of the mountains near the Arctic Circle, and forest vegetation disappears about 65° N. (67° in the plains).

The section between 64° and 61° N. has again a wholly distinct character. Here the main water-parting is a succession of plateaus stretching in a northwesterly direction It has broad, flat, marshy valleys, while here and there are isolated summits, mostly under 3,000 ft. (Yang-tump, 62° 43′ N., 4,170 ft) The whole region, except the mountain summits, is densely clothed with coniferous forests. This part of the range is uninhabited.

The Middle Urals, about 80 mi. broad, contain rich iron, copper and gold mines (Bogoslovsk, Goroblagodatsk and Ekaterinburg Urals) The Denezhkin Kamen in the north (4,841 ft.) and the Tara-tash in the south (2,800 ft) mark the limits of this section. Here the orographical structure is more complicated. In the north (61st to 60th parallel) there is a succession of chains with a distinct northeastern trend. South of Kachkanar (2,866 ft) the Urals assume the appearance of broad swellings 1,000 to 2,000 ft. in height, deeply trenched by ravines. These low plateaus have been utilized for centuries as the chief highway to Siberia. The water-parting between the Russian and Siberian rivers is here not more than 1,245 ft. above sea level on the great eastward road, west of Sverdlovsk (Ekaterinburg). The valleys have a decidedly southeastern direction, as has the railway from Perm to Kurgan. The Middle Urals are densely forested. The valleys and lower slopes have a rich soil and contain large and wealthy villages The mines also support a considerable population.

The Southern Urals (55° 20′ to 51° N.) consist of three parallel chains running northeast and southwest and constitute an independent part of the Ural system. The Urals proper are a low sinuous chain hardly exceeding 2,200 to 2,800 ft. in altitude. Farther west there is a parallel chain which, although pierced by rivers, reaches 5,230 ft ; while farther west still is another series of equally high chains. The gentle slopes of the hilly tracts are dotted with woods, mostly of deciduous trees, while the hollows contain rich pasture grounds. The region is being colonized.

Farther south the main range, except when deeply trenched by the rivers, is a plateau which hardly reaches 1,500 feet. It is continued towards the Volga under the name of Obshchiy Syrt.

South of the great bend of the Ural river, quite independent ranges of hills, or flat swellings, appear (*e g.*, Dzhaman-tau, Mugodzhar hills). A range of heights connects the Mugodzhar hills with the Ust-Urt plateau.

In the distribution of the races of mankind the Urals have played an important part. The Northern Urals are inhabited by Finnish races (Samoyedes, Syryenians, Voguls and Permians) who have been driven from their former homes by Slav colonization, while the steppes on the slopes of the Southern Urals have continued to be inhabited by the Turkish Bashkirs. The Middle Urals were in the 9th century the abode of the Ugrians, and their land, Bjarmeland, or Biarmia (later Perm), was well known to the Byzantine historians for its mineral wealth—there being at that time a lively intercourse between the Ugrians and the Greeks. Compelled to abandon these regions, they moved (in the 9th century) south along the Ural slopes towards the land of the Khazars, and through the prairies of southeastern and southern Russia [the *Λεβεδία*] of Constantine Porphyrogenitus) towards the Danube and to their later seat—Hungary—leaving but very few memorials behind them in the Northern and Middle Urals

Geology.—The Ural mountains are no more than the western edge of a broad belt of folding of which the greater part is buried beneath the Tertiary deposits of western Siberia. Throughout the greater portion of the chain a broad strip of granites, diorites, peridotites, gneisses and other crystalline rocks rises directly from the Siberian plain, and is covered towards the west by Silurian, Devonian, Carboniferous, Permian and Triassic strata, which are thrown into numerous folds parallel to the length of the chain and usually rise to much greater heights than the crystalline zone.

URALSK, a town in West Kazakhstan in the Kazakh S.S.R., on the Ural river, where the railway crosses it. Pop. (1939) 66,201. Founded in 1775, it is a centre for grain and cattle from the Kirghiz steppe. There are seven flour mills and four leather and gut preparing works with iron and woollen industries; also a model farm, a museum, and branches of the Russian Geographical and of the Fisheries societies.

It has two cathedrals: one founded in the 18th century, the other in 1837.

URANIUM. The metallic element uranium has the symbol U, atomic number 92 and chemical atomic weight 238 07. It occupies a position in the periodic system of the elements as the third member of a transition series, the actinide series, which includes the heaviest known elements, and in which an inner electronic shell (the 5*f* shell) is being filled The electronic structure of the gaseous atom has been determined to be that of the element radon plus three 5*f*, one 6*d* and two 7*s* electrons. The following table lists the known isotopes, natural and artificial:

Isotope	Half Life	Type of Radiation and Energy (Mev)	Source
U^{240}	20.8 days	α (5.86)	Artificial
			Pa^{240} β^- decay
U^{238}	70 yr.	α	Artificial
			Pa^{233} β^- decay
U^{233}	1.62×10^5 yr.	α (4.80)	Artificial
			Pa^{233} β^- decay
$U^{234}(U_{II})$	2.35×10^5 yr.	α (4.76)	Natural
			Pa^{234} β^- decay
U^{235}(AcU)	7.07×10^8 yr.	α (4.52)	Natural
U^{227}	6.8 days	β^- (0.26)	Artificial
			U-n-2n
$U^{238}(U_I)$	4.51×10^9 yr.	α (4.21)	Natural
U^{239}	23 min.	β^- (1.2)	Artificial
			U-n-γ

Naturally occurring uranium consists of the three isotopes of mass numbers 238, 235 and 234 with relative abundances 99 28%, 0.71% and 0.006%, respectively The isotope U^{238} is the parent of the natural uranium ($4n+2$) radioactive series; the isotope U^{234} is also a member of this series, and thus these two are linked by radioactive decay. The isotope U^{235} is of other origin, is the parent of the actinium ($4n+3$) radioactive series, and has a great importance because it undergoes nuclear fission with slow neutrons. It is prepared at Oak Ridge, Tenn., in nearly pure isotopic composition in substantial amounts. The synthetic transuranium element plutonium, which is also fissile with slow neutrons, is prepared by the absorption of neutrons by the isotope U^{238}.

History.—The element uranium was discovered in 1789 by Martin Heinrich Klaproth in the course of an examination of pitchblende mineral originating in Saxony. To this new substance he gave the name uranium in honour of Sir William Herschel's discovery of the planet Uranus in 1781. Klaproth and two gegerations of chemists who followed him were under the impression that uranium metal itself had been prepared. In 1841, however, Eugène Melchior Péligot demonstrated that Klaproth's substance was actually the oxide UO_2; Peligot then succeeded in preparing the metal by the reduction of uranium tetrachloride with potassium. Péligot may thus be properly considered the founder of uranium chemistry.

The formulation of the periodic system by Dmitri Ivanovich Mendeleyev in 1869 directed attention to uranium as the heaviest of the elements, a position which was confirmed and held until the discovery of the first transuranium element in 1940 In 1896 Henri Becquerel discovered in uranium the phenomenon of radioactivity, a property that was later found in many other elements

(*see* RADIOACTIVITY, NATURAL). This significant discovery stimulated a new and lasting interest in the previously rather obscure element Becquerel exposed a photographic plate wrapped in black paper to the action of the beautiful fluorescent salt, potassium uranyl sulphate, $K_2SO_4 \cdot UO_2SO_4 \cdot 2H_2O$, and observed that a distinct impression had been produced on the plate Further experiments indicated that metallic uranium, all uranium salts and uranium minerals (especially pitchblende) give rise to the same phenomenon These epoch-making observations were closely followed by the discovery of radium in pitchblende (*see* RADIUM)

Occurrence.—Although uranium is usually regarded as one of the rarer elements, it is actually present in the earth's crust to a considerably greater extent than such "common" elements as cadmium, bismuth, mercury, silver or iodine. The bulk of the uranium seems to be present in the upper 12–13 mi of the lithosphere, in an amount estimated to be roughly 10^{14} tons, an average content of approximately 4×10^{-6} g. per gram of rock Concentration varies in normal rocks between about 0.2×10^{-6} and 25×10^{-6} g. per gram of rock, with higher values present in acid (high silica content) rocks such as granite Relatively minor amounts are found in the "basic" basalt rocks such as form the floors of the ocean. It is also found in very small quantities in meteorites.

Uranium is present in sea water to the extent of about $\frac{1}{2,000}$ as much as is present in an equal weight of average rock Living matter contains uranium in amounts varying from 10^{-4} to 10^{-9}% by weight, but the biological significance of the element is obscure The fixing of uranium by algae may have played a role in the formation of certain uranium deposits. There is no simple relationship between the mean concentration of an element in the earth's crust and the probability of finding economically important deposits of that element. In the case of uranium, despite the existence of widely distributed uranium minerals, only two, pitchblende and carnotite, exist in substantial deposits, and these are very few. Pitchblende is a dark bluish-black massive mineral possessing a pitchlike lustre, from which fact its name is derived, and it consists of an impure oxide of the formula U_3O_8 Carnotite is essentially a complex vanadate of potassium and uranium of the approximate composition $K_2O \cdot 2UO_3 \cdot V_2O_5 \cdot 3H_2O$

The most important sources of uranium in 1948 were the pitchblende deposits of the Belgian Congo and the Great Bear lake area, Northwest Territories, Canada. It is entirely possible that large deposits exist elsewhere as well. The pitchblende deposits of Czechoslovakia are of much smaller extent, and even smaller deposits are to be found elsewhere, as in England, East Africa, Australia, the United States and continental Europe. There are carnotite deposits in the United States in southwest Colorado and southeast Utah and also in other places such as Australia and continental Europe.

The extraction of uranium from ores is usually rather complicated since most uranium ores contain a great variety of accompanying metallic elements. The ore is ground and leached with acid, and the uranium can be separated by precipitation reactions. The uranium often leaves the refinery as the oxide, U_3O_8, which may be dissolved in nitric acid to yield solutions of uranyl nitrate The uranyl nitrate can be further purified by extraction into diethyl ether.

Uranium and its chain of decay products correspond to a source of radioactive energy which has some importance and has been much studied with respect to the problem of the internal heating of the earth. Its long half life makes possible determinations of the age of the earth by measuring the amount of lead, uranium's ultimate decay product, in certain uranium-containing rocks

Uses.—Uranium had very limited uses before its use for nuclear energy. It has been suggested for filaments of lamps. A small tube of UO_2, connected in series with the tungsten filaments of large incandescent lamps used for photography and motion pictures, tends to eliminate the sudden surge of current through the bulbs when the light is turned on, and thereby extends their life. Its compounds have been used in photography for toning and as a dye or stain in the leather and wood industries. Uranium salts are mordants for silk or wool. A little ferrouranium has been utilized in making special steels, but its value in this connection is questionable, since such alloys may be pyrophoric if they contain 20% or more of uranium Sodium and ammonium diuranates have been used in ceramics to produce coloured glazes Only 0.006% is needed to give good yellow colours By increasing the percentage, the colour may be changed to orange, brown, green or black Uranium carbide has been suggested as a good catalyst in making synthetic ammonia. Small quantities of uranium salts are claimed to stimulate plant growth, but large quantities are poisonous to plants

By far the most important use of uranium lies in its application for nuclear (or atomic) energy This use, in fact, so increased the value of uranium as to eliminate its use for many of the purposes mentioned above The element with its natural isotopic composition can be used in large chain-reacting "piles," where the reaction is sustained by the rare isotope U^{235}, and the synthetic element plutonium (the isotope Pu^{239}) is manufactured at the same time by transmutation of the U^{238}. The first self-sustaining nuclear chain reaction was produced at the wartime Metallurgical laboratory of the University of Chicago on Dec. 2, 1942 The reactions may be written.

(1) ${}_{92}U^{235}$ + neutron $\rightarrow$ fission products + energy + neutrons

(2) ${}_{92}U^{238}$ + neutron $\rightarrow {}_{92}U^{239} \xrightarrow{\beta^-} {}_{93}Np^{239} \xrightarrow{\beta^-} {}_{94}Pu^{239}$

Smaller nuclear "reactors" may be built to use the pure or nearly pure isotopes U^{235} or Pu^{239} as fuels The abundant isotope U^{238} can thus be indirectly "burned," at least in part, as nuclear fuel through the transformation to Pu^{239}, leading to a more efficient use of the uranium A fissionable isotope such as U^{235} or Pu^{239} gives rise to an amount of "heat energy equivalent" of about 10,000,000 kw hr per pound, when it completely undergoes the fission reaction.

The isotopes U^{235} and Pu^{239} can be used as the explosive ingredients for nuclear (atomic) weapons (*see* ATOMIC ENERGY). This possibility led in a number of countries to a certain amount of control over the mining and processing of uranium.

PHYSICAL PROPERTIES

Uranium is a lustrous white metal resembling steel in appearance It melts at 1,130° C, boils perhaps at 3,500° C, and has a density, calculated from X-ray data, of 18.97 g per c c. The metal is ductile, malleable, capable of taking a high polish and not hard enough to scratch glass. It undergoes two transitions, at 665° C and 892° C., respectively, and, according to some authorities, is "pseudometallic" in character. The crystal lattice at room temperature is orthorhombic (unit axes of crystal all at right angles to each other and all of unequal length) and can best be interpreted as having distorted hexagonal closest packing; its structure is thus quite different from that of chromium, molybdenum and tungsten metals. It has not been possible to assign an unambiguous radius to uranium in the metallic state. The abnormalities of the uranium structure are reflected in various properties such as an abnormally high electrical resistivity ($32\text{-}76 \times 10^{-6}$ ohm-cm) of the metal at room temperature.

Metallic uranium is a highly reactive substance It decomposes water, and in the form of powder may spontaneously inflame in air. It combines directly with oxygen at 170° C, with chlorine at 180° C., with bromine at 210° C and with iodine at 260° C. The metal reacts with gaseous hydrogen at 250° C to form a hydride of the formula UH_3. It reacts with nitrogen, carbon monoxide, carbon dioxide and many other gases, uranium can therefore be used in the laboratory for gas purifications Metallic uranium reacts with acids with the liberation of hydrogen and the formation of compounds of U^{III} and U^{IV}; caustic alkalis are without action upon it. Uranium metal appears to stand between aluminum and manganese in the electromotive series; it displaces tin and metals below it from solutions of their salts The oxidation-reduction potential for $U \rightarrow U^{IV}$ appears to be about 1.40 volts (on the scale in which the potential for $\frac{1}{2} H_2 \rightarrow H^+$ is taken as zero).

CHEMICAL PROPERTIES

Oxidation States of Uranium.—Uranium has the four oxidation states +3, +4, +5 and +6, and the ions in aqueous solution are usually represented by U^{+3}, U^{+4}, UO_2^{+} and UO_2^{++} The oxidation-reduction scheme is indicated below

$$U^{+3} \underset{0.63 \pm 0.02\text{ v.}}{\text{———}} U^{+4} \underset{(-0.662\text{ v.})}{\text{———}} UO_2^{+} \underset{-0.066 \pm 0.002\text{ v}}{\text{———}} UO_2^{++} \quad (U^{+4} \text{ to } UO_2^{++}: -0.334\text{ v.})$$

Oxidation-Reduction Potential of Uranium Ions
(In 1 Molar Hydrochloric Acid)

The UO_2^{++} ion is unstable in solution and undergoes disproportionation to U^{+4} and UO_3^{++}. A few solid compounds of this oxidation state U^{V} are known, as for example, UF_5 and UCl_5.

The ion U^{III} forms intense red solutions in water and is oxidized by water at an appreciable rate The rate of oxidation appears to increase with increasing ionic strength, although strong solutions are claimed to be stabilized by strong acids such as hydrochloric. Solutions of U^{IV} are green, and U^{VI} solutions, yellow. Considerable data on the absorption spectra of the various ionic states have been obtained, and these are useful for analytical purposes.

U^{VI} and U^{IV} are the important oxidation states, and therefore the important chemistry of uranium may be related to the two oxides UO_3 and UO_2, uranium dioxide and uranum trioxide A series of salts such as UCl_4 and $U(SO_4)_2 \cdot 8H_2O$ is obtained from UO_2. The more common uranyl salts, $UO_2(NO_3)_2$ etc. UO_2Cl_2 and $UO_2SO_4 \cdot nH_2O$, in which the UO_2^{++} (uranyl ion) acts as a radical, are derived from UO_3.

The element also exhibits a formal oxidation number of U^{II} in a few solid, sesmmetallic in nature, compounds such as UO and US. No simple ions of oxidation state U^{II} are known in solution.

Uranium Oxides.—In addition to the three oxides, UO_2 (brown), U_3O_8 (greenish-black) and UO_3 (yellow), which have been known for a long time, there are known to exist the monoxide, UO, and the oxide U_5O_8. There is also some evidence for the existence of U_4O_9 and U_6O_{17}. The phase relationships in the uranium-oxygen system are very complex because solid solutions are readily formed, so that it is possible to obtain uranium "oxides" with practically any composition intermediate between UO and UO_3.

Uranium trioxide exists in a number of crystal modifications It is usually prepared by thermal decomposition of uranyl nitrate at about 300° C The oxide U_3O_8 is formed when any uranium oxide is ignited in air at about 700° C Uranium dioxide is usually obtained by hydrogen reduction of UO_3 at elevated temperatures (500° C). All of these oxides dissolve readily in nitric acid to give uranyl solutions. Uranum trioxide decomposes to U_3O_8 upon ignition at 500°–700° C., UO_2 is refractory, melting above 2,000° C.

Closely related to the oxides are the uranates and diuranates. Sodium duranate, $Na_2U_2O_7 \cdot 6H_2O$ is the uranium yellow of commerce. The simple uranates have the typical formula Na_2UO_4; this type of compound is much more difficult to prepare than the diuranates which are obtained by addition of alkali to uranyl solution. These compounds correspond to chromates and dichromates, but, of course, lack the strong oxidizing properties of the latter

Uranium peroxide, the formula of which is usually given as $UO_4 \cdot 2H_2O$, is formed by precipitation from solutions of uranyl nitrate by hydrogen peroxide Alkali hydroxide, hydrogen peroxide, and sodium peroxide form soluble peroxyuranates, $Na_4UO_8 \cdot 4H_2O$ and $Na_4UO_8 \cdot 8H_2O$, when added to solutions of uranyl salts.

Uranium Nitrides and Carbides.—Two uranium carbides are known, the monocarbide UC and the dicarbide UC_2. These can be prepared by direct reaction of carbon with molten uranium, or by reaction of carbon monoxide with metallic uranium at elevated temperatures The latter reaction yields a mixture of UC and UO_2. The sesquicarbide U_2C_3, although reported in the older literature, does not exist at room temperature; it is actually an equimolar mixture of UC and UC_2. However, U_2C_3 may exist as such above 2,000° C.

Uranium and nitrogen form an extensive series of compounds that can be prepared by direct action of nitrogen on the metal. Uranium mononitride, UN, is the lowest nitride of uranium. If the mononitride is treated with more nitrogen at atmospheric pressure, UN_2 is formed. With nitrogen under high pressure UN_2 can be prepared, but it is difficult to obtain samples of UN_2 that are completely free of UN.

The carbides and nitrides of uranium are relatively inert semimetallic compounds. Uranium mononitride is stable in the absence of air to temperatures above 2,000° C ; the monocarbide is likewise refractory. Both carbides and nitrides are converted to U_3O_8 by ignition in air. They are soluble with difficulty in acids.

Uranium Hydride.—As mentioned above, uranium metal reacts with hydrogen at 250°–300° C. *to form a well-defined hydride*, which resembles the rare-earth hydrides in many respects. The formula of this substance has been shown to be UH_3. The hydride undergoes decomposition with increasing temperature; the dissociation pressure of UH_3 is one atmosphere at 436° C

Uranium hydride is of considerable importance in the syntheses of other uranium compounds. Since the formation of uranium hydride from massive uranium metal is accompanied by a complete disintegration of the metal to a microcrystalline powder, and since the hydrogen can then be driven off by heating *in vacuo* to 350°–400° C , very finely divided reactive uranium metal can be prepared. Further, the hydride itself is very reactive and can be used conveniently to prepare halides, carbides, nitrides, etc , of uranium at relatively moderate temperatures with the appropriate reagent.

Uranium Halides.—The halides of uranium constitute a numerous and important set of compounds. The following table lists the known uranium halides:

*Halides of Uranium**

Fluorides	Melting Point °C.	Chlorides	Melting Point °C	Bromides	Melting Point °C	Iodides	Melting Point °C
UF_3	(1,430)	UCl_3	835	UBr_3	752	UI_3	(757)
UF_4	1,036	UCl_4	590	UBr_4	499	UI_4	506
U_2F_9	↑	UCl_5	(327)				
U_4F_{17}	↑	UCl_6	179				
UF_5	(327)						
UF_6	64‡						

*Parentheses indicate estimated values
†Undergoes disproportionation to UF_5 and UF_6 on heating
‡Under pressure, UF_6 sublimes below its melting point

Uranium tetrafluoride serves as a starting material for the preparation of the other fluorides It is best prepared by hydrofluorination of uranium dioxide:

$$UO_2 + 4HF \xrightarrow{500^\circ\text{ C.}} UF_4 + 2H_2O.$$

Uranium trifluoride can be prepared by reduction of UF_4 with hydrogen at 1,000° C. Uranium hexafluoride, UF_6, is best obtained by direct fluorination of UF_4, although any uranium compound will yield UF_6 by reaction with fluorine at elevated temperatures

$$UF_4 + F_2 \xrightarrow{350^\circ\text{ C.}} UF_6.$$

The intermediate fluorides U_2F_9 ($UF_{4.5}$), U_4F_{17} ($UF_{4.25}$) and UF_5 are prepared by reaction of solid UF_4 and gaseous UF_6 under appropriate conditions of temperature and pressure.

Uranium hexafluoride is probably the most interesting of the uranium fluorides. Under ordinary conditions it is a dense, white solid with a vapour pressure of about 120 mm at room temperature. It can readily be sublimed or distilled and is by far the most volatile uranium compound known. Despite its high molecular weight, gaseous UF_6 is almost a perfect gas, and many of the properties of the vapour can be predicted from kinetic theory. Uranium hexafluoride is a strong fluorinating agent and is therefore corrosive; it is sensitive to traces of moisture and must be handled by special techniques.

Uranium tetrachloride can be prepared by direct combination of chlorine with uranium metal or hydride; it can also be obtained by chlorination of uranium oxides with carbon tetrachloride, phosgene, sulphur chloride or other powerful chlorinating agents. The trichloride as obtained by reduction of UCl_4 with hydrogen, and the higher chlorides by reaction of UCl_4 with chlorine Uranum pentachloride disproportionates on heating to UCl_4 and UCl_6. Uranium hexachloride is a rather volatile, somewhat unstable substance All of the uranium chlorides dissolve in or react readily with water to give solutions in which the oxidation state of the ion corresponds to that in the solid. All of the solid chlorides are sensitive to moisture and air

The bromides and iodides of uranium are obtained either by reaction of the elements or by treatment of UH_3 with the appropriate halogen acid. The thermal stability of the halides decreases as the atomic number of the halogen increases. No higher uranium bromides or iodides are known.

A series of oxyhalides of the type UO_2F_2, $UOCl_2$, UO_2Cl_2, UO_2Br_2, etc., are known. They are all water-soluble substances which become increasingly less stable in going from fluoride to iodide.

Aqueous Systems.—As mentioned above, aqueous solutions of U^{III}, U^{IV} and U^{VI} are readily obtained Solutions of U^{III} are blood-red in appearance; hydrogen is slowly evolved with the formation of U^{IV} solutions. Solutions of U^{IV} are quite stable in the absence of air. As may be judged from its potential, U^{IV} is a strong reducing agent and is easily oxidized to uranyl by oxygen, peroxide and numerous other oxidizing agents. Uranyl solutions in turn may be reduced to U^{IV} with sodium hydrosulphite, zinc or cadmium amalgam, or by electrochemical or photochemical means

No trivalent uranium compounds can be precipitated from U^{III} solutions; rapid oxidation to U^{IV} compounds occurs when such precipitations are attempted. Ordinarily only chloride or perchlorate solutions of U^{III} are encountered, although bromide, iodide and sulphate may be obtained.

The common water-soluble salts of U^{IV} are the chloride, bromide, sulphate and perchlorate. Solutions of these salts show a slight acid reaction which indicates a moderate degree of hydrolysis. The main absorption bands of U^{IV} solutions are at 650 mμ, 550 mμ, 495 mμ and 430 mμ. A number of different types of experiments indicate that in one molar acid, the U^{IV} ion is essentially U^{+4} (in the absence of complexing agents). Chloride and bromide ions form complex ions with U^{IV} only to a small extent in dilute solution; sulphate ion complexes U^{IV} more strongly. Insoluble U^{IV} oxalate, phosphate, fluoride, molybdate, arsenate, ferricyanide and hydroxide can be precipitated from U^{IV} solutions

Uranyl solutions are readily obtained and are more stable than those of any of the other oxidation states. Well known and extensively studied are uranyl nitrate, chloride, perchlorate, acetate, carbonate and sulphate systems. In many respects UO_2^{++} behaves like a simple doubly-charged ion. Solutions of UO_2^{++} have a characteristic yellow colour and

are slightly hydrolysed In concentrated solutions there is some evidence for the formation of polymerized ions such as UO_3^{++}. An interesting property of uranyl nitrate solutions known since the mid-19th century is extractibility with diethyl ether, uranyl nitrate hydrates are markedly soluble in ether. The addition of hydroxide, phosphate, ferricyanide, oxalate, etc., results in the precipitation of insoluble salts The uranyl ion has, however, a strong tendency to form soluble complex ions with an excess of carbonate or oxalate ions. In general, uranyl salts of weak acids have a marked tendency to form complex ions. Characteristic is the precipitation of double salts such as sodium uranyl acetate, $NaUO_2(C_2H_3O_2)_3$, and sodium magnesium uranyl acetate, $NaMg(UO_2)_3(C_2H_3O_2)_9.H_2O$. The latter type has considerable analytical significance. Uranyl solutions are fluorescent and undergo a great variety of photochemical reactions in the presence of organic compounds. (*See* also RADIOACTIVITY, ARTIFICIAL; RADIOACTIVITY, NATURAL.)

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URANUS, Heaven, in Greek mythology, the husband of Gē, and father of Cronus (*q.v.*) and other deities (*see* TITANS). As such he represents the generative power of the sky, which fructifies the earth with the warmth of the sun and the moisture of rain.

The Roman Caelus is simply a translation of the Greek *Ouranós* not the name of a distinct national divinity. In art, Uranus is shown as an old, bearded man holding a robe stretched out over his head in the form of an arch.

URANUS, in astronomy, the seventh major planet in the order of distance from the sun, and denoted by the symbol ♅. It was discovered by Sir William Herschel on March 13, 1781 He saw it as a round nebulous disc, slowly moving among the stars, and at first supposed it to be a comet, and announced it as such to the Royal Society A few weeks' observation, however, showed it to be moving in a nearly circular orbit at a distance from the sun about nineteen times that of the earth. Its planetary character was thus established, and Herschel named it the Georgium Sidus in honour of his royal patron. "The Georgian" was used in the *Nautical Almanac* up to 1850; but it was disliked outside England as was Herschel's name, proposed by Lalande. The name Uranus was proposed by Bode.

The mean distance of Uranus from the sun is 1,782,800,000 miles, and the time required for a revolution in its orbit just over 84 years The diameter has been found to be about 30,900 miles, and, since observations of the satellites show its mass to be 14·6 times that of the earth, its density is very low; viz., 0·25 that of the earth, and 1·36 times that of water The spectrum of the planet contains a number of strong absorption bands of as yet unknown origin, similar to those in the spectra of Jupiter, Saturn and Neptune. They are much more intense than those of Jupiter and Saturn, but less strong than those of Neptune. It is evident that Uranus is in the same physical state as the other planets of the outer group. Despite its distance from the sun Uranus, in consequence of its high albedo, shines as a star slightly brighter than the 6th magnitude. It is therefore, under favourable conditions, within the reach of naked eye vision Indeed, long before its discovery by Herschel, Flamsteed had taken it for a star. Lemonnier during the opposition of 1768–69 observed it eight times, but did not detect its planetary character.

Its disc, which is of a pale sea-green colour, has a diameter of rather less than 4″, and measurements by several observers have shown it to be definitely elliptical. A white streak has also been recorded crossing the centre and some faint dusky bands or belts have been noted, but it has not been possible to determine the period of its rotation in the usual way by observation of definite surface features. Spectroscopic observations, based on the Doppler principle (*see* LIGHT), by the late Professor Lowell and Dr. Slipher in 1912, however, indicated a rotation period of $10^h\ 45^m$, and photometric observations by Leon Campbell at Harvard have revealed variations of brightness, which might well be due to an outbreak of spots combined with axial rotation, in excellent accord with this value.

Satellites of Uranus.—In Jan. 1787 Herschel detected two satellites of Uranus of which the inner one, now known as Titania, had a period of 9 days, the outer, Oberon, of 13½ days. He also on other occasions saw what he supposed to be two additional satellites, but these objects could not have been of this character. In 1851–52 William Lassell at Malta, in conjunction with his assistant A Marth, observed two satellites yet nearer the planet than those of Herschel These are now known as Ariel and Umbriel Their periodic times are about 2½ and 4 days respectively Lassell's (telescopes, which were reflectors, were superior in light-power to others of his time, and these inner satellites were not seen by other astronomers for more than twenty years after their discovery Indeed, doubts of their reality were only resolved in 1873, when they were observed with the Washington 26-in telescope

The most remarkable feature about these satellites is the very high inclination of their orbit planes. This amounts to 98° to the plane of the planet's orbit, and 97·8° to the ecliptic, so that the motion of the satellites is really retrograde. The result of the high inclination is that, as Uranus revolves in its orbit, there are two opposite points at which the planes are presented edgewise to view, and the satellites will be seen to travel nearly north and south in the telescopic field. At intermediate points their orbits will appear circular. The former appearance last occurred in 1924, and the latter will next be seen in 1945.

The Satellites of Uranus

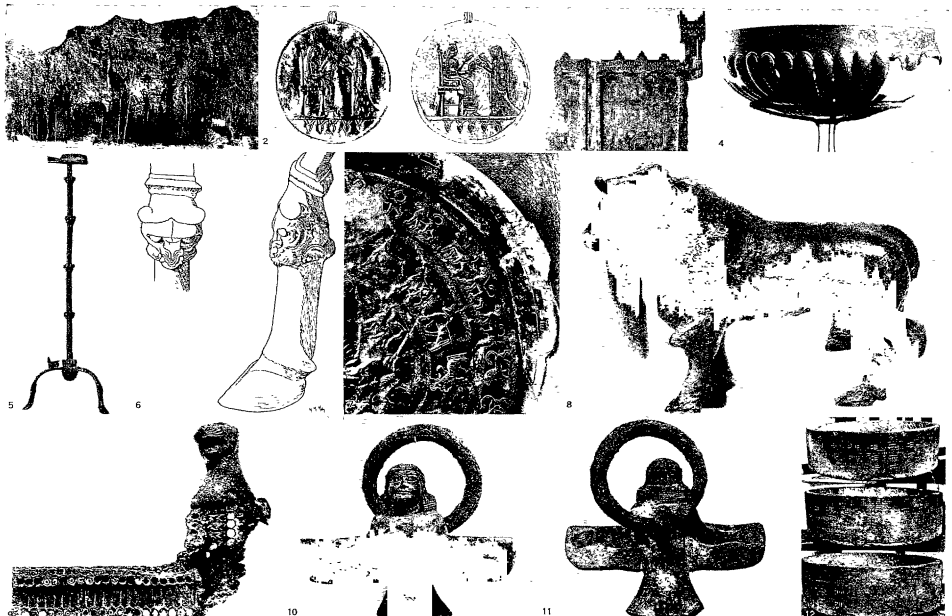
Satellite	Distance from Uranus in miles	Sidereal period	Stellar magnitude
		d. h m. s.	
i Ariel .	119,100	2 12 29 20·8	16
ii. Umbriel . .	165,900	4 3 27 36·7	16–17
iii Titania .	273,200	8 16 56 26·7	14
iv. Oberon .	364,000	13 11 7 3·5	13

For the irregularity in the motion of Uranus which led to the discovery of Neptune, *see* NEPTUNE.

URARṬU, the Assyrian name for the country called later on Armenia and for its inhabitants. It is identical with the country of Ararat, on one of whose mountains Noah's ark stopped, according to Genesis, the name survives in the Armenian province of Ararat and has been transferred to Mount Ararat south of the river Araxes. Herodotus's Alarodoi are the Urartaeans who after the immigration of the Armenians (after 600 B.C.) retained or formed a distinct nation in the valley of the Araxes. The inhabitants of Urarṭu, however, in their cuneiform inscriptions call themselves *Chaldini* (plural).

The writing of the cuneiform inscriptions of the Urartaeans was taken from the Assyrians, but whereas Assyrian is a Semitic language, Urartaean is neither Semitic nor Indo-European The Urartaeans or Chaldians must have immigrated from the west into what was then to a greater part called Nairi Apparently Sardur I., son of Lutipris, who built a fort to the west of the rock of Van, out of huge stones brought from afar, united the "Nairi-countries" under his rule after a long war against the Assyrians about the time of Assurnasirabal II, the father of Shalmaneser III This kingdom of Nairi was replaced by the kingdom of Urarṭu-Chaldia. Aram, who was the king of Urarṭu, was fought by Shalmaneser III. (859–824 B.C.), and so was his successor Sardur (Seduri II), father of King Ispuinis who chose the rock of Van for his residence and as the holy seat of the god Chaldis. Ispuinis was the contemporary of Adadnirari IV. of Assyria—son of Shalmaneser III. and husband of Queen Shammuramat, *i.e.*, the historical Semiramis—whom he fought successfully, these successes enabling him to found a Chaldian colony at Muṣṣair, west of the pass of Kelishina A bilingual Chaldian and Assyrian inscription was erected by Ispuinis upon this occasion.

Menuas, his son, was the mightiest and most successful of the Chaldian rulers. His greatest work is the aqueduct (the so-called Shamiram-su "river of Semiramis") more than 75 km. in length, irrigating the plain of Van to this day and bringing drinkable water to the eastern borders of Lake Van (whose water is undrinkable), thus enabling him to found a "Menuas-city." Menuas was succeeded by Argistis I, a son, who left records of 14 years of his reign and his successful wars, on the outer walls of the set of chambers hewn into the solid rock of Van. His son Sardur



REMAINS OF URARTU CIVILIZATION

1 Rock of Van Kalah showing rock chambers (to the left) and staircases, the former probably built during the fourteenth year of the reign of Argistis I. 2 Gold medal showing goddess and female worshipper; excavated at Toprak Kalah near Van in 1899 Photograph (left), and drawing (right), Berlin Museum. 3, Bronze model of wall with gate and tower. British Museum. 4 Bronze vessel inscribed with unknown signs Berlin Museum. 5 Candelabrum excavated in 1899 at Toprak Kalah, near Van. Gewerbe Museum, Hamburg. 6 Detail of foot of candelabrum, zoomorphic juncture: bull's foot coming out of lion's mouth. 7 Sacred shield adorning wall of Temple at Toprak Kalah with inscription of Rusas III British Museum. 8 Bronze bison; one of three chief races of big cattle living in Babylonia in the oldest times British Museum 9. Mythical animal Tiamat; holes partly filled with ornamental glass. British Museum. 10. Bronze vase handle in form of winged disc of the sun with goddess (front side) British Museum. 11. Reverse side of bronze vase handle in fig 10. 12. Stone vessel of King Ispuinis, founder of the fortress on the Rock of Van. (Three views.) British Museum.

III., contemporary of Assurnirari (755–745 B.C.) and of Tiglath-pileser III (745–727) of Assyria, was defeated by the latter, who destroyed the Manaus-city (735 B.C.).

Rusas I (714 B.C.), son of a Sardur, belonging to a side-line of the dynasty, removed the capital to a hill called Toprakkalah nowadays, after digging an artificial lake, the outflow of which irrigated the side of the hill and the plain where he founded the Rusas-city. All this he recorded in a *stela* set up only a few years after the traditional date of the founding of Rome (754 B.C.). It was taken (1898–99) to the Berlin museum Rusas I was a most energetic enemy of Sargon II of Assyria (722–705 B.C.) against whom he summoned a coalition of the states of Western Asia, of which Mardukabaladdin of Babylonia (the Merodach-Baladan of the Bible) probably was one. In a bilingual *stela* erected over against the capital of Musasir, which had developed into a sort of independent buffer-state, Rusas commemorated his feats against Assyria in re-establishing Chaldian sovereignty and the petty king Urzana in Musasir.

But in 714 the Cimmerians, breaking into the north of Urartu through the passes of the Caucasus, drove Rusas to suicide Sargon had made a raid into Urartu and on his return had conquered Musasir, robbing its temple and overthrowing and mutilating Rusas I's *stela*, which, however was later on re-erected, evidently by Rusas II, the grandson of Rusas I who once more restored the power of Chaldia Rusas II used Cimmerian mercenaries in his combats with Esarhaddon of Assyria (680–668 B.C.) and succeeded in getting rid of the bulk of the Cimmerians who went on to the west of Asia Minor. Rusas III, son of Erimenas, finished the temple of Chaldis on Toprakkalah Sargon's sculpture of the temple of Musasir shows its front adorned with ornamented shields, a custom which the Chaldians had in common with the Cretans of Minoan times Such shields, with inscriptions chiefly of Rusas III, were excavated in Toprakkalah. Their circular friezes are divided into semicircles upon which the animals are going in different directions so as to prevent any one appearing to stand on its head (fig. 7), a peculiarity only recurring on Cretan shields of the archaic period The royal residence at Toprakkalah and the temple of Chaldis were evidently destroyed under Rusas III. The Medes must have overrun Urartu before they crossed arms with the Lydians on the Halys (May 28, 585 B.C.).

The pottery excavated at Toprakkalah, apart from other peculiar features, partly shows in red, and sometimes in black, a glazed surface which is practically equal to "bucchero" The gold medal (fig. 2) showing a goddess of fertility and her female adorer in beaten work has peculiarities which have left their mark in archaic Greek, especially Ionic art. A candelabrum (fig 5) and parts of a throne with a baldachin show a wreath of falling leaves the latter in exactly the shape in which it (the forerunner of the *kymation*) appears on the eldest Ionian or pre-Ionian capitals The legs of the above mentioned candelabrum (fig 6) and of another one preserved in Erlangen show the "zoomorphic juncture," one member of an animal coming forth out of the mouth of the same or another animal: this feature being entirely restricted to the art of the Chaldians and of the Etruscans. The bronze vessel from Toprakkalah (fig. 2) with vertical rims has innumerable parallels in Etruscan tombs. The way the Chaldians built their walls and towers is illustrated by a model found at Toprakkalah (fig. 3). A very striking likeness of the bison, one of the three chief races of big cattle living in Babylonia in the oldest times, in bronze stressing the beard as its special feature (fig. 8) shows its existence in ancient Armenia in the first millennium B.C. The attaches or handle figures of big bronze vessels in the form of a female divinity in the winged disc of the sun (fig. 10) are a Chaldian speciality, recurring in archaic Greek and in Etruscan art. The bronze snake, probably Tiamat, the animal of the Chaos, shows, as do numerous other pieces, a combination of different materials, the holes, for example, being partly filled with coloured glass

The Chaldians must have come from more western parts of Asia Minor where they were in touch with elements of Minoan culture; their culture is principally western with only minor traces of Assyrian influence; they influenced archaic Greek art in their turn, and had peculiar relations to the Etruscans which were probably based on a former relatively close proximity. When the Armenians invaded Urartu, the Chaldians withdrew into the mountains keeping up their warlike spirit and their metallurgic accomplishments. They were also called Chalybes, probably from the name of the steel which they were the first to produce. The region south of Trebizond was one of the last resorts of the Chaldians. The Byzantine *thema* of this region was called Chaldia and an archbishopric of the Greek church about Gumushchana is called Chaldia to the present day

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(C. F. L.-H.)

URBAN (Urbanus), the name of eight popes.

ST. URBAN, first pope of that name, was bishop of Rome from 222 to 230. Preceded by Calixtus, he was followed by Pontianus.

URBAN II (Odo or Otho or Eudes de Lagary), pope from March 12, 1088, to July 29, 1099, was born near Reims, became archdeacon of Auxerre, and later joined the congregation of Cluny, when he became sub-prior He was created cardinal-bishop of Ostia in 1078 by Gregory VII, to whom he displayed such loyalty, especially as papal legate in Germany (1084), that he was imprisoned for a time by Henry IV He was designated by Gregory as one of four men most worthy to succeed him, and, after a vacancy of more than five months following the decease of Victor III., he was elected pope on March 12, 1088, by an assembly of cardinals and others at Terracina. Throughout the major part of his pontificate he had to reckon with the presence of the powerful antipope Clement III (Guibert of Ravenna) in Rome He maintained an alliance with the Norman Duke Roger, Robert Guiscard's son and successor, and united the German with the Italian opposition to the emperor by promoting the marriage of the Countess Matilda with young Welf of Bavaria. He aided Prince Conrad in his rebellion against his father and crowned him king of the Romans at Milan in 1093. By excommunicating Philip I of France for matrimonial infidelity in 1095, Urban opened a struggle which was not terminated until after his death Invited to Tuscany by the Countess Matilda, he convoked a council at Piacenza in March 1095, attended by so vast a number of prelates and laymen that its sessions were held in the open air, and addressed by ambassadors of Alexis, the Byzantine emperor, who sought aid against the Mussulmans. Urban crossed the Alps in the summer, and remained over a year in France and Burgundy. He held a largely attended council at Clermont in November 1095, where he preached the First Crusade His sermon is printed in J. R. Watterich, *Pontif. Roman. Vitae* Crusaders on their way through Italy drove the antipope Clement III. finally from Rome in 1097, and established Urban firmly in the papal see. With a view to facilitating the crusade, a council was held at Bari in October 1098, at which religious differences were debated and the exiled Anselm of Canterbury combated the Eastern view of the Procession of the Holy Ghost. Urban died suddenly at Rome on July 29, 1099, fourteen days after the capture of Jerusalem, but before the tidings of that event had reached Italy. His successor was Paschal II.

See authorities quoted under PAPACY, also M. F. Stern, *Zur Biographie des Papstes Urbans II.* (Berlin, 1883); A de Brimont, *Un Pape au moyen âge—Urbain II.* (Paris, 1862).

URBAN III. (Uberto Crivelli), pope from Nov 25, 1185, to Oct 20, 1187, was a Milanese, and had been made cardinal-priest of St Lorenzo in Damaso and archbishop of Milan by Lucius III., whom he succeeded. He continued vigorously his predecessor's quarrels with the emperor, including the standing dispute about the territories of the Countess Matilda. His opposition to the pretensions of the Roman senate to govern the Papal States, moreover, compelled him to remain in exile through his pontificate He suspended the patriarch of Aquileia for crowning the emperor's son, Henry, king of Italy (January 1186), in violation of his own rights as archbishop of Milan, and only the entreaties of

the citizens of Verona, where he was stopping, prevented him from excommunicating Frederick. In 1187 he exhorted the Christian kings to renewed endeavours in the Holy Land, and the fall of Jerusalem (Oct 2) is said to have caused his death He died at Ferrara and was succeeded by Gregory VIII. His letters are in J. P Migne, *Patrol Lat.*, vol 202.

URBAN IV. (Jacques Pantaléon), pope from Aug. 29, 1261, to Oct. 2, 1264, was the son of a shoemaker of Troyes Having received a monastic education, he became archdeacon of Liége and papal legate of Innocent IV. to Poland and Prussia, he was consecrated bishop of Verdun in 1253, and two years later was translated to the patriarchate of Jerusalem. He was on a visit to Italy when he was elected to succeed Alexander IV. in the Holy See He spent most of his pontificate at Orvieto. Under him began that preponderance of the French in the curia which later led to the papal residence at Avignon, and indirectly to the Great Schism. In 1264 he instituted the festival of Corpus Christi. He favoured the claim of Charles of Anjou to the crown of the Two Sicilies. Urban died before the arrival of Charles of Anjou, and was succeeded by Clement IV

The registers of Urban IV. have been published by L. Dorez and J. Guiraud in the *Bibliothèque des écoles françaises d'Athènes et de Rome* (Paris, 1892).

URBAN V. (Guillaume Grimoard or Grimaud de Beauvoir), pope from Oct. 28, 1362, to Dec. 19, 1370, was born in 1309 near Lozère in Languedoc, and entered the Benedictine priory of Chiriac. He held many preferments, and was returning from a mission as papal legate to Italy, when he heard that he had been chosen to succeed Innocent VI. He was consecrated at Avignon Nov 6, 1362. Urban witnessed the completion of the work of tranquillising Italy under the able Cardinal Albornoz, and in 1364, in the interests of peace, made heavy concessions to Bernabo Visconti. Moved by Peter of Lusignan, king of Cyprus, and by the celebrated Carmelite Peter Thomas, who had come to Avignon in February 1363, the pope proclaimed another crusade, which found some echo in France and resulted in the temporary occupation of Alexandria (1365). Urban, yielding to the entreaties of the Emperor Charles IV. and of Petrarch, left Avignon on April 30, 1367, despite the opposition of the French cardinals, and made his entry into Rome on Oct. 16. The following year he was visited by Charles IV., and crowned the Empress Elizabeth (Nov. 1), and in 1369 he received the Greek emperor, John Palaeologus. Urban sanctioned the order of Jesuates and founded the medical school at Montpellier. He at length announced his intention of returning to France, avowedly to settle trouble between France and England. He arrived at Avignon on Sept. 24, 1370, died on Dec. 19 Urban was serious and humble, opposed to all nepotism, simony and secular pomp. He was himself of blameless morality and reformed many abuses in the curia. He was honoured as a saint immediately after his death, and beatified by Pius IX. in 1870. Urban's successor was Gregory XI.

See H. J. Tomaseth, "Die Register u Secretäre Urbans V. u. Gregors XI." in *Mittheilungen des Instituts für österreichische Geschichtsforschung* (1898).

URBAN VI. (Bartolommeo Prignano), pope from April 8, 1378, to Oct. 15, 1389, was born at Naples in 1318. He was made bishop of Acerenza in 1364, and in 1377 was translated to the archiepiscopal see of Bari and placed in charge of the papal chancery. On the death of Gregory XI., who had finally returned to Rome from Avignon, he was elected pope. Urban VI. turned his attention at once to the reformation of the higher clergy, and, in spite of the warnings of Catherine of Siena, so angered the cardinals by his harsh and ill-tempered measures that they assembled at Anagni in July 1378, and revoked his election, in which they declared they had acted under fear of violence. On Sept. 20, they elected at Fondi the Cardinal Robert of Geneva, who called himself Clement VII. and took up his residence at Avignon. Urban, on the other hand, remained at Rome, where he appointed twenty-six new cardinals and excommunicated Clement and his adherents Thus began the Great Schism which divided the Western Church for about fifty years. Urban deposed Joanna of Naples (April 21, 1380) for adhering to France and Savoy in support of the antipope, and gave her kingdom to Charles of Durazzo. Charles was crowned at Rome on June 1, 1381, but three years later quarrelled with the pope and shut him up in Nocera Urban escaped to Genoa, where he put several of his cardinals to death for suspected disloyalty. On the death of Charles he set out with an army apparently to seize Naples for his nephew To raise funds he proclaimed, by bull of April 11, 1389, a jubilee for every thirty-three years, but before the celebration could be held he died of injuries caused by a fall from his mule

The chief sources for the life of Urban VI. are in Baluzius, *Vitae Pap Avenion.* (Paris, 1693); *Theoderici de Nyem De schismate Libri tres*, ed. by G Erler (Leipzig, 1890), Sauerlande, "Actenstucke zur Gesch. des Papstes Urban VI.," in *Hist Jahrbuch der Gorres-Gesellschaft*, XIV. (1893), "Acta Urbani VI. et Bonifatii IX.," ed C Krofta. in *Monumenta vaticana res gestas Bohemicas illustrantia* (Prague, 1905); *Der Liber Cancellariae Apostolicae vom Jahre 1380*, ed. by G. Erler (Leipzig, 1888); *Il Trattato di S Vincenzo Ferrer intorno al grande scisma d'Occidente*, ed. by A. Sorbelli (Bologna, 1906). *See* also W. St. C. Baddeley, *Charles III. of Naples and Urban VI.* (1894); J. B. Christophe, *Histoire de la papauté pendant le XIVe siècle*, vol. 3 (Paris, 1853).

URBAN VII (Giovanni Battista Castagna), successor of Sixtus V, was born on Aug 4, 1521. He became governor of Bologna, archbishop of Rossano, and was long nuncio to Spain. Gregory XIII. made him a cardinal, 1583; and in 1590 he was elected pope by the Spanish faction, but died twelve days later, on Sept. 27, 1590, and was succeeded by Gregory XIV.

See Ciaconius, *Vitae et res gestae summorum Pontif. Rom.* (Rome, 1601-02); Cicarella, continuator of Platina, *De vitis Pontif Rom.* (both contemporary; the latter prolix and tedious); Arrigho, *Vita Urbani VII.* (Bologna, 1614); and Ranke, *Popes* (Eng trans., Austin), ii. 227.

URBAN VIII (Maffeo Barberini), pope from 1623 to 1644, was born in 1568, of a wealthy Florentine family. He early entered the prelacy, became prefect of Spoleto, twice nuncio to France, cardinal (1606), and finally, on Aug. 6, 1623, succeeded Gregory XV. as pope. Urban accepted the papacy chiefly as a temporal principality, and made it his first care to provide for its defence and to render it formidable He built Castelfranco on the northern frontier; fortified the port of Civita Vecchia; and strengthened the Castel Sant' Angelo, equipping it with cannon made from the bronze of the Pantheon, an act of vandalism which the Romans punished by the epigram, "Quod non fecerunt barbari, fecerunt Barberini." He also established an arsenal and a factory of arms But the only territory gained during Urban's pontificate, the duchy of Urbino, the last addition to the papal states, was acquired by reversion (1631); and in his one war, with the duke of Parma, for the district of Castro, he met defeat and humiliation (1644). The Thirty Years' War Urban professed to regard as waged for political, not for religious, ends. He therefore threw in his lot with France, supported the duke of Nevers in the Mantuan Succession, and, under stress of fear of Habsburg supremacy, suffered himself to be drawn into closer relations with the Protestants than beseemed his office.

Urban was the last pope to practise nepotism on a grand scale. He failed to found a princely house; but he enriched his family to an extent that astonished even the Romans Urban bore a hand in the condemnation of Galileo He acknowledged the genius of the astronomer, and had not approved of the action of the Inquisition in 1616; but subsequently, believing himself to have been caricatured in the *Dialogo*, he permitted the Inquisition to have its way and to compel an abjuration (1633). Urban also denounced the doctrines of Jansen, 1644 (*See* JANSENISM.) He promulgated the famous bull *In Coena Domini* in its final form, 1627; published the latest revision of the Breviary, 1631; founded the College of the Propaganda for the education of missionaries, 1627; and accorded the title of "eminence" to the cardinals, 1630. Urban did much to embellish the city. Conspicuous among his works are the Barberini Palace, the College of the Propaganda, the Fountain of the Triton, and the baldachin of St Peter's. His hymns and poems, which have frequently been published, are evidence of his literary taste and ability. Urban died on July 29, 1644, and was succeeded by Innocent X.

For contemporary accounts of Urban *see:* Tommasucci, in Platina, *De vitis Pontif. Rom*; Oldoin, continuator of Ciaconius, *Vitae et res gestae summorum Pontif. Rom.*; and Simonin, *Gesta Urbani* (Antwerp.

1637) A rich collection of materials was made by Andrea Niccoletti, *Della vita di Papa Urbano VIII, e storia del suo pontificato*, never published, but extensively used by Ranke and others *See also* Gregorovius, *Urban VIII im Widerspruch zu Spanien u. dem Kaiser* (Stuttgart, 1879), and Weech, *Urban VIII* (London, 1905)

URBANA, a city of eastern Illinois, U.S. Pop. 23,007 in 1950. Urbana and the adjoining city of Champaign (*q.v.*) are separately incorporated, but together form a population centre of 62,404. Urbana is the seat of the University of Illinois (*q.v.*).

URBANA, a city of Ohio, U S, the county seat of Champaign county. Pop. (1950) 8,439 It is the seat of Urbana university (Swedenborgian), a junior college founded in 1850. Urbana was founded in 1797 by Col William Ward, of Greenbriar, Va., who owned the land and gave many lots to the city on condition that the proceeds from their sale should be used for public improvements. The village was incorporated in 1805 and was chartered as a city in 1867.

URBANIZATION. The growth of cities was characteristic of modern industrial society, particularly after 1800. It arose largely as a result of the in-migration of population from rural areas, where the rate of natural increase has always been higher than in the cities. The fundamental economic reasons for this movement are manifold, including the change from hand to power-driven machines (as in the textile industry in England), and the growth of specialization in manufacturing, which tended toward the establishment of large production units. Specialization in production progressed so far, even in agriculture, that most farmers, in the U.S., at least, came to produce mainly one or a very few products for the market and to purchase most of their needs in the market—in contrast with the old-time almost self-sufficing family farm.

World Population.—The changes in the urban-rural distribution of population have been recorded, in some fashion, in most of the later censuses taken in various parts of the world. Unfortunately for one who wishes to make close comparisons, the definition of what constitutes urban population has not been by any means uniform as between one country and another. The most inclusive definition of urban population was that employed in Iceland, where all places of 300 inhabitants or more were counted as urban, and among the least inclusive definitions was that of the Netherlands, where a city had to have a population of 20,000 or more to be classified as a part of the urban area. The population of the world in 1949 was estimated at 3,270,453,000. The approximately 50 nations that obtained figures for urban population in later censuses had an aggregate population of about 1,138,000,000, of which about 409,000,000 or 36.0% were classified as urban.

United States.—As defined by the censuses up to and including 1940, urban territory in the United States was made up mainly of incorporated places having 2,500 inhabitants or more. The

TABLE I.—*Total and Urban Population of Selected Countries* (Census dates ranging from 1930 to 1951)

Country	Date	Population			Basis of urban classification
		Total	Urban		
			Number	Per cent	
EUROPE					
England and Wales	1931	39,952,377	31,951,918	80.0	County boroughs and other urban districts
Scotland	1931	4,842,980	3,879,936	80.1	Places having 1,000 inhabitants or more
Northern Ireland	1951	1,370,745	671,545	52.9	County boroughs and other urban districts
Ireland (Eire)	1951	2,960,593	1,227,393	41.5	Towns having 1,500 inhabitants or more
Norway	1950	3,278,546	1,054,820	32.2	Cities or towns officially designated as urban
Sweden	1945	6,673,749	2,822,487	42.3	Cities or towns with urban administration
Denmark	1945	4,045,232	1,947,838	53 3	Cities and towns
Iceland	1950	143,961	104,734	72.8	Towns of 300 inhabitants or more
Netherlands	1946	9,494,214	5,138,100	54.1	Municipalities of 20,000 inhabitants or more
Belgium	1930	8,092,004	4,893,683	60.5	Administrative subdivisions of 5,000 inhabitants or more
Luxembourg	1947	286,786	166,671	58.1	Communes having more than 2,000 inhabitants in chief town
Switzerland	1941	4,265,703	1,402,335	32.9	Communes having more than 5,000 inhabitants
France	1946	40,502,513	21,551,420	53.2	Communes having more than 2,000 inhabitants in chief town
Germany					
British zone	1946	21,804,099	17,175,184	78.4	Administrative subdivisions with more than 2,000 inhabitants
French zone	1946	5,029,342	2,558,404	50 9	Administrative subdivisions with more than 2,000 inhabitants
U.S. zone	1946	8,738,412	4,733,568	54.4	Administrative subdivisions with more than 2,000 inhabitants
Poland	1946	23,929,800	7,459,400	31.2	Communities with urban administration
Czechoslovakia	1947	12,164,661	5,935,433	48.8	Administrative districts having 2,000 inhabitants or more
Austria	1946	6,818,593	4,384,103	64 3	Self-governing units of more than 2,000 inhabitants
Hungary	1941	9,316,613	3,328,949	35.7	Administrative towns
Yugoslavia	1948	15,751,935	2,555,638	16.2	Administrative units governed by city committee
Finland	1947	3,849,097	956,302	24.8	
Rumania	1948	15,872,624	3,713,139	23.4	Cities and towns under urban administration
Greece	1940	7,344,860	2,618,075	35.6	Municipalities and communes having 5,000 inhabitants or more in chief town
Italy	1936	42,993,602	19,184,352	44.6	Communes with less than 50% of active population engaged in agriculture
Portugal	1950	8,441,312	*	*	Places of 2,000 inhabitants or more
Spain	1950	27,976,755	16,935,624	60.5	Places of 2,000 inhabitants or more
Trieste	1936	343,100	282,292	82.3	Communes with less than 50% of active population engaged in agriculture
NORTH AMERICA					
Continental U.S.	1950	150,697,361	96,440,528	64.0	Places of 2,500 inhabitants or more and suburban area around cities of 50,000 or more
Puerto Rico	1950	2,210,703	895,000	40.5	Places of 2,500 inhabitants or more
Canada	1941	11,506,655	6,252,416	54.3	Incorporated cities, towns, and villages
Mexico	1940	19,653,552	6,896,669	35.1	Places (localidades) of 2,500 inhabitants or more
Guatemala	1940	3,283,209	877,835	26.7	Cities, towns, and villages
Honduras	1950	1,368,605	424,453	31 0	Administrative centres of municipalities
El Salvador	1950	1,855,917	675,619	36.4	Populated centres
Panamá	1940	622,576	210,525	33.8	Towns of 1,500 inhabitants or more
Cuba	1943	4,778,583	1,834,340	38.4	Cities of 5,000 or more
Dominican Republic	1935	1,479,417	266,565	18.0	Capitals of districts, etc.
Leeward Islands	1946	108,838	23,159	21.3	The two cities
Windward Islands	1946	251,671	43,173	17.1	Towns, including some down to "1,000 or more"
SOUTH AMERICA					
Venezuela	1941	3,850,771	1,165,910	30.3	Places (lugares) of 2,500 inhabitants or more
Colombia	1938	8,701,816	2,533,680	29.1	Places of 1,500 inhabitants or more which are capitals of municipalities or districts
Brazil	1940	41,236,315	12,880,182	31.2	Principal towns of districts and their suburbs

TABLE I.—*Total and Urban Population of Selected Countries—Continued*
(Census dates ranging from 1930 to 1951)

Country	Date	Population			Basis of urban classification
		Total	Urban Number	Urban Per cent	
Peru	1940	6,207,967	2,107,133	35.4	Capitals of departments, provinces and districts
Argentina	1947	16,105,214	9,894,951	61.4	Cities, towns, or villages of 2,000 inhabitants or more
Chile	1940	5,023,539	2,633,479	52.4	Places of 1,000 or more
AFRICA					
Egypt	1937	15,920,694	4,002,406	25.1	Administrative centres and chief towns of provinces and districts
Union of South Africa	1946	11,391,940	4,144,983	36.4	Towns and villages with local self-government
Belgian Congo	1947	10,804,761	1,705,171	15.8	Populated centres with 100 or more nonindigenous inhabitants, etc.
ASIA					
Ceylon	1946	6,657,339	1,023,042	15.4	
India	1941	388,997,955	49,696,053	12.8	Cities and urban towns of 5,000 inhabitants or more
Japan	1950	83,199,637	31,203,191	37.5	Municipal administration areas—approximately cities of 30,000 or more
Korea	1944	25,000,142	1,951,566	7.5	The 12 incorporated cities
AUSTRALASIA					
Australia	1947	7,580,820	5,209,895	68.7	Capital cities and other cities separately incorporated
New Zealand	1945	1,702,298	1,024,292	60.2	Cities, boroughs and towns of 1,000 inhabitants or more
Total (all countries listed)		1,167,381,512	414,745,765	35.5	

*Totals do not include Portugal, figures for which were not available.

percentage of the population classified as urban, in accordance with this definition, increased from 5.1% in 1790 to 15.3% in 1850 and then more rapidly to 51.2%, or more than one-half, in 1920 and to 56.5% in 1940. If the same definition had been applied in 1950, the percentage would have been about 59.0

A new definition was adopted, however, for the 1950 census. This definition included also in the urban classification the thickly-settled urban area, or "urban fringe," around each city of 50,000 or more, and a considerable number of unincorporated places which had a population of 2,500 or more, but which were excluded from the earlier definition because of their lack of municipal incorporation. Under the new definition the urban population, including these added areas, amounted to 64.0% of the total.

TABLE II.—*Population of U.S. in Groups of Urban Places Classified by Size: 1950*
(All population figures are preliminary)

Size of places	Number of places	Population	Per cent of	
			Total population	Urban population
Total population, including rural (preliminary)	..	149,855,592	100.0	.
Total urban	.	95,891,539*	64.0	100.0
Urban places	4,270	87,992,647	58.7	91.8
Places of 1,000,000 or more	5	17,302,538	11.5	18.0
Places of 500,000 to 1,000,000	13	9,110,922	6.1	9.5
Places of 250,000 to 500,000	23	8,131,010	5.4	8.5
Places of 100,000 to 250,000	65	9,410,440	6.3	9.8
Places of 50,000 to 100,000	125	8,826,709	5.9	9.2
Places of 25,000 to 50,000	246	8,044,050	5.8	9.0
Places of 10,000 to 25,000	780	11,962,110	8.0	12.5
Places of 5,000 to 10,000	1,174	8,123,192	5.4	8.5
Places of 2,500 to 5,000	1,839	6,481,676	4.3	6.8
Other urban territory inside urban fringe	..	7,898,892	5.3	8.2

*A semifinal figure, involving an estimated distribution of the supplementary returns, sets the urban population of the United States at 96,440,528, which is 64.6% of the final total population of 150,697,361

In 1820 there was only 1 city with more than 100,000 inhabitants in the United states; in 1850 there were 6, of which 1 had more than 500,000; in 1880 the first city reported a population of 1,000,000 or more and there were 19 other cities of more than 100,000; in 1910 there were 3 cities of 1,000,000 or more, and 50 all together with more than 100,000; and in 1950 there were 5 with more than 1,000,000 and 106 with more than 100,000.

(L. E. T.)

URBINO, a city of the Marches (*Urbinum Metaurense*), Italy. Pop. (1936): 5,450, town; 22,248, commune. It is picturesquely situated on an abrupt hill 1,480 ft. above sea-level; its streets are narrow and crooked, and the town has a mediaeval aspect. It is dominated by the ducal palace erected by Luciano da Laurana, a Dalmatian architect, in 1465–82, for Federigo Montefeltro (well represented in a picture by Justus of Ghent in the gallery), and regarded by the contemporaries of the founder as the ideal of a princely residence. The monumental staircase, sculptured doorways, chimneys and friezes of the interior are especially fine. Some are by Domenico Rosselli of Florence. The rich intarsia work of the Duke's study is by Baccio Pontelli.

In the cathedral there is a Pietà in marble by Giovanni da Bologna. Opposite the palace is the church of S. Domenico, a Gothic building with a good early Renaissance portal and a relief in the lunette by Luca della Robbia (1449). S. Francesco has a fine 14th century portico and campanile, and a handsome portal of a chapel in the interior by Constantino Trappola (15th century) S. Bernardino, outside the town, is a plain early Renaissance structure. On the walls of the chapel of San Giovanni Battista are frescoes by Lorenzo and Giacomo Salimbeni da San Severino (1416) The modest house where Raphael was born and spent his boyhood forms a museum of engravings and other records of Raphael's works. A monument was erected to him in the piazza in 1897 The theatre, decorated by Girolamo Genga, is one of the earliest in Italy, in it was performed the first Italian comedy, the *Calandra* of Cardinal Bibbiena, the friend of Leo X and Raphael. The magnificent library formed by the Montefeltro and Della Rovere dukes was incorporated in the Vatican library in 1657. There is a free university founded in 1506.

The ancient town of *Urvinum Metaurense* takes its name from the river Metaurus. The walls can be traced. It was important in the Gothic wars, and is mentioned by Procopius. About the end of the 12th century Urbino came under the rule of the family of Montefeltro, and especially of Federigo da Montefeltro, lord of Urbino from 1444 to 1482, who was an unusually enthusiastic patron of art and literature.

Federigo da Montefeltro much strengthened his position by his own marriage with Battista Sforza, and by marrying his daughter to Giovanni della Rovere, the favourite nephew of Pope Sixtus IV, who conferred upon Federigo the title of duke. Federigo's only son Guidobaldo, who succeeded his father, married in 1489 the gifted Elizabeth Gonzaga, of Mantua. Guidobaldo in 1508 bequeathed his coronet to Francesco Maria della Rovere, nephew of Julius II In 1626 the last descendant of Francesco, Francesco Maria II, abdicated in favour of Pope Urban VIII, and Urbino, with its subject towns, which included Pesaro, Fano, Fossombrone, Gubbio, Castel Durante and Cagli together with outlying small villages, about 300 in number, became incorporated in the domain of the Papal States.

During the reigns of Federigo and Guidobaldo, Urbino was one of the foremost centres of activity in art and literature in

Italy. Here Piero della Francesca wrote his celebrated work on the science of perspective, Francesco di Giorgio Martini his *Trattato d' architettura* and Giovanni Santi his poetical account of the chief artists of his time

Throughout the 16th century the state of Urbino manufactured majolica, especially at Gubbio and Castel Durante. Most of the finest pieces were made for the dukes Famous citizens include the Ferrarese painter and friend of Raphael, Timoteo della Vite, and Brumante (*q v*).

This city was also the birthplace of Pope Clement XI, of several cardinals of the Albani family, and of Raffaelle Fabretti, and other scholars.

URDU, the name of that variety of Hindōstānī which borrows a great part of its vocabulary from Persian and Arabic, as contrasted with "Hindi," the variety which eschews such words, but borrows from Sanskrit instead. It is spoken by Moslems and those Hindus who have come under Moslem influence, and has a considerable literature *See* HINDŌSTĀNĪ LANGUAGE and HINDŌSTĀNĪ LITERATURE.

UREA or CARBAMIDE, a colourless crystalline substance known after 1773 as a constituent of urine. It is the chief nitrogenous end product of the metabolism of proteins (*q v.*) in all mammals and some fishes. (For birds, reptiles and most fishes, the corresponding product is uric acid) It is present not only in the urine of mammals but also in their blood, bile, milk, perspiration and other body fluids Moreover, it has been recognized in many lower forms of animal life and has been identified in certain plants and in fungi and moulds. Human urine contains 2 to 5% of urea, which is excreted by an adult man to the extent of about 30 grams (1 oz) daily.

In 1773 H. M Rouelle obtained, by alcoholic extraction of the solid residue from evaporated urine, an alkaline nitrogenous substance which on bacterial fermentation yielded carbonic acid and ammonia. Subsequently Antoine F. Fourcroy and Louis N. Vauquelin (1798) prepared urea nitrate from urine, and the isolation of pure urea from this same source was first accomplished by Joseph L Proust in 1821. Friedrich Wohler in 1828 discovered the artificial formation of urea from ammonia and cyanic acid

Urea crystallizes in long rhombic needles or short prisms having a cooling, saline taste. It is readily soluble in water, methyl alcohol and ethyl alcohol, but not in ether or hydrocarbons It melts without decomposition at 132.7° C. (270 9° F.) and sublimes in a vacuum at temperatures just below and up to its melting point. Heating to higher temperatures causes decomposition.

Chemical Properties of Urea.—Urea is the diamide of carbonic acid (*see* AMIDES)—hence the alternative name "carbamide." Its chemical formula was originally given as $NH_2CO NH_2$, but since this formula has seemed to some chemists not to explain the behaviour of urea under all circumstances, a number of others have been proposed. The best view in 1946 seemed to be that urea is a resonance hybrid, receiving contributions from the structure given above and also from the two further structures, $^{+}NH_3=C\overline{O}-NH_2$ and $NH_2-C\overline{O}=\overset{+}{N}H_2$. For reasons of convenience, however, the formula is most commonly written in its original form, $H_2N\,CO.NH_2$, and resonance with the remaining two structures is left implicit.

The above mentioned method of Wöhler for the synthesis of urea consists essentially in the isomerization of ammonium cyanate, NH_4NCO, to urea, $NH_2.CO.NH_2$. This process, however, is a reversible one, and the relative amounts of cyanate and urea depend on reaction conditions.

When urea is heated above its melting point it decomposes at first to yield ammonia, ammonium cyanate and biuret and, at higher temperatures, cyanuric acid and ammelide. If an aqueous solution of it is boiled, urea is partially converted to ammonium cyanate, which in turn is hydrolysed to ammonia and carbon dioxide Heating such a solution in a sealed tube at 180° C. brings about complete decomposition.

Dilute aqueous solutions of acids and alkalis have no action on urea in the cold but, when heated, break it down to ammonia and carbon dioxide. Strong acids yield salts, such as urea nitrate.

Although urea reacts with alcohols to form urethanes (carbamic esters) and with many aldehydes, ketones, anhydrides and other organic compounds, its most important reactions are with formaldehyde to form methylolureas and with malonic acid derivatives to form malonylurea or barbituric acid derivatives

The enzyme *urease*, obtainable from the soy bean and the Jack bean (*Canavalia ensiformis*), brings about the rapid hydrolysis of urea, and this action serves as a convenient method for the determination of urea Other methods sometimes used are the Kjeldahl, the hypobromite and the xanthhydrol.

Commercial Manufacture of Urea.—Many ways have been found to synthesize urea in the laboratory but only (1) the hydrolysis of cyanamide, obtained from calcium cyanamide which is made by the reaction of nitrogen at high temperature with calcium carbide, and (2) the reaction of ammonia and carbon dioxide have been used industrially Method (1) was never employed extensively and by 1936, when world capacity was almost 400,000 lb. per day, only method (2) was in commercial use In this method carbon dioxide and ammonia are continuously injected into a reaction vessel maintained at temperatures up to about 200° C and pressures up to about 5,000 lb per sq in Solid urea is separated from the reaction vessel effluent which contains, besides urea, water and unreacted ammonia and carbon dioxide.

Industrial Uses of Urea.—Urea contains 46.7% of combined nitrogen in a form which is easily and rapidly converted to ammonia in the soil, therefore, it is a much more concentrated nitrogenous fertilizer than ammonium nitrate, ammonium sulphate or sodium nitrate. Moreover, modern manufacturing methods have made it possible to deliver urea to the consumer at about the same cost per unit of nitrogen as the other nitrogen-containing fertilizer materials. It may be used in the making of "mixed goods," containing other fertilizer ingredients, or it may be applied to the land alone. (*See* FERTILIZERS.)

Urea has two important uses in the wood industry—in seasoning and in bending. Green lumber to which urea has been suitably applied can be rapidly kiln-dried without checking. Economies have thus been realized because of saving in time and reduction in loss of material. Dry wood, well-soaked in a hot solution of urea can readily be bent without fracture, the bent wood retaining its shape when dried in a proper form. This procedure is used in boatbuilding, furniture manufacture and basketmaking

Although the nitrogen in urea is in nonprotein form, if urea is fed to a ruminant animal along with fermentable carbohydrate material the micro-organisms in the rumen build its nitrogen into proteins which can be used by the animal through action in the lower digestive tract. Experience has shown that the grain ration fed to the animal must not contain more than 3% urea. Even so, a significant part of the protein requirement can be supplied through the use of urea. In 1943, during World War II, when protein feeds were scarce, this use became important. Urea cannot be utilized by nonruminant animals such as horses, swine and poultry.

Urea is not poisonous, or as pharmacologists prefer to say, it is practically nontoxic. However, it has had little direct use in internal medicine except as a diuretic. Its most important application in medicine has been its employment in the treatment of wounds, and has proved especially valuable in promoting the healing of stubborn types of suppurating infections Urea dissolves dead tissue in which bacteria thrive, and in the resulting clean wound the living cells can successfully combat bacterial invasion, so that healing proceeds rapidly The use of urea has supplanted the use of blowfly maggots and allantoin in the treatment of purulent and stubborn wounds. In fact, maggots are effective since they secrete allantoin, and allantoin is effective because it yields urea in the wound.

Large amounts of urea are used by the pharmaceutical industry in the production of malonylurea and barbituric acid derivatives. Approximately 400 of these derivatives are known, and about 12 are commonly used as soporifics and sedatives under a great variety of trade names.

The most important use of urea other than as fertilizer is in

the production of urea-formaldehyde resins (*See* RESINS. *Synthetic Resins*) The primary reaction of formaldehyde and urea is the formation of water-soluble methylolurea. Application of heat or catalyst, or both, causes further reaction of methylolurea with itself and a hard, insoluble, infusible resin is finally obtained. Urea-formaldehyde resins are widely used in moulded articles, in lacquers and enamels, in the impregnation of paper, wood and textiles, as adhesives for plywood and other materials, as crease-proofing agents for fabrics, etc Although urea reacts with aldehydes other than formaldehyde, the resinous products obtained have no properties which make them useful.

Some of the many other less important uses of urea are as an ingredient in printing pastes, as a liquefying agent in the manufacture of glue, as a stabilizer for certain explosives, as an aid in the preparation of some dyes, as a textile-treating agent and as a nutrient for yeast culture.

Thiourea.—The sulphur analogue of urea, $NH_2.CS.NH_2$, is manufactured on a limited scale for employment in photography, synthetic resins, insecticides, pharmaceuticals and textile-treating agents, and as a starting material for various dyestuffs. It may be prepared (1) by heating ammonium thiocyanate at 160°–170° C.; (2) by the reaction of hydrogen sulphide with cyanamide. Thiourea crystallizes from water in colourless, six-sided prisms or silky needles melting at 180°–182° C.

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URETHANE is synthesized from ammonia and ethyl chlorocarbonate or diethyl carbonate by treatment of urea with alcohol under pressure or by the action of warm alcohol on urea nitrate with addition of sodium nitrite. Urethane, ethyl carbamate, $NH_2.CO_2C_2H_5$, crystallizes in large plates, readily soluble in water and melting at 49°–50° and boiling at 184° C. When heated with ammonia to 180° C. it gives urea. Cold alcoholic potassium ethoxide decomposes it into potassium cyanate and alcohol. When treated with concentrated nitric acid it yields nitro-urethane, $NO_2.NH.CO.OC_2H_5$, from which nitramide, $NO_2.NH_2$, may be obtained Physiologically, urethane has a rapid hypnotic action, producing a calm sleep and having no depressant effect on the circulation It is much used as an anaesthetic for animals. Di-urethane, $NH(CO_2C_2H_5)_2$, and hedonal, $NH_2CO_2CH(CH_3).(C_2H_5)$, are also hypnotics. Urethanes have also a decided diuretic effect.

UREY, HAROLD CLAYTON (1893–), U.S. chemist, was born in Walkerton, Ind., April 29, 1893. After receiving his early education in rural schools, he taught in them from 1911 to 1914. He then entered the University of Montana and received the B.S degree in 1917, with major interests in zoology and chemistry. After spending two years as a research chemist in industry and two years as an instructor at the University of Montana, he entered graduate school at the University of California (Berkeley), where he was granted the Ph.D degree in chemistry in 1923. He then spent one year as an American-Scandinavian foundation fellow with Nils Bohr at Copenhagen, Den., followed by 5 years on the staff at the Johns Hopkins university and 16 years at Columbia university. During the period 1939–42 he was executive officer of the department of chemistry at Columbia. In 1945 he joined the newly formed Institute for Nuclear Studies and the department of chemistry of The University of Chicago.

In 1934 Urey was awarded the Nobel prize in chemistry for his discovery of the heavy hydrogen isotope of mass two (deuterium). Later he worked out procedures for the separation of heavy isotopes of carbon, oxygen, nitrogen and sulphur. During the World War II period, 1942–45, he was director of research of the Substitute Alloy Materials laboratories, Columbia university. This project became a part of the Manhattan Engineers District program for the development of the atomic bomb. Urey's group provided the fundamental information for the separation of the fissionable isotope, uranium-235, from the more abundant isotope, uranium-238, by gaseous diffusion, and investigated methods for the concentration of the heavy isotope of hydrogen and for the separation of the boron isotopes. After the war he developed methods for the measurement of temperatures as they existed in the oceans of past geological ages, and developed a theory for the origin of the earth with particular reference to its chemical aspects. (W C. J.)

URFÉ, HONORÉ D', MARQUIS DE VALBROMEY, COMTE DE CHÂTEAUNEUF (1568–1625), French novelist and miscellaneous writer, was born at Marseilles on Feb 11, 1568, and was educated at the Collège de Tsarnon A partisan of the league, he was taken prisoner in 1595, and, though soon set at liberty, he was again captured and imprisoned. During his imprisonment he read Ronsard, Petrarch and above all the *Diana enamorada* of George de Montemayor and Tasso's *Aminta*. Here, too, he wrote the *Epitres morales* (1598). Honoré's brother Anne, comte d'Urfé, had married in 1571 Diane de Châteaumorand, but the marriage was annulled in 1598 by Clement VIII. Anne d'Urfé was ordained to the priesthood in 1603, and died in 1621 dean of Montbrison. Diane had a great fortune, and to avoid the alienation of the money from the D'Urfé family, Honoré married her in 1600 This marriage also proved unhappy, D'Urfé spent most of his time separated from his wife at the court of Savoy.

In Savoy he conceived the plan of his novel *Astrée*, the scene of which is laid on the banks of the Lignon in his native province of Forez. It is a leisurely romance in which the loves of Céladon and Astrée are told with digressions. Some episodes suggest the adventures of Henry IV. The two first parts of *Astrée* appeared in 1610, the third in 1619, and in 1627 the fourth part was edited and a fifth added by D'Urfé's secretary Balthazar Baro. *Astrée* set the fashion temporarily in the drama as in romance, and no tragedy was complete without elaborate discussions on love in the manner of Céladon and Astrée. D'Urfé also wrote two poems, *La Sireme* (1611) and *Sylvanire* (1625). He died from injuries received by a fall from his horse at Villafranca on June 1, 1625, during a campaign against the Spaniards.

URGA: *see* ULAN BATOR.

URI, one of the cantons of central Switzerland The name is popularly derived from *urochs* or *auerochs* (wild bull), a bull's head having been borne for ages as the arms of the region.

The total area is 414.7 sq mi , of which only approximately half (the lowest proportion in the confederation) is reckoned as "productive" (forests covering 48 sq mi.), while 7½ sq.mi. are occupied by a part of the Lake of Lucerne and more than 20% of the unproductive area is covered with glaciers The highest summit in the Uri is the Damma Stock (11,919 ft.), north of the Furka pass Little of the land is capable of further cultivation, for Uri is composed of the torrent section of the upper Reuss, draining, with its tributaries, steep-sided valleys. The chief railway is the main St. Gotthard line. Near Wassen are the remarkable looped and spiral tunnels. There is also an electric railway from Altdorf to its port, Flüelen. Communication is largely by the excellently planned roads which lead to the mountain passes; these give access to the cantons lying east and south; *e.g.*, Glarus (the Klausen pass, 6,404 ft.), the Grisons (Oberalp pass, 6,719 ft.), the Valais (Furka pass, 7,992 ft).

In 1950 the aggregate population was 28,556 (67 to 1 sq.mi.). Of the 1930 population of 22,968, 22,249 were German-speaking, 594 Italian-speaking and 62 French-speaking, while 21,674 were Catholics, 1,251 Protestants and 2 were Jews. After 1814 Uri was administered by the bishop of Coire; previously all the canton except Andermatt (Urseren) was in the diocese of Constance. The capital and largest town is Altdorf (pop. 6,576 in 1950), indissolubly connected with the legend of William Tell (*q.v.*).

Uri was organized as an administrative district containing 20 communes. The legislature until 1928 was a primitive democratic assembly (*Landsgemeinde*) composed of all male citizens of 20 years of age and over. This assembly had met, uninterruptedly, since 1309, usually once annually, near Altdorf The procedure was controlled by many antique ceremonies. After 1928 there was an elected legislature of 49 members. (*See* SWITZERLAND: *Government*.)

History.—Uri is first mentioned in 732 as the place of banishment of Eto, the abbot of Reichenau, by the duke of Alamannia. In 853 it was given by Louis the German to the nunnery (*Frauenmunster*) at Zurich which he had just founded.

and of which his daughter, Hildegard, was the first abbess. As early as 1243 Uri had a common seal, and in the confirmation of its privileges (1274) granted by Rudolf of Habsburg mention is made of its "head-man" (*Amman*) and of the "commune" (*universitas*) It took part, with Schwyz and Unterwalden, in founding the "Everlasting League" (*q v.*) on Aug 1, 1291, defending its liberty in the fight of Morgarten (1315) and renewing the League of the Three at Brunnen (1315). It took part in the victory of Sempach (1386), and (1512) in the conquest of Lugano. At the Reformation Uri clung to the old faith. In 1798, on the formation of the Helvetic republic Uri became part of the huge canton of the Waldstätten and lost all its Italian possessions. In 1803 Uri became an independent canton again, with Ursern, but without the Val Leventina It tried hard to bring back the old state of things in 1814–15, and opposed all attempts at reform, joining the League of Sarnen in 1832 to maintain the pact of 1815, opposing the proposed revision of the pact, and being one of the members of the Sonderbund in 1845. (*See* SWITZERLAND: *History*)

URIC ACID, in organic chemistry, an acid which is one of the penultimate products of the tissue waste in the human body. (*See* PURINES) While the bulk of the nitrogen of the albuminoids is excreted by kidneys and bladder as urea, a small portion of it stops at the uric acid stage Human urine contains only a fraction of a per cent. of the acid, chiefly as sodium salt; abundance of uric acid is met with in the excrement of serpents and birds, in which it is the principal nitrogenous product of tissue waste Pure uric acid, $C_5H_4N_4O_3$, forms a snow-white microcrystalline powder, devoid of smell or taste, soluble in 1,600 and 50,000 parts of water at the boiling and freezing points, respectively For its detection in urine, excess of hydrochloric acid is added; uric acid then separates, generally coloured red by impurities. The precipitate is dissolved in a few drops of nitric acid and after evaporation to dryness the residue on addition of ammonia assumes the intense purple colour of murexide (*q v.*).

URICONIUM (more correctly *Viroconium* or *Vriconium*), *chef-lieu*, as proved by an inscription, of the Cornovii, now Wroxeter on the Severn, 5 m E of Shrewsbury. At first perhaps (47–65) a Roman legionary fortress, held by Legiones XIV. and XX against the Welsh hill tribes. When the garrison was removed, it became a flourishing town with public baths (excavated 1859–61), town hall, and market (excavated 1924–27).

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See Journ of R. Studies, 1923–27, xii. 252, xiv. 226, xv 228, xvi. 224, xvii. *Classical Review* (1924), p 146 *seq* and (1928), p. 10 *seq.*

URIM and **THUMMIM,** in the Bible. These descriptive terms are applied to one of the methods of divination employed by the ancient Hebrews, which, it is now generally agreed, consisted in a species of sacred lot. Together with "dreams" and the prophetic oracle it formed the recognized channel by which divine communications were given (*cf.* I. Sam. xxviii. 6). That some method of casting lots is denoted by the terms is evident from I Sam xiv. 41, *f.*

From this illuminating passage it is clear (*a*) that by means of the Urim and Thummim the guilt or innocence of the suspected parties was determined; (*b*) that this was effected by a series of categorical questions implying the simple alternative of "yes" or "no," or something positive or negative. A further inference (*c*) from a comparison of I Sam. xiv. 41, *f* with ver. 36 (Greek text) is that this method of casting the sacred lot was closely connected with divination by the Ephod (*q.v.*), and was the prerogative of the priests. For this last point the "Blessing of Moses" (Deut. xxxiii.), where the opening words of the Benediction on Levi run thus (text as emended by Ball, following LXX.; *Proc. of Soc. of Bibl. Arch*, 1896): "Give to Levi Thy Thummim, and Thy Urim to the man of Thy favour." For a similar Arabic custom, *cf* G. F. Moore *Ency. Bib.* IV., col. 5236.

In the post-exilic Priestly Code the Urim and Thummim figure as part of the equipment of the High Priest (*cf.* Ex. xxviii. 30; Lev. viii. 8; Num. xxvii. 21). Here it is stated that they are kept in a square pouch which is worn upon the high priest's breast ("the breastplate of judgment"), and attached to the ephod. Thus the association of the Urim and Thummim with the ephod, is retained.

That Urim and Thummim were not then in use is shown by Neh vii 65 (Ezra ii 63; I Esdras v. 40). Later references (Ecclus xiv. 10, in Josephus and the Talmud) prove that no real tradition survived on the subject. As vocalized in the Massoretic Hebrew text the names="Lights and perfections" But the Greek translators read the former *orim* and connected it with *torah*, "decision"; it would thus mean "doctrine", so Symmachus (*cf.* I. Esd. v. 40).

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URINARY SYSTEM. The urinary system in the fully developed human being consists of (1) the kidneys, (2) the ureters, (3) the urinary bladder, and (4) the urethra.

The Kidneys.—The *kidneys* are two firm, reddish brown organs about 4½in. long, placed obliquely behind the other abdominal viscera—one on each side of the last thoracic and three upper lumbar vertebrae. Each is imperfectly covered on its ventral surface by peritoneum. Around them there is usually much fat and areolar tissue. The degree to which the kidney is fixed in position varies somewhat. In so-called moveable or floating kidney the mobility may give rise to symptoms. The kidney in the foetus is lobulated, but becomes smooth in later years of childhood Each organ has a firm, fibrous capsule, easily stripped off when the kidney is healthy. The inner and ventral margin of each kidney is concave

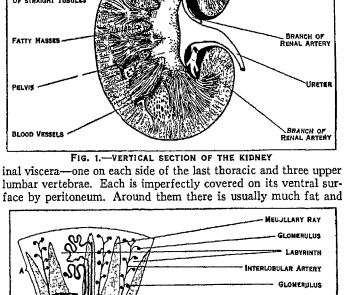
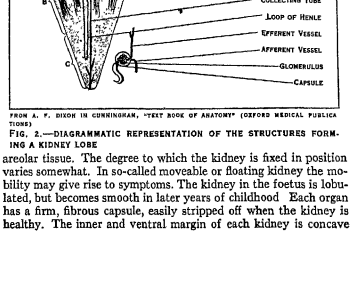


FIG. 1.—VERTICAL SECTION OF THE KIDNEY



FROM A. F. DIXON IN CUNNINGHAM, "TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 2.—DIAGRAMMATIC REPRESENTATION OF THE STRUCTURES FORMING A KIDNEY LOBE

(*hilum*) and contains the renal artery and vein and the ureter which is always behind and below the blood vessels. Longitudinally divided from hilum to outer edge, the cut surface is seen to consist of two parts—an outer layer, the cortex, and an inner part, the medulla (fig. 1). The latter consists of a series of eight to sixteen pyramids, whose bases and sides are invested with cortical matter, and whose apices or papillae project into the pelvis of the

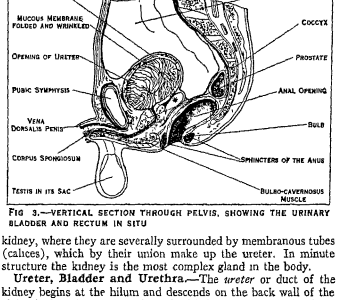


FIG 3.—VERTICAL SECTION THROUGH PELVIS, SHOWING THE URINARY BLADDER AND RECTUM IN SITU

kidney, where they are severally surrounded by membranous tubes (calices), which by their union make up the ureter. In minute structure the kidney is the most complex gland in the body.

Ureter, Bladder and Urethra.—The *ureter* or duct of the kidney begins at the hilum and descends on the back wall of the abdominal cavity to open into the bladder. It is usually about 12in. in length and as thick as a goose quill. At its termination it passes obliquely through the coats of the bladder, so that when the bladder is distended the lumen of its end is closed. The *urinary bladder* is a membranous bag lying in the pelvic cavity directly behind and above the dorsal surface of the pubes. In the foetus and infant, however, the bladder lies in the abdomen, not in the pelvis. During life it is seldom distended so as to hold more than about 10oz. When distended it rises and is applied closely against the back of the ventral abdominal wall. The bladder has a strong wall of unstriped muscle in several layers, which are innervated by branches from the sacral nerves. It has a peculiar epithelial lining of several strata, the superficial cells of which are cubical when the sac is collapsed, but flattened and scale-like when it is distended. At the lower part of the bladder is a triangular space known as the trigone, the angles of which are formed by the openings of the two ureters and the urethra. In this space the mucous membrane is smooth and firmly bound to the subjacent muscle; elsewhere it is thrown into numerous folds when the bladder is empty. The female urethra is 1½in. in length and is comparable only with that part of the male urethra which extends from the bladder to the openings of the seminal ducts (fig. 3). The male urethra is described under REPRODUCTIVE SYSTEM, ANATOMY OF.

Embryology.—The excretory organs are developed as a series of small tubes situated in the intermediate cell mass, the ventral part of which projects to form the Wolffian ridge. Three sets of these tubes appear in succession and occupy the whole length of the body from the cervical to the lumbar region. The most anterior—*pronephros* or *head kidney*—is represented in man by only two or three small tubules on each side which appear as ingrowths from the neighbouring coelom (fig 4). It is probable that these are only mere vestiges. Although the pronephros is rudimentary, the duct which in lower types carries away its excretion is well developed. This is the *Wolffian duct*, which appears in man before the pronephric tubes are formed, and runs longitudinally back in each intermediate cell mass to open into the cloaca (fig. 4). In certain parts of its course it is, at an early date, close to the skin on the dorsal side of the intermediate cell mass, and many embryologists hold that it is originally ectodermal and has sunk into the mesoderm secondarily. Morphologically, this view seems likely.

When the pronephric tubules disappear, which they do early in the embryo's development, the Wolffian duct persists as the drain for another and more important series of tubules (the *mesonephros* or *middle kidney*), formed in the intermediate cell mass behind the pronephros (fig. 4). There is some doubt whether these tubes are strictly homologous and in series with those of the pronephros; they are of later development.

By about the sixth week of intra-uterine life these tubules reach their maximum development and form the *Wolffian body*, which projects into the coelom as the now very definite *Wolffian ridge* and acts as the functional excretory organ of the embryo. When the permanent kidney is formed this organ degenerates; for its ultimate fate *see* REPRODUCTIVE SYSTEM, ANATOMY OF.

The *metanephros* or *hind kidney* begins as a diverticulum from the dorsal side of the Wolffian duct close to its opening into the cloaca (*see* fig 4); this organ occurs about the fourth week of intra-uterine life, and the diverticulum grows forward (cephalad), dorsal to the hind end of the Wolffian body. In doing this it forms a duct—the *metanephric duct* or *ureter*—the cephalic end of which enlarges and divides to form the calices of the kidney. From the calices numerous smaller ducts grow into the mesoderm of the hind (caudal) end of the intermediate cell mass and become the collecting tubes of the kidney. While this is going on another set of tubules, probably in series with the mesonephric tubules, develops independently in the intermediate cell mass and forms the rest of the tubular system of the kidney. Toward these tubules, at one point, branches from the aorta push their way and invaginate each tube, thus forming the Malpighian corpuscles.

By the eighth week the kidney is definitely formed and takes over the excretory work of the mesonephros, which now atrophies.

At first, as has been stated, the ureters open into the Wolffian ducts, but later on each gains a separate opening into the cloaca, and eventually these shift ventrally until they reach their permanent connection with the allantoic bladder.

The *bladder* is developed from that part of the allantois which is nearest the cloaca. At first it is tubular, but after the second month becomes pyriform, the stalk of the pear corresponding to the fibrous *urachus* which reaches the umbilicus.

The *Müllerian ducts* (fig. 4) are formed after the Wolf-

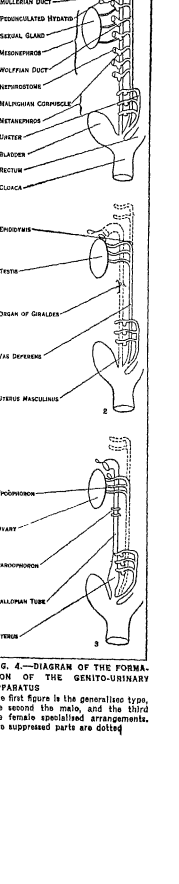


FIG. 4.—DIAGRAM OF THE FORMATION OF THE GENITO-URINARY APPARATUS

The first figure is the generalised type, the second the male, and the third the female specialised arrangements. The suppressed parts are dotted.

fian ducts are fully developed. A ridge appears in the intermediate cell mass ventral to the Wolffian duct, and into the anterior (cephalic) end of this a tubular process of the coelom forces its way backward (caudad) Before reaching the cloaca the two Mullerian ducts coalesce and open between the orifices of the two Wolffian ducts. These ducts form the oviducts, uterus and at least part of the vagina.

Comparative Anatomy.—In the Acrania (Amphioxus) the nephridial tubules are segmental and are only found in the pharyngeal region; each opens into the coelom by several ciliated funnels (nephrostomes) and also into the atrium, which is the exterior of the animal, by an opening called the nephridiopore.

Among the Cyclostomata (lampreys and hags) the pronephros persists throughout life in Bdellostoma and probably in the hag (Myxine), but a Wolffian (archinephric) duct has been evolved so that the tubules no longer open on the surface by nephridiopores. In the Teleostomi (bony and ganoid fish) the pronephros is aborted and the mesonephros is the functional kidney.

In the Elasmobranchii (sharks and rays) the pronephros is more completely and more early aborted than in the last subclass, and the mesonephros is divided into an anterior or genital part (which receives the vasa efferentia in the male from the testis and thus is the first appearance phylogenetically of an epididymis) and a posterior or renal part The Wolffian duct therefore acts both as a vas deferens for the sperm and a ureter for the urine, though in the female it is merely a ureter

The Dipnoi or mudfish are remarkable for having a cloacal caecum which probably functions as an urinary bladder.

In the Amphibia the snake-like forms (Gymnophiona) show a very primitive arrangement of the kidney tubules, each having its nephrostome, Malpighian capsule and short convoluted part leading to the Wolffian duct which acts both as ureter and vas deferens.

In Reptilia the hind kidney or metanephros is developed and takes over all the excretory work; it is usually lobulated, its nephridia are never provided with nephrostomes and its duct (the ureter) opens into the Wolffian duct or vas deferens before reaching the cloaca. Birds resemble reptiles very closely in their urinary system except that there is no bladder and that the ureters and vasa deferentia open independently into the cloaca.

In the Mammalia the bean shape of the kidney is fairly characteristic In foetal life the organ is always lobulated, and this often persists in the adult as in the ox, bear, seal and whale.

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URMIA (Urumia), recently renamed Rezaieh, a city in the province of Azerbaijan in Iran, on a plain at an elevation of 4,400 ft., in 37° 34′ N, and 45° 4′ E., 155 mi. around the lake by road via Marand and Khoi from Tabriz. The population before the war was roughly estimated at 45,000, being mainly Turkish, with Armenian and Assyrian (Nestorian) minorities. It is clean with broader and less oriental-looking streets than in most Iranian towns; and the bazaars, a maze of domed and brick-vaulted corridors The plain of Urmia is fertile. By means of irrigation, cultivation especially of fruits and tobacco reached a high standard. Large amounts of raisins, dried apricots and tobacco are exported to Russia.

In World War I there was a wholesale exodus of Christians—said to have reached 59,000—in July 1918, during the Turkish advance after the Russian debacle; and, in the same year, there were massacres by the Turks and Kurds of two-thirds of those who remained. In 1919, the remnant of 600 Christians was transferred to Tabriz Some survivors were repatriated by the Iranian government, and by loans for the repair of buildings and the purchase of seed, oxen and implements, agriculture has been fully restored.

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URMIA (URUMIA), LAKE OF, in northwestern Iran, between 37° 10′ and 38° 20′ N. and between 45° 10′ and 46° E., which takes its name (Pers. *Deryacheh i Urmua,* Turk. *Urmi gol*) from the town of Urmia, situated near its western shore, but is also known as the Deryacheh i Shahi and Shahi göl. The limits of the lake vary much, the length (north to south) from 80 to 90 mi, the width (east to west) from 30 to 45, being greater in the season of high water in spring when the snows melt.

The mean depth of the lake is 15 to 16 ft., and its greatest depth probably does not exceed 50 feet. The lake has in recent years exhibited extraordinary changes of level, either due to a movement of the earth's crust or merely to an increase of rainfall as compared with evaporation. De Morgan gives an area of 4,000 and 6,000 sq.km. (1,544 and 2,317 sq.mi.) for low and high water respectively.

In the south is a cluster of about 50 rocky islands, the largest of which, Koyun daghi, *i.e.,* "Sheep-mountain," is 3 to 4 mi. long and has a spring of sweet water near which a few people graze their goats and sheep.

All the other islands are uninhabited. The lake is about three-fifths as salt as the Dead sea—far too salt to permit of any life, except of lower organisms.

By the U.S.S.R treaty with Iran, of 1921, the railway from Tabriz to Julfa and branch line from Sofian to Lake Urmia and all the properties pertaining to navigation on the lake—formerly a Russian concession—were gratuitously transferred to Iran. From the port of Sharaf-Khaneh on the eastern shore of the lake a fleet of motor boats of 20–160 h.p. is operated in conjunction with the railway. The service is weekly. The lake is also navigated by clumsy craft with round bows and flat sterns carrying enormous sails. (*See* Urmia)

UROLOGY. The branch of medicine—chiefly surgical—that deals with diseases of the genito-urinary organs. Recent progress in urology has been due largely to improvements in the cystoscope, advances in radiology, use of diathermy and close co-operation between urologists, bacteriologists, and bio-chemists.

Endovesical instruments are now available from the simplest cystoscope, consisting of a telescope within an irrigating sheath, to complicated instruments with which lesions can be treated surgically under direct vision instead of by an open operation

Similarly, advances in radiology have led to the detection of calculi hitherto regarded as transparent to the rays, and to stereoscopic radiograms indispensable for locating a suspicious shadow in the neighbourhood of the kidney or ureter. Pyelography also gives information concerning the size and shape of the renal pelvis and calices.

A skiagram is taken after a fluid opaque to the X-rays (*e.g.,* sodium iodide or lipiodol) has been introduced into the renal pelvis by means of a ureteric catheter. It is of great value in diagnosing early dilation of the kidney, silent hydronephrosis, polycystic kidney, malformation of the pelvis and renal tumours encroaching on the pelvis; in localising shadows in the renal area such as calcified mesenteric glands and gall stones, and in differentiating between abdominal and renal tumours.

By similar means, silhouettes of the bladder or male urethra can be obtained, though in the latter instance they are not indispensable, for the canal can be examined easily and thoroughly with a urethroscope.

Perirenal inflation with CO_2 was introduced by Carelli of Buenos Aires and in radiographs shows clearly alterations in shape, size and density, therefore being useful in such conditions as early hydronephrosis, polycystic kidneys, tuberculosis, tumours and stones not dense enough to show by ordinary radiography; but its greatest value lies in giving a clear and distinct radiogram of the suprarenal capsule.

Diathermy.—Diathermy (*see* ELECTROTHERAPY) acts by virtue of the heat generated in the tissues by the resistance they offer to the passage of an electric current. For this purpose a very strong current must be used, deprived of its stimulating and electrolytic properties by alternations of not less than 500,000 per second

The only sensation produced by a current of such high frequency is one of heat ranging, according to the strength of the current, from a pleasing warmth to a temperature high enough to char the tissues for a distance of about 1 cm from the electrode All degrees of diathermy are used for diseases of the genito-urinary system, the lower temperatures for testicular neuralgia and epididymo-orchitis, chronic urethritis and prostatitis, and benign enlargement of the prostate when a radical operation is inadvisable. Destructive diathermy is now the method of choice in the treatment of certain forms of papilloma of the bladder and urethra, and in the median bar type of prostatic obstruction. It has been used with moderate success for carcinoma of the prostate.

Use of Radium.—Radium (*q.v.*) has been used extensively for carcinoma of the prostate and bladder It is applied in the form of needles and emanation tubes or seeds implanted directly into the growth, but has not yet emerged from the experimental stage Caution is required in its use, for large doses produce great irritation and may be followed by excessive infiltrations of the bladder neck Again, emanation tubes placed too close to the pouch of Douglas have caused peritonitis and death. In view of these disadvantages and the discouraging results they have encountered many urologists are now averse to using it at all.

Urinary Antiseptics.—Both mercurochrome and hexyl-resorcinol are powerful antiseptics, and though not "ideal" are valuable additions to the comparatively few powerful bactericides which can be administered with safety. Mercurochrome can be used either locally or intravenously. In cases of chronic cystitis, usually due to the colon bacillus, instillation of a watery solution (0·2–1·0%) sometimes has a remarkable effect. In pyogenic coccal infections the results are not so striking. In pyelitis, irrigation with mercurochrome is not so irritating as with silver nitrate. Instillations appear to be particularly valuable for chronic posterior urethritis, especially when complicated by prostatitis and vesiculitis. When given intravenously in doses of from 1 to 5 mg. per kg of body weight results have been most encouraging, especially in acute coccal and bacillary infections of the genito-urinary tract associated with pyrexia Chronic afebrile colon bacilluria, on the other hand, does not always respond so readily to this treatment. In rare cases, pronounced febrile and gastro-intestinal reactions follow the injection but these usually subside in 24 hours. The danger to the kidneys of such a powerful mercurial compound must never be overlooked, but Young (Baltimore) considers it may be used intravenously without fear of injury.

Hexyl-resorcinol $[C_6H_3(OH)_2C_6H_{13}]$ is a synthetic compound first described by Leonard. Possessing forty-five times the germicidal power of phenol, it conforms experimentally to the qualifications necessary for an ideal urinary antiseptic in that it is chemically stable, non-toxic, non-irritating to the urinary tract, has an antiseptic and bactericidal action in high dilution in urine of any reaction, and is eliminated in high percentage by the kidneys. On the other hand, it can only exert its germicidal properties on tissues with which the urine comes in contact, and therefore infections of the renal parenchyma and submucous tissues of the urinary tract are not affected by it. If taken on an empty stomach the drug may cause griping or catharsis. Infections due to pyogenic cocci appear to yield to the drug with remarkable rapidity. *B. coli* infections of the urinary mucosa with a low bacterial count can be cured with hexyl-resorcinol, but when the count is high and the sub-mucous tissues are infected, prolonged treatment combined with appropriate local treatment is necessary. When administered prophylactically two days before, and daily after operations on the bladder, the wounds remain healthy and healing is accelerated

Tests of Renal Function.—Tests for estimating the function of one or both kidneys are now employed regularly. Though not conclusive, they are capable of giving a warning which should be heeded, particularly in operations on the urinary tract. Thus in prostatectomy they serve to determine a one- or two-stage operation, and since they have been adopted as a routine the mortality from uraemia has become almost negligible. The chief tests in use in England are. (1) The urea concentration test (Maclean and de Wesselow), (2) estimation of blood urea; (3) colour tests. The technique of applying these tests can be found in text-books

The range of normality of the blood urea is so great that this test alone is of little value unless the urea retention is above 50 mg per 100 cu cm of blood, but when combined with the urea concentration test it gives an excellent indication of the renal efficiency. In some clinics on the Continent great reliance is placed on the elimination of creatinin and chlorides as tests of renal efficiency. The dyes chiefly employed for colour tests are indigo-carmine and phenolsulphonaphthalein. Indigo-carmine can be employed during a cystoscopy and gives a good indication of the function of one kidney without the use of a ureteric catheter (chromocystoscopy). A 0·4% solution injected either intravenously (5 c c) or intramuscularly (20 c.c.) should tinge the urine of a healthy kidney in five minutes. Phenolsulphonaphthalein is excreted solely by the kidneys and so differs from indigo-carmine, which is only partly excreted by the kidneys. In America it is used almost exclusively, but in England it has not been popular owing to the somewhat elaborate technique required and to the difficulty, since the War, of obtaining a reliable preparation of the dye The test is very reliable provided the pure compound is used.

The capacity or otherwise of a patient to resist the spread of sepsis to the upper urinary tract after an operation, such as prostatectomy, is a factor which may upset the calculations of both surgeon and bio-chemist. MacAdam and Shiskin have found that the *cholesterol content* of the blood gives a fair indication of the power of resistance. The average in a series of healthy adults under 50 years of age was found to be 0·16%. Above 50 years it ranges between 0·13% and 0·19%. Practical experience led these workers to conclude that in prostatic obstruction a blood-cholesterol below 0·13% indicates such a lowered resistance to the spread of sepsis as to constitute a bad operative risk Cases with a high blood-urea and a normal blood-cholesterol all recovered from a two-stage prostatectomy, but out of eight cases with a high blood-urea and a low blood-cholesterol all died save one

The Kidney.—Dudgeon and others have pointed out that the combination of pus cells and a pure culture of staphylococcus albus in the urine of one kidney is almost pathognomonic of a stone in that kidney. With certain reservations all cases of renal calculus are now subjected to operation, for the stone, whether causing symptoms or not, slowly but surely injures the kidney and often determines a serious bacterial infection. Small stones are more dangerous than large ones, for they may lodge in the ureter and cause hydronephrosis, anuria and so on.

The problem of bilateral lithiasis is a difficult one, but on the whole urologists advocate operation on the healthiest kidney first, as there is always the possibility that nephrectomy may be necessary on the side which is more grossly affected. Pyelolithotomy is now performed in preference to nephrolithotomy whenever possible

Decapsulation of the kidney for nephritis has been performed on many occasions with varying success, but is viewed with increasing favour. The benefit obtained is probably due to the mechanical relief of renal tension, and this certainly explains the immediate improvement following unilateral decapsulation in eclamptic uraemia. The indications for this operation are uraemia, anuria, oedema, excessive albuminuria and obstinate haematuria. Contra-indications are age, heart diseases and extensive cardiovascular changes.

Renal Tuberculosis.—Investigations by Braasch in the Mayo clinic have disproved the common opinion that renal tuberculosis is usually primarily unilateral In seven out of 22 apparently unilateral cases, the urine from the supposed healthy kidney was proved to contain tubercle bacilli by animal inoculation, a fact which goes far to explain the comparatively heavy mortality in the first few years after nephrectomy. Continental writers estimate

that in life the infection is bilateral in about 15% of cases, whereas in the post-mortem room it is as high as 65%. This fully bears out the experience that spontaneous cure is extremely rare and that the only rational treatment of unilateral tuberculosis is early nephrectomy. In bilateral infections, Ekehorn advocates and practises removal of that kidney which is found by inspection to be the most diseased, or is thought to be the cause of pyrexia and distressing bladder symptoms. In 20 cases reported by him the results were good enough to justify the operation. The treatment of the tuberculous ureter is still under discussion, most workers considering that it heals naturally after the diseased kidney has been removed, while others advocate a primary nephro-ureterectomy to prevent infection of the lower urinary tract by the diseased ureter. All are now in favour of a post-operative course of tuberculin.

Movable Kidney.—Operations for nephroptosis are decreasing in number year by year, for surgeons have now realised that the condition is commonly associated with Glenard's disease and with such general symptoms as headache, gastric discomfort, neurasthenia and ptoses of various kinds, for which fixation of the kidney gives no relief whatever. Nephropexy is now reserved chiefly for cases of intermittent hydronephrosis, haematuria, casts and albuminuria, and for uncomplicated renal pain relieved absolutely by rest in the horizontal position

Ureteral Calculus.—In the case of small stones impacted in the ureter most urologists favour removal by manipulative and other methods rather than by ureterolithotomy. The chief methods employed are: (i) dilation of the ureter combined with instillation of sterile liquid paraffin, subcutaneous injection of atropine, and forced diuresis with Contrexéville water; (ii) intra-ureteral instillation of 5 cu cm. of a 2% solution of papaverine sulphate, selected for its analgesic and antispasmodic properties; (iii) dilation of the ureter by diathermy, and (iv.) division of the ureteric meatus with scissors through a cystoscope.

Severe reactions after cystoscopic manipulations, and irregular stones greater than 1 cm. in diameter are indications for ureterolithotomy. The pelvic portion of the ureter is now always exposed extraperitoneally, either through a paramedian subumbilical incision or by Kidd's inguinal operation.

Bladder.—The ureter may be implanted into another part of the bladder, either for stricture of its extramural portion or after partial cystectomy for growths involving the ureteric orifice. For inoperable bladder growths and for extrophy of the bladder, Coffey has devised a method of simultaneous transplantation of both ureters into the pelvic colon, which does not obstruct the ureters or disturb kidney function.

The bacteriology of cystitis and pyelocystitis has received much attention from bacteriologists. The most important recent communications on this subject are by Dudgeon, Wordley and Bawtree. These workers have isolated from different cases:—

(1) A special group of haemolytic bacilli, strongly resembling but not identical with the paratyphoid bacillus; (2) the colon bacillus; (3) Proteus.

Improvements in the cystoscope have led to earlier recognition of diverticula. Swift Joly reviews the whole subject and discusses the relative value of the different operations. He also points out that accompanying prostatic or urethral obstruction should be treated at the same time whenever possible

Papilloma.—These tumours are now treated by fulguration through a cystoscope whenever possible, and in many instances can be destroyed completely at one sitting and under local anaesthesia. When the papilloma is sessile and diathermy can only be applied to the surface nearest the cystoscope, several treatments at intervals of a week or ten days may be required, a portion of the growth being destroyed at each sitting. Subsequently a cystoscopic examination should be made at intervals of three to six months for at least three years, so that fresh growths can be kept in check. Open operation by the suprapubic route is reserved for large growths, especially if sessile and for those involving the ureteric orifice. In some cases the tumour can be destroyed by diathermy with a large electrode, in others a partial cystectomy, with or without transplantation of the ureter, is necessary. Attention has been called to the danger of "graft-recurrences" in the abdominal wall after removal of papillomata by the suprapubic route, and Maybury and Dyke have reported a case in which three successive implants grew in the abdominal wall. The primary vesical growth was benign but the recurrent implants became progressively malignant. Carcinoma should be excised whenever possible, for as yet the results of treatment with imbedded radium is disappointing and uncertain. In the flat ulcerating form of carcinoma, peculiar to the aged, a fair measure of comfort and relief can be obtained from deep X-ray therapy.

The Prostate.—For chronic inflammatory lesions of the prostate and seminal vesicles diathermy is valuable and acts, not only on the gland itself, but also on the arthritic and other complications so frequently associated with gonorrheal prostatitis and vesiculitis. In cases of enlarged prostate where operation is impossible owing to age, cardiovascular changes, advanced renal disease, etc., a fair measure of relief can be obtained by medical diathermy or by deep X-ray therapy. In all other cases prostatectomy is undoubtedly the correct procedure. The type of enlargement most suitable for operation is that due to chronic lobular prostatitis with pronounced adenomata; the second type, chronic interstitial prostatitis or fibrous prostate, presents many difficulties to the operator but should be removed whenever possible, as it causes a severer degree of obstruction and consequent impairment of the renal function than the adenomatous variety. Before deciding on an operation the chemical tests of renal efficiency should be carried out, for the type of operation selected will depend almost entirely on these tests. Careful preliminary treatment, often lasting several weeks, is nearly as important as the operation itself.

After much discussion, the majority of urologists have decided in favour of the suprapubic operation in one or two stages. The two-stage operation has reduced the mortality from uraemia to a negligible quantity and is indicated in all cases with renal deficiency, severe cystitis, retention, or four or more ounces of residual urine. The Thomson-Walker operation is undoubtedly an improvement on the somewhat crude but remarkably effective operation practised by Freyer. It takes longer but eliminates the risk of post-operative stricture. The perineal operation, performed almost exclusively by Young of Baltimore, is in England reserved for carcinoma and for the fibrous type of prostate. Here the advantages of control of haemorrhage and perfect drainage are outweighed by the dangers of pelvic cellulitis, perineal fistula and incontinence of urine.

In about 25% of patients with symptoms of prostatic obstruction but without palpable enlargement of the prostate, a careful cystoscopic examination reveals the presence of a ridge of hypertrophied tissue, either on the posterior lip of the prostate overhanging the internal meatus, or projecting upwards from the floor of the prostatic urethra and constituting the so-called median bar. For the relief of this type of obstruction H. Young invented his well-known punch, later improved by Kenneth Walker, by adapting it for diathermy. (*See* ELECTROTHERAPY.)

Hitherto, treatment of prostatic carcinoma by radium has been so unsatisfactory that many surgeons have ceased to use it. Diathermy has been more or less successful in conferring relief, but the results can hardly be described as brilliant. Whenever possible, Young's perineal resection appears to be the most satisfactory procedure; failing this, excellent results have been sometimes obtained from deep X-ray therapy.

The Testis.—Steinach of Vienna performed vasoligation in *senile* rats with a view to increasing the internal secretion of their testes and thereby stimulating their failing energies. For two to four weeks after bilateral division of the vas between ligatures no appreciable change was noticeable. The rats then began to show a return of sexual excitement and vigour, in some instances equalling that of young males. This was followed in rapid succession by a return of pugnacity, increase in muscular energy and a copious growth of fur The change lasted for about six months, when the animal gradually lost his youthful appearance and powers and became senile again, eventually dying within a few weeks of the onset of the change. Steinach found that the operation induced degeneration of the seminal epithelium (later followed by regeneration) and an increase in the interstitial tissue In man the operation has been attended by very variable results. The

greatest successes appear to have occurred in cases of premature old age; when performed for impotence alone it is not so satisfactory, and is quite useless if the testis be already atrophied Some cases of arteriosclerosis have been greatly benefited by it.

Testicular Grafts (*see* REJUVENATION) —Grafts from lower animals have been employed for many years with more or less similar results, viz , improvement shortly after implantation, followed by atrophy and absorption of the graft, and a return on the part of the patient to the original condition. Voronoff in 1920 used testes of anthropoid apes and found that they survived for three years or longer, and that the initial improvement in the patient's condition was maintained. Kenneth Walker has on several occasions employed a healthy human ectopic testis. He concludes that the life of a hetero-graft is not longer than two years. that absorption of the graft does not necessarily imply a return of the patient to his former condition, and that permanent improvement is probably due to increased growth in other endocrine tissues stimulated into activity by the graft

Tuberculous Epididymitis.—When this disease is advanced castration is indicated, but when it is localised to the globus major or minor epididymectomy is now regarded as the correct procedure. The full extent of the disease must always be determined with care

The Urethra.—The great improvement in urethroscopes has simplified the diagnosis and treatment of urethral conditions. With the Joly type of posterior urethroscope, diathermy can be applied where formerly a serious cutting operation was necessary. There is now an increasing tendency to revert to former methods and to treat stricture of the urethra by gradual dilatation with metal sounds or gum elastic bougies, urethrotomy being reserved for resilient and cartilaginous strictures and those complicated by fistulae. If contraction recurs after internal urethrotomy many surgeons advocate excision of the stricture and axial anastomosis. When a large amount of cicatricial tissue has been excised, the gap has been successfully bridged in one case by implantation of the patient's appendix, and in another by a child's prepuce fashioned into a canal around a catheter.

(*See* also BLADDER AND PROSTATE DISEASES)

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(C. A. R. N.)

UROTROPIN, known also as uritone, a chemical substance (hexamethylenetetramine) formed by the action of ammonia on formaldehyde, used in medicine. It consists of colourless granular crystals freely soluble in water and having an alkaline reaction. Urotropin is among the most powerful of urinary antiseptics It is used to render the urine acid in cases where it is alkaline, loaded with phosphates or purulent, as in cystitis. It is slightly diuretic. Experimentally it has been shown to have a solvent action on uric acid, but its action in this direction in the body requires confirmation. Urotropin is valuable in sterilizing the urine of "typhoid carriers." (*See* CARRIERS) Analogous preparations are cystamine, helmitol and hetralin Chinotropin is urotropin quinate, and borovertin is urotropin triborate.

URQUHART, DAVID (1805–1877), British diplomatist, was born at Braelangwell, Cromarty. He was educated in France, Switzerland and Spain, and at St. John's college, Oxford He served (1827–28) in the Greek navy in the War of Independence, being severely wounded In 1830 his reports on the new Greek frontier, as determined by the protocol of March 22, 1829, were of great service to the British Government. In Nov. 1831 he was appointed attaché to Sir Stratford Canning (Lord Stratford de Redclyffe, *q.v.*) on his mission to the sultan for the final delimitation of the frontiers of Turkey and Greece In 1833 he went on a secret mission to Turkey in the interests of British trade, but he was recalled by Palmerston on account of his indiscreet advocacy of British intervention on behalf of the sultan against Mehemet Ali. In 1835 he founded the *Portfolio*, printing in the first issue a series of Russian State papers, which made a profound impression As M.P. for Stafford (1847–52) he vigorously opposed Palmerston's foreign policy. He protested against the action of England in the Crimean War, advocating Turkish autonomy. He organized "foreign affairs committees" (known as "Urquhartite") throughout the country, in opposition to the Government, and in 1855 founded the *Free Press* (renamed in 1866 the *Diplomatic Review*) to which Karl Marx was a contributor His health obliged him to retire to Montreux in 1864, and he died in Naples on May 16, 1877.

He published *Turkey and its Resources* (1833); and *England, France, Russia and Turkey* (1833), both violently anti-Russian; and *The Lebanon* (1860).

URQUHART or URCHARD, **SIR THOMAS** (1611–1660), Scottish translator of Rabelais, was the son of Sir Thomas Urquhart of Cromarty, and of Christian, daughter of the fourth Lord Elphinstone. After part of his estate had been alienated he received a "letter of protection" from his creditors from Charles I. in 1637. He took part in the "Trot of Turriff" in 1639, and was knighted in 1641. He then published his *Epigrams* In 1645, he produced a tract called *Trissotetras*, a treatise on logarithms, adjusted to a kind of memoria technica, like that of the scholastic logic. In 1649 he was proclaimed a traitor for taking part in the rising at Inverness At Worcester, he was wounded and taken prisoner. His mss. were almost wholly destroyed. Urquhart was released by Cromwell's orders in 1651 He published during 1652 and 1653 three tracts with quaint titles and quainter contents, the last being on a universal language.

The *Translation of Rabelais* (Books I and II.), which Urquhart produced in 1653, is a masterpiece of translation. Though not a close rendering, it reproduces the spirit of the original The translation was reprinted in 1664, and in 1693 that of the Third Book was added It is said the Urquhart sought refuge during the Commonwealth, like other cavaliers, on the continent, and died (1660) of a fit of laughing, brought on by joy over Restoration

URSA MAJOR ("The Great Bear"), in astronomy, a constellation of the northern hemisphere, supposed to be referred to in the Old Testament (Job ix. 9, xxxviii. 22), and mentioned by Homer, "Αρκτον θ', ἣν καὶ ἅμαξαν ἐπίκλησιν καλέουσιν (*Il.* 18. 487). The Greeks identified this constellation with the nymph Callisto (*q.v.*) placed in the heavens by Zeus in the form of a bear together with her son Arcas as "bear-warder," or Arcturus (*q.v.*); they named it Arctos, the she-bear, Helice, from its turning round the pole-star. The Romans knew the constellation as *Arctos* or *Ursa;* the Arabians termed the quadrilateral formed by the four stars α, β, γ, δ, *Na'sh*, a bier, whence it is sometimes known as *Feretrum majus*. The Arabic name should probably be identified with the Hebrew name *'Ash* and *'Ayish* in the book of Job (*see* G. Schiaparelli, *Astronomy in the Old Testament*, 1905). Ptolemy catalogues eight stars. Of these, the seven brightest (six stars, α, β, γ, ε, ζ and η are of the 2nd magnitude, and δ of the third magnitude) constitute one of the most characteristic figures in the northern sky; they have received various names—Septentriones, the wagon, plough, dipper and Charles's wain (a corruption of "churl's wain," or peasant's cart). With the Hindus these seven stars represented the seven Rishis. The stars α and β are called the "pointers," since they point to the pole-star Five stars of the Plough form an associated group with common proper motion; but α (the upper pointer) and η (the last star of the tail) have no connection with the others. Stars in other parts of the sky have been found to belong to the same cluster; in particular Sirius is a stray member of it

URSA MINOR ("The Little Bear"), in astronomy, a constellation of the northern hemisphere, mentioned by Thales (7th century B.C.). By the Greeks it was sometimes named *Cynosura* (Gr. κυνός, dog's; οὐρά tail), alleging this to be one of the dogs of

Callisto, who became *Ursa major*. The Phoenicians named it Phoenice, or the Phoenician constellation, possibly in allusion to the fact that the brightest star, Polaris, being situated very close to the north pole, is of incalculable service to navigators Polaris, a second magnitude star, was in 1937 distant 1° 2′ from the celestial pole It is a Cepheid variable with very small light-range.

URSINS, MARIE ANNE DE LA TRÉMOILLE, PRINCESSE DES (1642–1722), lady of the Spanish court, daughter of the duke of Nourmontier and Renée Julie Aubri. After the death of her second husband, Flavio Orsini, duke of Bracciano, she assumed the title of Princess des Ursins, a corruption of Orsini, and for her unofficial services in securing Neapolitans and Spaniards of rank at Rome as French partisans in view of the approaching death of Charles II. of Spain, she was rewarded in 1699 by a pension When Philip, duke of Anjou, grandson of the French king was declared heir by the will of Charles II the princess took an active part in arranging his marriage with a daughter of the duke of Savoy Appointed *Camarera Mayor* by quiet diplomacy and the help of Madame de Maintenon, she accompanied the young queen to Spain in 1701. Till 1714 she was the most powerful person in the country She was expected to look after French interests in the palace, and to manage the Spanish nobles. But she wisely held that the young king should rely on his Spanish subjects and was in frequent conflict with the French ambassadors. Recalled in 1704, she still had the support of Madame de Maintenon, and her own tact placated Louis XIV. In 1705 she returned to Spain, with practically the power to name her own ministry. During the war of the Spanish Succession she was the real head of the Bourbon party. She was so far from offending the nation, that when Louis XIV. threatened in 1709 to desert his grandson, she dismissed all Frenchmen from the court On the death of the queen, acting by advice of Alberoni, she arranged a marriage for the king with Elizabeth Farnese of Parma She was rudely disillusioned in her hopes of governing the new queen as she had done the old Driven from Elizabeth's presence with insult, at Quadraque, whither she had gone to meet her, she was sent out of Spain without being allowed to change her court dress. After a short stay in France, Madame des Ursins went to Rome, where she died Dec. 5, 1722

See F. Combes, *La Princesse des Ursins* . . (1858); *Lettres inédites de Mme de Maintenon et de . . . la Princesse des Ursins* (1826; Eng. trans., 1827); *Lettres inédites de la princesse des Ursins* (1859), C. Hill, *Story of the Princess des Ursins in Spain* (1905).

URSULA, ST., and her companions, virgins and martyrs, are commemorated on Oct. 21. The *Breviary* gives no legend; but in current works, such as Butler's *Lives of the Saints*, it is to the effect that "these holy martyrs seem . . . to have met a glorious death in defence of their virginity from the army of the Huns . . . They came originally from Britain, and Ursula was the conductor and encourager of the holy troop." The scene of the martyrdom is placed near the lower Rhine.

The date has been assigned by different writers to 238, *c.* 283 and *c.* 451. The story, however, is unknown both to Jerome and to Gregory of Tours—and this though the latter gives a somewhat detailed description of the Cologne church dedicated to that Theban legion with which the tradition of the martyred virgins was very early associated. The story of their fate is not entered under Oct. 21, in the martyrology of Bede (*ob c.* 735), of Ado (*c.* 858), of Usuard (*ante* 877), Notker Balbulus (896) or Hrabanus Maurus (845); but a 9th-century life of St Cunibert (*ob.* 663) associates a prominent incident in the life of this saint with the basilica of the sacred virgins at Cologne (Surius vi sant 275, ed 1575). Not only does Archbishop Wichfrid attest a grant to the church of the sacred virgins outside the walls of Cologne (in 927), but he was a large donor in his own person. Still earlier a Cologne martyrology, written, as Binterim (who edited it in 1824) argues, between 889 and 891, has the following entry under October 21: "xi. virg. Ursule Sencie Gregorie Pinose Marthe Saule Britule Satnine Rabacie Saturie Paladie." Much shorter entries are found in two of the old martyrologies printed in Migne (cxxxviii 1207, 1275). A more definite allusion to the legend may be found (*c.* 850) in Wandelbert of Prüm's metrical martyrology (Oct. 21):

> Tunc numerosa simul Rheni per littora fulgent
> Christo virgines erecta tropaea manipla
> Agrippinae urbs, quarum furor impius olim
> Millia mactavit ductricibus inclyta sanctis.

The full legend first makes its appearance in a festival discourse (*sermo*) for Oct 21, written, as internal evidence seems to show, between 731 and 839 This *sermo* does not mention St. Ursula, but makes Pinnosa or Vinnosa the leader of these spiritual "amazons," who, to avoid Maximian's persecution, left their island home of Britain, following their bridegroom Christ towards that East whence their faith had come a hundred years before The concurrent traditions of Britain, Batavia, etc, the Netherlands (where many chapels still preserved their memory), and Cologne are called in evidence to prove the same origin. The legend was already very old and the festival "nobis omni tempore celeberrima"; but, as all written documents had disappeared since the burning of the early church erected over the sacred bones, the preacher could only appeal to the continuous and careful memory of the society to which he belonged (*nostrates*)

Two or three centuries later the *Passio XI. MM. SS Virginum*, based apparently on the revelations made to Helentrude, a nun of Heerse near Paderborn, gives a wonderful increase of detail The narrative in its present form may date somewhere between 900 and 1100, while Helentrude apparently flourished before 1050. According to her account, the son of a powerful pagan king demands in marriage Ursula, the beautiful daughter of Deonotus, a king "in partibus Britannıae" Ursula is warned by a dream to demand a respite of three years, during which time her companions are to be 11,000 virgins collected from both kingdoms. After vigorous exercise in all kinds of manly sports, to the admiration of the populace, they are carried off by a sudden breeze in eleven triremes to Thiel on the Waal in Gelderland Thence they sail up the Rhine by way of Cologne to Basel, at which place they make fast their vessels and proceed on foot to Rome Returning, they re-enter their ships at Basel, but are slaughtered by the Huns when they reach Cologne Their relics are then collected and buried "sicut hodie illic est cernere," In a spot where "to this day" no manner sepulture is permitted.

The legend of Cologne grew to further dimensions with the revelations of St Elizabeth of Schonau in the 12th century, motived apparently by the opening up of an old Roman burial ground in Cologne It advanced still further with Hermann Joseph, a Praemonstratensian canon of Steinfeld in 1183, who explained the presence of the bones of little children among those of the sacred virgins

See H. Crombach, *Vita et Martyrium S Ursulae* (Cologne, 1647), and the Bollandist *Acta Sanctorum*, 21st October, where the story fills 230 folio pages. The rationalization of the story is to be found in Oscar Schade, *Die Sage von der heiligen Ursula* (Hanover, 1854), of which there is a short *résumé* in S. Baring-Gould's *Lives of the Saints* See also S Baring-Gould, *Popular Myths of the Middle Ages*; A. G. Stein, *Die Heilige Ursula* (Cologne, 1879). The credibility of some of the details was doubted as early as the 13th century by Jacobus de Voragine in the *Legenda aurea*. (T. A A.; A. J. G.)

URSULINES, a religious order founded at Brescia by Angela Merici (1470–1540) in November 1535, primarily for the education of girls and the care of the sick and needy. It was approved in 1544 by Paul III., and in 1572 Gregory XIII. declared it a religious order under the rule of St. Augustine. In the following century it was encouraged by St Francis of Sales and the Ursulines in Canada did valuable work among the French, the Indians and half-breeds. About 1700, the order embraced some 20 congregations, with 350 convents and from 15,000 to 20,000 nuns.

URTICACEAE (nettle family), a family of flowering plants belonging to the order Urticales, which order includes also Ulmaceae (elm family), Moraceae (mulberry, fig, etc) and Cannabaceae (hemp and hop). It contains 41 genera, with about 480 species, mainly tropical, though several species such as the common stinging nettle (*Urtica dioica*) are widely distributed and occur in large numbers in temperate climates. Two genera are represented in the British Isles, *Urtica* (*see* NETTLE) and *Parietaria* (pellitory, *q.v.*). In addition to *Urtica* and *Parietaria*, four other genera,—*Boehmeria*, *Hesperocnide*, *Laportea* and *Pilea*, are represented in North America, with some 15 native species.

The plants are generally herbs or somewhat shrubby, rarely, as in some tropical genera, forming a bush or tree. The simple, often serrated, leaves have sometimes an alternate sometimes an opposite arrangement and are usually stipulate—exstipulate in *Parietaria*. Stinging hairs often occur on the stem and leaves The bast-fibres of the stem are generally long and firmly attached end to end, and hence of great value for textile use. Thus in ramie (*q.v.*) (*Boehmeria utves*) a single fibre may reach nearly 9 in. in length, and in stinging nettle as much as 3 in *Maoutia* and *Urtica* have also been used as sources of fibre The small inconspicuous regular flowers are arranged in definite (cymose) inflorescences often crowded into head-like clusters. They are unisexual and monoecious or dioecious. The four or five green perianth leaves (or sepals) are free or more or less united; the male flowers contain as many stamens, opposite the sepals. The flowers are adapted for wind-pollination. The female flower contains one carpel bearing one style with a brush-like stigma and containing a single erect ovule. The fruit is dry and one-seeded; it is often enclosed within the persistent perianth The family is divided, according to Engler, into two main classes: (1) the *Urereae* with stinging hairs, including the genera *Urtica, Urera, Laportea*, and (2) others, which are without stinging hairs.



COMMON NETTLE (URTICA DIOICA)

URTICARIA, popularly known as nettlerash or "hives," is characterized by the appearance on the skin of slightly raised red or white patches, varying in shape and size, termed wheals, which develop suddenly, persist for a few hours, and then fade spontaneously and completely. The eruption is invariably accompanied by sensations of itching or burning which may be very pronounced. It is customary to distinguish between an acute and a chronic variety of urticaria. The former is marked by its abrupt onset, the profuse and extensive character of the eruption, and in many cases by the general symptoms which accompany the rash, such as fever, diarrhoea and vomiting. It is often caused by tainted food, and the whole attack is usually limited to a few hours or a few days. In chronic urticaria the eruption is either continuously present over periods of months or years, or is developed in bouts with intervals of comparative or absolute freedom. The onset as a rule is insidious, and the general health is little disturbed unless the degree of itching is sufficient to interfere with sleep or repose.

Nettlerash is now generally held to represent a symptom rather than a genuine disease, for it may be provoked by a great many and very different agents acting externally (nettles, jellyfish), or internally. The theory of sensitization has a special application in urticaria. For example different kinds of foods are capable of causing urticaria under special conditions. A certain individual suddenly becomes unduly "sensitive" to some article of diet which has, up to this point, been eaten without harm, while a second individual develops "hypersensitiveness" to a completely different type of food, a third to something different again, and so on. This acquired condition is specific, that is to say the individual who is "sensitized" only reacts to what is now his own harmful substance (*see* ANAPHYLAXIS) The human tissues can also become "sensitized" to many other agents besides food, such as the poisons liberated from collections of germs in the teeth, tonsils, bowel and other regions of the body (focal infection). In other cases a second injection of horse-serum (diphtheria or tetanus anti-toxin), if given at a sufficient interval of time after the first will sometimes cause urticaria and anaphylactic shock. The mechanism of the reaction is similar in all these cases and the same degree of specificity is observed. The theory of sensitization does not cover every case as, for example, where the eruption is related to an emotional crisis.

(H. MACC.)

URUGUAIANA, a city and river port of Rio Grande do Sul, Brazil, on the Uruguay river. Pop. of the *município* (1950), 49,785. The upper Uruguay is navigable from the Quaraí to the town of Santo Tomé. Opposite Uruguaiana is the Argentine town of Restauración, or Paso de los Libres. The river is 2 mi. wide at this point, and 154 ft. above sea-level. Uruguaiana is situated on a low hill rising gently from the riverside and its low houses are surrounded by orange groves. Uruguaiana was captured by a Paraguayan force Aug. 5, 1865, and recaptured without a fight by the allied forces on Sept 18.

URUGUAY (officially the República Oriental del Uruguay, and still locally called the *Banda Oriental*, the "Eastern Shore" of the Uruguay river), the smallest independent state in South America. It lies between Brazil on the north and the estuary of the Río de la Plata on the south, extending from the Uruguay river to the Atlantic coast. It has a sea-board of some 120 mi, a shore-line on the Plata of 235 mi. and one of 270 mi along the Uruguay. The southern part of the country is mostly undulating plains, an extension eastward of the Argentine pampas. The coast-line is fringed with tidal lakes and sand dunes; the banks of the two bordering rivers are low, unbroken stretches of level land. The northern section of the republic presents greater variety of relief, with occasional ridges and low ranges, alternating with broad valleys, a true southward extension of southern Brazil. None of the sierras or mountains of Uruguay exceeds 2,000 ft. in elevation. There are no large rivers within Uruguayan territory. The Río Negro, the largest stream, is navigable only in its lower part. No other streams are navigable except for vessels of light draught The Santa Lucía, Queguay and Cebollati are the other principal water courses. The Uruguay river, along the border, is navigable for steamers of 14-ft. draught from its mouth to Paysandú, and above that point for smaller vessels to the falls at Salto, 200 mi. in all.

Geology.—The eastern and southern half of Uruguay is a low, rolling prairie, whose subsoil is of weathered ancient schist and granite, through which protrude low ridges of less weathered rocks. In central and north-central Uruguay a basement of ancient schist is overlain by nearly horizontal Permian beds, which form a low plateau. The northwestern portion is occupied by a southward extension of the Paraná plateau of southern Brazil. This plateau is formed of horizontal beds of Triassic red sandstone of continental origin, in places faulted and capped by sheets of Triassic basalt. The plains of Uruguay are covered with Pleistocene deposits of sand and clay like those found on the pampas of Argentina and with alluvial beds.

Climate.—Uruguay has an excellent climate, the average temperature for the summer months of January and February being 72° F. and that of the coldest month, July, being 50°. Frost is almost unknown. The climate of both summer and winter is marked by great variability from day to day, due to the passing of cyclonic storm centres. Brusque windshifts are common, the hot northerly *sonda* sometimes being followed immediately by the chill *pampero* from the southwest and bringing a sudden drop in temperature. These changes give a middle latitude character to the climate of Uruguay. There are no decided rainy and dry seasons. A rainfall maximum is reached in the autumn (April and May), not in the winter months as is often supposed. Winter rains are most frequent but autumn rains are heaviest. The mean annual precipitation is about 35 in., decreasing with distance from the sea, but everywhere well distributed throughout the year. Many of the summer-time *tormentas* are thunderstorms, convectional and purely local in character. Fogs are frequent from May to October, but seldom last all day on land.

Flora.—Uruguay is primarily a grass-producing country, a true continuation eastward, in this respect also, of the Argentine pampas. There are more trees, however, both native and introduced, than on the pampas, but these are found chiefly in narrow ribbons along the bottom lands of the water-courses. The principal species are the ombú, alder, aloe, poplar, acacia, willow and eucalyptus. The *montes,* by which are understood plantations as well as native

thickets, produce, among other useful wood, the *algarrobo*, the *guayabo*, the *quebracho* and the *urunday*. Indigenous palms grow in the valleys of the Sierra de San José Ignacio, as also to some extent in the departments of Minas, Maldonado and Paysandú The myrtle, rosemary, mimosa and the scarlet-flowered ceibo are common. The valleys within the hills are fragrant with aromatic shrubs The prairies are gay with the scarlet and white verbenas and other brilliant wild flowers

Fauna.—As in most of the inhabited parts of the world, the wild animals have largely disappeared Even the rhea (the American ostrich) is now seldom seen, except in a semidomesticated state Pumas and jaguars are found on the wooded islets and banks of the larger rivers and along the northern frontier The fox, deer, wild cat, the *carpincho*, or water hog, and a few small rodents nearly complete the list of native quadrupeds A little armadillo, the *mulita*, is the living representative of the extinct giants, mylodon and megatherium, whose fossils are found over the pampa There are a few specimens of the vulture, a native crow (lean, tall and ruffed) and many partridges and quails. Parakeets are plentiful in the *montes* and the lagoons swarm with waterfowl The most esteemed is the *pato real*, a large duck. A characteristic sight on the prairies is that of the tiny burrowing owl, sitting on top of every little eminence Large flocks of the lapwing, *teru-teru*, are common, with their habit of warning other game of the approach of danger. Of birds of bright plumage, the humming bird and cardinal—the scarlet, the yellow and the white—are the most attractive, while white herons are frequently seen in swampy lands. The scorpion is rare, but large and venomous spiders are common The principal reptiles are a lizard, a tortoise, the *vibora de la cruz* (a dangerous viper, so called from marks like a cross on its head) and the rattlesnake in Maldonado and the stony lands of Minas Along the upper waters of the Uruguay river the *caimán* (alligator) is not uncommon. Seals are found on small islands off the southeast coast, particularly Lobos island, which so gets its name. (X.)

History.—The first European to visit Uruguay was probably Juan Díaz de Solís, who discovered the Río de la Plata in 1516, although some earlier explorers may have sighted the Atlantic shores of the country. Solís himself was killed by Indians, possibly the Charruas, the very warlike tribe who dominated the region at the time Subsequent Spanish explorers touched the Uruguayan shores of the Plata, but found occupation even more difficult than on the south shore. Long after Buenos Aires, across the estuary, was permanently founded in 1580, Uruguay remained unoccupied. In the 17th century some precarious Jesuit missions existed for a while. Then, in 1680, the Portuguese, who regarded the country as a natural extension of Brazil, founded Colonia. In 1726 the Spanish under Gov. Bruno Mauricio de Zabala of Buenos Aires countered by formally establishing Montevideo. Colonia was taken and given up several times, and until late in the 19th century the region, known as the Banda Oriental del Uruguay, or Eastern Shore of the Uruguay, was a bone of contention between Spain and Portugal and, later, between their respective successors. The result was the creation of an independent-minded people.

When the Wars of Independence broke out in 1810, the great Uruguayan national hero, José Gervasio Artigas, led the independence movement, but insisted upon autonomy for the Banda. Artigas proposed a federal system of government for the Spanish provinces of the Plata basin, and for a time maintained himself supreme over neighbouring provinces which are now part of Argentina; but in 1816, the Portuguese, on pretext of restoring order, invaded the country and after four years conquered it. Independence was reasserted in 1825 and, with Argentine aid, obtained after a war with Brazil. The republic was formally constituted in 1830, but for the next 22 years there was internal factional strife, aided and furthered by Juan Manuel de Rosas, dictator of Buenos Aires His forces, allied with Uruguayan partisans of Gen. Manuel Oribe, besieged Montevideo for nine years (1843–51).

After the declaration of independence, the history of Uruguay became a record of intrigues, financial ruin and political folly and crime. The two great political factors for generations were the Colorados and the Blancos So far as political principles were concerned, there was small difference between them. Men were Colorados or Blancos largely by tradition and not from political conviction. The Colorados held control for many years, and the attempts of the Blancos to oust them caused a series of revolutions, including the revolution of 1910 The military element, moreover, frequently conspired to elect a president amenable to its demands The old Blancos and Colorados were superseded by conservatives or progressives, the latter favouring advanced social legislation.

A new kind of revolution took place with the beginning of the second administration of Pres José Batlle y Ordóñez in 1911. Batlle immediately launched a program of social reform which soon gave Uruguay the reputation of being the most progressive state in South America. Laws providing for the eight-hour day, national insurance, university education for women, state control of monopolies, divorce and the general furthering of education were but some of the measures adopted under Batlle's influence. Immigration was encouraged, and agricultural aid was given through grants of free seed

Uruguay continued to prosper under Batlle's successor, Feliciano Viera (1915–19), who relied upon able advisers from among the young and progressive group who had studied abroad. In 1916 a convention met to discuss a new constitution to replace that of 1830. This came into effect on March 1, 1919, and provided a definite separation of church and state. Decentralization of the national government was brought about, and the executive power was divided between the president and a newly created national administrative council. This constitution continued in effect until 1933, when Pres. Gabriel Terra seized dictatorial power.

Late in President Viera's administration, Uruguay broke off relations with Germany (Oct. 1917) While still professing neutrality, the government formally declared that "no American government forced into war with nations of other continents in the protection of its own rights would be regarded as a belligerent." Shortly afterward several German ships which had been in the harbour of Montevideo since 1914 were seized and, subsequently, leased to the United States for wartime use.

Baltasar Brum, foreign minister under President Viera and a leader in the move for a new constitution, took office as president on March 1, 1919. Uruguay ratified the treaty of Versailles in 1919 and entered the League of Nations.

Uruguay was one of the few Hispanic American republics to escape revolution between 1929 and 1931, but its laudable record was seriously marred in March 1933 when Pres Gabriel Terra, who had been elected in 1931 on a platform of support for the constitutional system of 1919, found himself at odds with the national administrative council and congress, and forcibly dissolved both bodies after a coup d'état. Former President Brum, who resisted, was arrested and was reported to have committed suicide. Terra forced, first, a modification of the constitution to permit his own re-election, and in 1936 submitted a new constitution to the people for approval. This constitution materially strengthened presidential powers. All in all, Terra's rule was a rigid one, but through his dictatorial control, he effected many economies in the nation's finances. In March 1938, Alfredo Baldomir was chosen president for a four-year term in what was regarded by impartial observers as an honestly conducted election

The first year and a half of the Baldomir administration was marked by a slow but steady economic improvement until outbreak of World War II thoroughly disrupted Uruguayan foreign trade. Although Uruguay promptly declared her neutrality, flight of the German battleship "Admiral Graf Spee" to Uruguayan waters (Dec. 1939) brought serious difficulties. During May and June 1940, German "fifth column" activity in the country threatened to bring about revolution and the overthrow of the Baldomir government

Uruguayan declarations of American solidarity were issued promptly after the Japanese attack on Pearl Harbor, and in Jan. 1942 Uruguay severed diplomatic relations with Germany, Italy and Japan In July 1942 Uruguay signed a reciprocal trade agree-

ment with the U.S which, it was hoped, would help to offset its lost European markets and also partially prepare for postwar conditions

Juan José Amézaga, supported by Baldomir and representing the traditionally liberal Colorado party, became president on March 1, 1943 He continued the active collaboration in inter-American defense laid down by his party in 1941–42 The Blanco Nacionalista party, under the leadership of Luis Alberto Herrera, continued to oppose the government. In Feb 1947 the congress declared Tomas Berreta and Luis Batlle Berres, the candidates of the Colorado party, the officially elected president and vice-president. After Berreta died on Aug 2, 1947, Batlle became president Andrés Martínez Trueba, president of the Bank of the Republic and the Colorado party candidate, became president on March 1, 1951 He sponsored a constitutional reform, which was approved by the two leading political parties, to return to the executive council system which had been in effect in 1919–33 When the federal council was installed on March 1, 1952, Martínez Trueba was named chairman

Area and Population.—The area of the republic is 72,172 sq mi, the smallest in South America According to the census of 1908, the population was 1,042,686, official estimates of 1950 gave 2,365,000. The average density of population is therefore about 32.8 per square mile, the greatest of any national area in South America There is a large number of foreign-born inhabitants, most of them Italians and Spaniards, with lesser numbers of Brazilian, Argentine and French birth. Small-scale immigration from northern and eastern Europe continued after 1918 The average annual birth rate was estimated in 1944 at 20.7 per 1,000; the death rate, 8.9 per 1,000. In 1900 the birth rate was 33.43 per 1,000 Montevideo, the capital and most important commercial centre, had an estimated population of 850,000 (1950) More than 75% of the foreign trade of the country passes through Montevideo. Other cities, with their approximate 1950 populations, are Paysandú, at the head of deep-water navigation on the Uruguay river, 50,000; Salto, higher up the Uruguay, 48,000; Mercedes, an agricultural and livestock centre on the lower Río Negro, 33,000; Fray Bentos, important for meat-packing, on the lower Uruguay, 18,000, and Colonia, oldest city in the republic, immediately across the Plata from Buenos Aires, 10,000.

Agriculture.—In 1885 Uruguay imported most of her breadstuffs; however, by mid-20th century not only was wheat grown in sufficient quantities to meet the local demand, but a small surplus usually became annually available for export.

Land for farming purposes is expensive; wages are high, leaving small profit, unless it happens that a man, with his family to assist him, works his own land Wheat, with an officially estimated crop in 1950–51 of 479,202 short tons, is the principle crop. In 1950, 61,500 tons of flour valued at $7,493,000 were exported. Other important crops include oats, potatoes, beans, alfalfa, barley and birdseed. Linseed, oats and potatoes are exported After 1890, cultivation of grapes and the manufacture of wines were extended, especially in the departments of Montevideo, Canelones and Colonia. In 1950, 70,000,000 l of wine were produced Approximately 10% of the land was under cultivation at mid-20th century, and agriculture was subordinate to the pastoral industry in the national economy.

Cattle breeding and sheep farming are the principal industries. At mid-20th century nearly 80% of the land was devoted to grazing, and the stock estimates of 1940 showed 8,700,000 cattle (7,127,912 in 1930) and 23,000,000 sheep (20,558,124 in 1930). There are modern meat-packing establishments in Uruguay where beef and mutton are chilled or frozen for export. Meat exports in 1950 included 68,815 short tons of frozen beef, 23,861 tons of canned beef and 14,482 tons of frozen mutton. Large quantities of liquid extract of beef are also prepared for the European trade. A smaller amount of meat each year is sent to the *saladero* establishments for the preparation of *tasajo*, or jerked beef, for the Brazilian and Cuban markets.

Sheep farming flourishes chiefly in Durazno and Soriano. Uruguayan wool is favourably regarded in foreign markets, because of the clean state in which it is shipped. Sheep are raised largely for their wool Wool exports in the period Oct. 1, 1950, to Sept 30, 1951, were 154,006 bales, of which 118,492 bales went to the U.S., 9,735 bales to Belgium and 5,278 bales to France.

Mining.—Mining is of slight importance in Uruguay Minerals are known to exist in the northern section of the republic, and gold mining is carried on to a small extent. The other minerals found are silver, lead, copper, talc and lignite coal.

Commerce.—Exports are overwhelmingly of raw materials. In 1950, livestock products comprised 89.31% of all exports, with wool aggregating 51.99%, meats, 17%; and hides, 11.53% Agricultural products were 5.88%, of which cereals totalled 5.59% The principal imports are machinery, textiles and clothing, foodstuffs and beverages. Tables I and II show percentages for the leading countries involved

TABLE I —*Exports (1950)*
(In thousands of dollars)

United States	$129,150	50.70%
Great Britain	31,688	12.86%
Belgium	14,657	5.76%
France	14,137	5.57%
Germany	13,081	5.14%
Sweden	8,122	3.19%
Holland	6,314	2.48%
Italy	5,443	2.14%
Brazil	2,450	0.96%
Argentina	1,305	0.51%
Total	$254,281	100%

TABLE II —*Imports (1950)*
(In thousands of dollars)

Great Britain	$45,082	22.45%
United States	30,252	19.94%
Brazil	17,268	8.60%
France	14,416	7.18%
Germany	10,677	5.32%
Belgium	8,596	4.28%
Italy	7,366	3.67%
Sweden	6,730	3.35%
Peru	5,792	2.89%
Venezuela	5,300	2.64%
Paraguay	5,254	2.54%
Total	$200,831	100%

Industrial activity includes manufacturing, power, construction, meat- and fish-packing and metal work

In 1950 production included 60,000 automobile and truck tires; 36,300,000 l. of beer, 3,550,000 lb. of rayon woven goods; and 28,600 short tons of paper. In 1951 there were four *frigoríficos* for treating meat, eight *saladeros* and seven meat-canning plants

Communications.—External communication is largely by water. Waterways are important also for internal communication between Montevideo and ports along the Plata and the Uruguay rivers. In 1948 there were approximately 1,870 mi. of railway In 1950 they carried 9,211,000 passengers and 2,091,930 short tons of freight. Highways in 1948 totalled 36,000 mi., of which 3,051 mi. were paved national roads. On Dec 31, 1949, there were 56,500 automobiles and 20,000 trucks In 1950, 2,072 ships with a net tonnage of 9,241,136 entered the port of Montevideo.

Government.—Under the constitution adopted in 1942, Uruguay's legislative body was comprised of a senate of 30 members and a chamber of deputies of 99 members, in which the parties were given proportional representation. On March 3, 1952, the offices of president and vice-president, established under the constitution of 1942, were abolished The executive was replaced by a nine-man federal council, made up of six representatives from the majority party and three from the minority. The *Colegiado* was established to perform the duties of a regular executive, representing the nation in domestic and foreign affairs and working with the various ministries

Education.—At the beginning of the 20th century, nearly half the population over six years of age was illiterate After that time, however, marked improvement took place Primary education became compulsory and most of the children of school age attend. In 1950 there were 546 urban schools with 157,033 pupils and 1,176 rural schools with 55,476 pupils. The total number of teachers was 6,744 There were also 191 private schools with 36,884 pupils The University of Montevideo had 11,948 students In 1950, 25,457,117 pesos were allocated for primary edu-

cation and 7,047,140 pesos for the university.

Finance.—Actual government expenditures in 1950 were 306,000,000 pesos, revenue, 280,000,000 pesos On June 30, 1951, the internal public debt was 779,504,000 pesos, external, 115,526,000 pesos The cost of living index for Montevideo stood at 207 in July 1951 (1937=100)

The Bank of the Republic (founded in 1896) had a capital of 70,000,000 pesos and a reserve of 26,194,283 pesos on March 31, 1951. In addition to Uruguayan banks, there are branches of a number of foreign banks (of which British, Canadian and North American are the most important) in Montevideo.

The monetary unit, the peso, on Oct 31, 1951, had a value of $0.5263 U S currency, controlled rate, $0.4082 commercial free rate, and $0.4149 uncontrolled rate

Defense.—Composed of volunteers, the army had a strength of 26,000 men in 1950, and the police force numbered about 5,500. During wartime, service in the national guard is compulsory Uruguay also established a small air force and navy. In 1951 the U.S authorized the transfer of two destroyer escorts to the Uruguayan navy.

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URUGUAYANA: *see* URUGUAIANA

URUMCHI (URUMTSI, TIHWA), the capital of the Chinese province of Sinkiang, in a valley of the Tienshan, at about 3,000 ft above sea level Estimate of the population in 1936 was 20,000. There is a large Turki element and some Mongols. The place trades in furs and skins It is on the main route from Kansu to Dzungaria and the Ili region

USBEGS. The Usbegs form the ruling clan in Bokhara, Khiva and Kokand, occupying there a very similar position to that of the Osmanli in Turkey They are also found in Samarkand and in some parts of Syr Daria and Ferghana, in which latter place the Kipchak also live, and should probably be classified as Sarts. They are a mixed people, closely allied to the Mongols, and are in a transition from a nomad to a sedentary life.

USHAK or UŞAK, a town of Turkey, in the Kutaiah (Kütahya) vilayet, connected with Smyrna and Konia by rail. Pop (1950) 19,946. It is noted for its heavy pile carpets, *khali*, known as "Turkey carpets." There the Turkish army captured the Greek commander in chief, Gen. Trikoupis, Sept 2, 1922.

USHANT (Fr. *Ouessant*), a rocky, reef-fringed island lying 11½ mi. off the mainland of northwestern France (Brittany). Pop (1946) 2,223. Ushant has a maximum east-west length of 5 mi. and a north-south width of 2 mi. Maximum elevation, 150 ft. Most of the coast is cliffed or high; only on the southeast at Lampoul, the major village, is access easy The population is dominantly engaged in fishing. Garden crops are cultivated and sheep are pastured.

USHAS, in Vedic Hindu mythology goddess of the dawn (from the same root as Lat *Aurora* and Gr. Ἠώς). Celebrated in some 20 hymns of the *Rig-Veda*, Ushas is its most graceful creation. Borne on a car drawn by ruddy kine, the sun is her lover She rises resplendent . . . showing her charms—ever shortening the lives of men she reveals their paths and bestows new life . . . she opens the doors of darkness as the cows their stalls.

USHER or USSHER, **JAMES** (1581–1656), Irish divine and archbishop, was born in the parish of St. Nicholas, Dublin, on Jan 4, 1581 He was sent to a school in Dublin opened by two political agents of James VI of Scotland, who sought to secure a party for James in Ireland in the event of the queen's death.

In 1594 Usher matriculated at the newly founded university of Dublin, whose charter had just been obtained by his uncle, Henry Usher, archbishop of Armagh. He graduated M A. in 1600, became a fellow of Trinity college, and was ordained in 1601. In 1607 he became regius professor of divinity and also chancellor of St Patrick's cathedral, Dublin. In 1613 he published his first printed work, though not his first literary composition—*Gravissimae Quaestionis de Christianarum Ecclesiarum, . . . Historica Explicatio*, wherein he took up the history of the Western Church from the point where John Jewel had left off in his *Apology for the Church of England*, and carried it on from the 6th till past the middle of the 13th century James nominated him archbishop of Armagh in 1625 As archbishop he discountenanced (1629) Bishop William Bedell's proposal to revive the Irish language in the service; he shared in drafting (1634) the code of canons of the Irish Church, and defeated the attempt to make the Irish Church conform exactly to the doctrinal standards of the English In 1640 he paid another visit to England on one of his usual scholarly errands, meaning to return when it was accomplished. But the Great Rebellion of 1641 prevented his return Usher pleaded in vain with Charles I not to abandon Strafford. By way of compensation for the loss of his Irish property he received the temporalities of the vacant see of Carlisle In 1643 he declined a seat in the Assembly of Divines at Westminster He quitted Oxford in 1645 and went into Wales, where he remained till 1646, when he returned to London, and was in 1647 elected preacher to the Society of Lincoln's Inn, an office which he continued to hold until near his death In 1648 he conferred with Charles I in the Isle of Wight, on the abortive negotiations with parliament on the question of episcopacy. In 1650–54 he published the work which was long accounted his most important production, the *Annales Veteris et Novi Testamenti*, in which he propounded a now disproved scheme of biblical chronology, whose dates were inserted by some unknown authority in the margin of reference editions of the Authorized Version In 1655 Usher published his last work, *De Graeca LXX Interpretum Versione Syntagma*. He died on March 20, 1656, in Lady Peterborough's house at Reigate, and was buried in Westminster abbey

Usher's works are very numerous, and were first collected by C. R. Elrington and J. H Todd (Dublin, 1847–64) in 17 vol. See *Life* by Carr (1895); W. B. Wright, *The Usher Memoirs* (1889).

USK, THOMAS (d. 1388), the author of *The Testament of Love*, a prose work formerly attributed to Geoffrey Chaucer, was born in London, Eng In 1897 Henry Bradley interpreted the acrostic comprised of the initial letters of its chapters—"Margarete of virtw, have merci on thus Usk"—as a statement of authorship. Thomas Usk was clerk of the closet to John of Northampton when he was mayor of London, 1381–83. In 1384 Usk was put in prison, but he was released on promising to bring charges against Northampton, who had been arrested for treason. Usk freely produced evidence which sent Northampton to prison. Usk fell with the king in the successful rebellion led by the duke of Gloucester, the king's uncle, in 1387. Tried for treason in 1388, Usk was condemned to death. At his execution, March 4, 1388, he was first hanged and then beheaded by 30 blows with a sword

The *Testament of Love*, which includes passages similar to the translations of Boethius by Chaucer, is a work of almost 60,000 words. It portrays the author in prison as he has interviews with an apparition in the form of a beautiful lady called Love. Excessively tedious, its obscurity and dullness was demonstrated by the fact that successive editors did not discover that the leaves of the original manuscript had been shuffled and the body of the treatise misarranged. No manuscript of the work was preserved; it was first printed by William Thynne in his edition of *Chaucer* (1532). In 1897 Walter William Skeat, with cancelled sheets to cover the unlucky mistake referred to above, issued a revised and annotated text in his *Chaucerian and other Pieces.*

USK, a small market town and urban district on the Usk river, Monmouthshire, England. Pop. (1938) 1,228 Area, 1 02 sq.mi. It was a Roman fort, *Burrium*, and there are ruins of a castle built

by the Clares in defense of the Welsh marches. The castle was taken by Simon de Montfort in 1265 and suffered under Owen Glendower. The church of St. Mary perpetuates a Benedictine nunnery founded by Richard de Clare in 1236. There is 12th-century work. Usk is well known to anglers. The ancient corporation was abolished under the corporations act of 1883.

USK, a river of Wales and England, 70 mi. long, flowing to the Bristol channel. The source is the north flank of Carmarthen Van, a summit of the Brecon Beacons; the course passes Brecon, Crickhowell, Abergavenny, Usk and Caerleon. The river is noted for its salmon and trout fishing.

USKOKS, a Serbo-Croat name meaning "refugee," applied to certain Christians who, after the Turkish conquest of Bosnia in 1463, fled, first to Glissa, in Dalmatia, then to Zengg, in the Croat military frontier. They turned to piracy, and became the terror of Adriatic commerce, which was largely Venetian. They received covert support from Austria, and an unsuccessful attempt by Turkey in 1592 to capture Zengg led to war between Turkey and Austria. In 1602 Austria allowed Venice to send a force against Zengg; it was defeated; and the piracy went on until in 1615 it led to war between Austria and Venice. The treaty of Madrid (1617) provided that they be disbanded and their ships destroyed; they were transported inland to the mountains to which they gave their name.

USTARANA, a Pathan tribe living to the extreme south of Dera Ismail Khan in the North-West Frontier of India.

USTER (1,532 ft.), a town in the canton of Zürich, Switzerland, near the Greifen See and on the railway Zürich-Rapperswil. It is an industrial centre with 10,588 inhabitants in 1941, speaking mostly German and chiefly Protestant.

ÚSTÍ NAD LABEM or AUSSIG A. D. ELBE, a town in N.N.W. Bohemia, in a highland district at the confluence of the Bela and the Elbe, is an important Elbe port. Pop. (1930), 43,802, mostly German. The town was ceded to Germany in 1938 by the pact of Munich

USTYUG VELIKIY, a town in the Archangel region of the Russian S.F.S.R., lat. 60° 47′ N., long. 46° 22′ E. Population 19,092. The town is the focus of post roads to Vologda and Gorky. It has distilleries, breweries, timber mills, leather factories and workshops for the production of agricultural machinery. It has two annual fairs. Special crafts include silver engraving and the making of boxes with secret locks.

USURY. The practice of lending at interest which exceeds a lawful or reasonable rate. For an account of professional moneylenders, legal rates of interest and legal control over usurious transactions, *see* MONEY-LENDING.

A long legal development has accompanied the allowance of interest against defaulting creditors. By Roman law the defaulting party to a contract was compelled, beyond fulfilment of the agreement, to pay compensation for the difference (*id quod interest*) to the creditor's position caused by his default. This difference could be based on actual loss accrued, and also on the profit that might have been made had performance been carried out. Mediaeval lawyers used the phrase *damna et interesse* for such compensation, and for damages and indemnity generally. Thus *interesse* became applied to the charge for the use of money, disguised as an indemnity for failure to perform a contract. At English common law an agreement to pay interest was only implied when supported, as in the case of negotiable instruments, by mercantile usage, or by the constant practice of a trade or business, or by the course of dealing between the parties. Otherwise an express agreement was required. By the Civil Procedure Act of 1833, provision was made for the allowance of interest at a rate not exceeding the current rate of interest upon debts evidenced by a written instrument from the time when their payment became due and in debts not so evidenced from the time a written demand for their payment had been made. In the United States the law regarding the allowance of interest has been more liberal. When there is default in the payment of a money debt, interest at the legal rate is allowable as damages for the delay in payment. Many States upon a similar theory allow interest upon unliquidated contractual demands where the default consists in something other than a failure to pay money. As in England, no interest is allowable upon claims for damages consequent upon a tort, but in America interest upon damages for torts to property is generally allowed In both countries compound interest is only claimable by express agreement or by established mercantile practice

In the United States a most significant development in the field of usury is the attempt to control the lending of small sums of money at usurious rates. The early statutes were ineffective to prevent usurious interest being demanded of necessitous borrowers, fixing rates of interest so prohibitively low as to drive the business outside the law. To remedy this situation a Uniform Small Loan Law, since adopted in many States, required licenses of lenders making loans under $300, supervised the conditions under which such loans were made, and permitted an interest rate not exceeding 3½% a month on unpaid balances. This legalizing of the small loan business at adequately remunerative rates has been highly effective, driving the illegal and extortionate lender from the field and opening it to the lawful investment lender from the field and opening it to the lawful investment of capital. *See* Ham, *Small Loan Legislation* (1922) (J. M LA.)

In the United States, where a penalty for usury is fixed both by State and Federal statutes, it is well settled that the penalty fixed by Federal legislation is superior to and exclusive of any State penalty.

UTAH, long called "Deseret," which in the *Book of Mormon* language means "a honey bee," is one of the Rocky mountain states in the western part of the United States. It is situated between approximately 37° and 42° N. and 109° 3′ and 114° 3′ W. Its area is 84,916 sq mi , of which 2,570 sq mi. are water surface. The area is equal to that of England and Scotland combined Utah was the main habitat of the Ute tribe of Indians.

Physical Features.—A line drawn with a slight westward concavity from the middle of the northern boundary to the southwestern corner would divide Utah into its two main physiographic regions, the Great Basin to the west and the plateau region to the east. For a long distance this line would follow the high crest of the Wasatch mountains, a magnificent range running north and south, forming the great backbone of the state, and dividing the drainage of the Colorado river system from that of the Great Basin. Centuries ago the Great Basin region was covered by a vast expanse of water, about 19,000 sq.mi. in area, known to geologists as Lake Bonneville. Shoreline at 17 distinct levels can still be traced on the mountain side. Great Salt lake is a shrunken remnant of this inland sea, and the rest of the basin is its one-time bed. The land of the basin floor, parched and barren in its uncultivated state, unless alkaline, is very fertile, and produces abundantly when irrigated. Along the eastern fringe of the basin, where the land can be watered by the streams flowing down from the Wasatch range, are to be found the most populous districts of Utah. The monotony of the level basin floor is broken here and there by steep isolated north and south mountain ranges of monoclinal structure which rise abruptly several thousand feet above the plain. There is no drainage outlet, so the streams merely flow into the low places where, during the dry season, the water evaporates, leaving barren "mud flats" on the basin floor. In the larger depressions the water does not entirely evaporate but remains, forming saline lakes whose areas increase and decrease with the season The largest of these is Great Salt lake, having an area at its greatest extent of 2,000 sq.mi. One-third of this area is lost annually by evaporation. Its waters at mid-20th century contained an average salt density of approximately 25%, or about five times that of the ocean. The lake is fed by Bear river from the north, Weber river from the northeast and Jordan river from the southeast. The Jordan carries the overflow from Utah lake, a fresh water body 127 sq.mi. in area. Southwest of Great Salt lake is a broad flat stretch, more and and barren than the rest of the basin, known as the Great Salt Lake desert. It is low, and in the spring covered partly by water. The Great Basin as a whole rises gradually and imperceptibly from an elevation of 4,300 ft. at the shores of Great Salt lake to an altitude of about 6,000 ft in the south of the state.

East of the Wasatch range is the so-called plateau region, much higher on the average than the Great Basin but deeply cut by valleys and canyons, which carry its drainage to the Colorado river. On the north this area is bounded by the Uinta mountains, the highest range in Utah and the only important range in the United States to run directly east and west. It extends at right angles to the Wasatch range and almost meets it on the west. King's peak (13,498) is the highest in the state, Mt Emmons (13,428), Gilbert peak (13,422), Mt Lovenia (13,250) and Tokewanna peak are the others rising above the 13,000-ft. mark. Between the peaks local glaciation has carved deep amphitheatrelike valleys, many of them containing alpine lakes, wild and difficult of access. South of the Uintas the plateau summits rise to 9,000, 10,000 and 11,000 ft. They are generally forested, but are too high and difficult of access to be inhabited The people of this region live in the valleys along the streams between the plateaus. Southeast from the Uinta mountains fossilized remains of dinosaurs and many other prehistoric animals have been found. Dinosaur National monument has been created in this area 6 mi. from Jensen on U.S. highway 40. Dinosaur remains have been found in other areas including Escalante valley and the San Rafael swell South toward the Colorado river the plateaus drop rapidly in a series of brightly coloured sandstone cliffs resembling giant terraced steps, and are named from the colour of the outcropping sandstone The Pink cliffs are the highest and most conspicuous; then come the White cliffs, Vermilion cliffs and Grey cliffs In this southern portion also are several interesting mountain groups which do not properly belong to the plateau system. They have been formed by the intrusion of molten igneous rock between the layers of sediments, causing the overlying layers to arch up into dome mountains. Such groups are the Henry mountains, west of the Colorado, and the La Sal and the Abajo mountains, east of the Colorado Southeast of the Colorado, and especially in the region drained by the San Juan river, there are few areas capable of cultivation; the soil is sandy and the population scanty Much of the area is relatively inaccessible even by pack horse, for trails and watering places are few. Yet there some of the most picturesque scenery of Utah is to be found. The richly coloured sandstone has been moulded by erosion into such figures as the Navajo Twins, Organ rock, Needle rock, Train cliff and Ostrich rock In Natural Bridges National Monument slender spires and mighty bluffs lift steep red stone sides perpendicularly to great heights The region abounds in natural bridges, including the Rainbow bridge, 309 ft. high and 274 ft between its abutments. Dainty Kachina, with a width of 186 ft. and height of 205 ft., and the Sipapu, 222 ft. high and 261 ft long, are wedged in the White canyon Innumerable prehistoric ruins and cliff dwellings are found in this region also.

The region has been only partly explored archaeologically, and new ruins are constantly being reported. Some caves have been found to contain remains of the Basket Makers, predecessors of the cliff dwellers. Many caves are covered with Indian pictographs and large paintings of animals. The whole region of southeastern Utah, a vast and weird land, was one of the last parts of the United States to be explored. It was not until 1904 that the outside world heard of its natural bridges, largest in the world.

Besides the great canyons of the Colorado, the Green and Grand rivers, there are many of similar grandeur in the tributary streams The San Juan canyon is sometimes called the "Little Grand Canyon of the Colorado." On the Rio Virgin in southwestern Utah is Little Zion canyon, set aside as Zion National park. It was named by the Mormons who discovered and settled it. In Bryce canyon there are acres of fantastic tower and turret formations formed by erosion only, the softer red rocks being capped by a harder stratum which resists weathering

In Utah climatic conditions vary by altitude as well as by latitude. Moderate summer temperatures are found in the mountains and on the plateaus. Precipitation also varies with the altitude, from 42 in. at Silver lake in Brighton to 5 or 10 in in the lowlands, and to 4.9 in. at Salduro in the deserts. The higher plateaus and mountain ranges bear forests of fir, spruce and pine, and the lower slopes are dotted with pinon, juniper and scrub cedar. Willows and cottonwoods grow along the streams Sagebrush is characteristic of the desert areas, and on the hillsides bunch grass affords valuable pasturage Bird life is prolific Besides the usual varieties found in the Rocky mountains, white pelicans established a rookery on Hat Island, so named from being shaped like a cowboy's hat, now known as Bird Island, where there are vast numbers of pelicans, blue herons and sea gulls. Many geese (snow, Canada, black brant and others) thrive about the lake. Bird sanctuaries have been provided by law, chief among which is the Bear River Bird refuge at the mouth of Bear river where it enters Great Salt lake.

History.—Utah was acquired by the United States from Mexico in 1848 by the Treaty of Guadalupe Hidalgo, which terminated the Mexican War. Before Mexico had become an independent nation, however, Utah was a part of Spanish possessions and the Spaniards were its first explorers. The first extensive exploration occurred in 1776, when Father Silvestre Vélez de Escalante and Father Francisco Dominguez set out to find an overland route from Santa Fe to Monterey, on the California coast. Crossing southwestern Colorado, they entered Utah in the east about where the Grand river enters the state, continued west across the Green river, followed an Indian trail over the Wasatch range, and descended the Spanish Fork to Utah lake, where they camped and preached to a large gathering of Indians From them the fathers heard of a great salt lake to the north, but they did not visit it. Instead they headed southwest, crossing the divide to the Sevier river and then across the Sevier desert. There their guide deserted them, so they decided to return to Santa Fe The fathers did not fully accomplish their purpose, but the first part of their route later became part of the Old Spanish trail from Santa Fe to Monterey. Three separate parties of U.S trappers under William Wolfskill and Ewing Young journeyed over the entire route in 1830 It was also the road taken by John Frémont on his return eastward in 1843–44.

The first Americans to penetrate Utah or the Great Basin region, apparently, were the four men, Miller, Hoback, Robinson and Rezner, detached in 1811–12 from the overland expedition of John Jacob Astor to trap in eastern Idaho. Their vague account seems to indicate that they crossed northeastern Utah. There has been much discussion as to who discovered Great Salt lake On a map of North America engraved for Gutherie's *New System of Geography* (1811) a considerable lake with no outlet is represented in the same position approximately as Great Salt lake, and it bears this legend "Lake, etc., laid down according to Lawrence, who is said to have travelled through to California in 1790–91." As nothing further is known of Lawrence, credit is usually given to James Bridger, who came into the country with a trapping expedition sent out in 1824 by William Ashley of St. Louis. The expedition was divided into detachments, Bridger accompanying that which wintered on Bear river, while Étienne Provost led another which may have wintered on Great Salt lake. If so, Provost was the discoverer of the lake, for Bridger did not make his discovery until the spring of 1825, when, to settle a wager as to the outlet of Bear river, he went down its course to the lake Finding it salt he believed it was an arm of the ocean. In 1826, the next year, Jedediah S. Smith started from Great Salt lake to explore the unknown southwest to the Pacific. On his return he struggled 20 days across the deserts of Nevada and Utah to reach Great Salt lake, which he did without loss of a man. It was the first expedition to cross the western country by the central route or to penetrate any distance into the basin west of Great Salt lake, so opening up a vast territory.

On July 23, 1847, the first Mormon company entered Salt Lake valley. Next day their leader, Brigham Young, proclaimed: "This is the place." From Feb. 1846, when they were forced to leave Nauvoo, Ill., they had been on the move. About 15,000 Mormons crossed Iowa that summer, and wintered along the Missouri in camps they built. In April, Brigham Young's advance party of 143 men, 3 women and 2 children left Iowa with 73 wagons loaded with seeds and implements. In July Parley P. Pratt's party of 1,550 started with 580 wagons. This party, typical of later ones, was divided into companies of 100 wagons, and these again

into companies of 10, each with its captain Horses, cattle, sheep, hogs and chickens were taken along About 2,000 Mormons were in Salt Lake valley at the end of autumn in 1847 In 1848 other parties were on their way, and about 1,000 wagons arrived that year But this did not end the expeditions Missionaries were working throughout the east and in Europe, especially in England and the Scandinavian countries, preaching of the new Zion Party after party crossed the plains by ox teams in the years following, until the Union Pacific railway was built in 1869 Many of the immigrants came from far lands. A fund was provided by the church to aid the poor, and the money was returned as soon as the immigrant could afford to pay In 1856 there was such an increased number of poor refugees from Europe that a cheaper way to transport them to Utah was needed So handcarts were provided them at Iowa City, the terminus of the railroad, and three expeditions set off during the summer The first reached Utah safely, but the last two were caught by winter storms on the plains, and before they could be rescued 66 of the first party and nearly 250 of the second died from lack of food and the cold

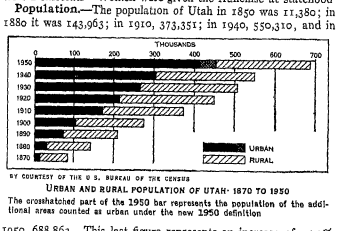
The winter of 1848–49 severely taxed the resources of the pioneer community at Salt Lake, but after the emigration of gold-seekers to California began in 1849 matters brightened A large percentage of the teams came by way of Salt Lake City and found the settlement a welcome stop on their journey. The Mormons traded with them, receiving high prices for fresh horses and food supplies In Feb 1849, after the southwest was transferred to the United States, a convention was called to organize a state under the name of Deseret The petition for statehood was sent in at once and a provisional state government set up to function meanwhile In the first election Brigham Young, already the president of the church, was elected governor. Instead of gaining statehood at this time, Deseret was only made a territory and its name was changed to Utah. Young's election was confirmed by appointment from the president. In contrast with other western states, order and harmony prevailed in Utah before the government was established because the church superintended matters and acted as a government. Its officials distributed provisions, apportioned lots and farm plots, and ordered what work was to be done and the methods to be followed. Even after the territorial government was under way, the church continued to direct affairs and so often came into conflict with the appointive officers sent out by the federal government, and with non-Mormons. (*See* MORMONS.)

The very same afternoon that the advance body of Mormons reached the valley of the Great Salt lake, three plows were put into the soil, potatoes were planted and the waters of City creek turned over the plot. Thus began the agricultural life upon which their communities were founded, and thus also began the irrigation that was to make agriculture possible. The Mormons were the first to practise irrigation on a large scale in the United States. The farm area grew quickly along the western slopes of the Wasatch range, but the church did not rely on that only. Explorers were sent in all directions to select the most fertile valleys with plenty of convenient water available. Colonists were then selected, 30 or 40 families from those that were constantly coming, to go and settle each valley. In 1848 the Ogden valley was settled, in 1849 the Sanpete valley and Utah valley, and in 1851 the valley of the Little Salt lake. In time there were few valleys in Utah that Mormon colonies had not settled, spreading out like bee swarms from the mother hive at Salt Lake City. They settled by church congregations, as in early New England, and all the temporal, social and spiritual activities of the people were under direction of their ecclesiastical leaders Most of the manufactured articles needed were made in the home, though small grist and saw mills and tanneries were quickly set up. In 1850 the U.S. census gave the value of manufactures in Utah as $291,220. Merchants were establishing stores and bringing their stock over the plains from the east by long freight trains, one of them in 1853 numbering more than 400 wagons. Coal was early sought, and the mines developed. In 1849 iron was discovered, plans for an iron foundry laid, and the call sent to Europe for "blowers, moulders and all kinds of furnace operators." In 1852 the first pig iron was made. Erastus Snow went to England to study the great iron factories of that country and in 1853 became president of the newly incorporated Deseret Iron company The mining of precious metals, however, was discouraged by Young, partly because he felt prosperous farms made better homes than the feverish, impermanent mining camps; and partly because he knew gold discoveries would draw hordes of "Gentiles," out of harmony with his ideals and plans, to his colony. In 1863 when Col Patrick E Conner brought his company into Utah, he allowed his men, many of whom were old California miners, to prospect, and he also actively aided them He himself staked the first claim in the state. Thus even during Young's lifetime many mines were opened The early ore was sent to Wales for smelting, but in 1870 the Woodhull brothers of the Little Cottonwood mine completed the first smelter. In 1871 the Walker brothers built the Pioneer Crushing and Amalgamating mill with 15 stamps to work the silver ore of the Ophir mine, which they had located the previous year The coming of the Union Pacific railway in 1869 greatly stimulated mining It also brought an influx of non-Mormons who were to increase steadily as the years went by The Utah Central and the Utah Southern railways built extension lines to the Bingham, Little Cottonwood and American Fork mining districts. Later the Utah Eastern passed up Parley's canyon and helped in the development of the Park City mines.

Six separate efforts, in 1849, 1856, 1862, 1872, 1882 and 1887, to gain statehood were made by Utah Each time a constitutional convention met, a constitution was drawn up and a petition sent to the federal government They were refused statehood because of their polygamous practices The U S government had enacted legislation in 1862, 1882 and 1887 forbidding polygamy Resistance was made by the Mormons which resulted in fines, imprisonment and, in the case of Pres John Taylor, exile. Church property amounting to $100,000 was temporarily confiscated. Finally in 1890 the church yielded and refused henceforth to sanction plural marriage The final movement for statehood came from the U.S congress in 1893, when it passed the enabling act, one of the provisions of which was that the constitution of the new state should forever prohibit polygamous marriages. The constitution was framed at a convention in 1895, submitted to the voters at the general election in November and approved The proclamation of admission was signed by the president on Jan. 4, 1896.

Politically Utah remained essentially independent. Five Republicans and four Democrats had served as governor by 1950 In national elections the state by 1950 had voted Republican seven times and Democratic seven times. In 1951 the two senators and the governor were Republicans. The congressman and congresswoman, Utah's first woman elected to congress, Judge Reva Beck Bosone, and all elected state officials except the governor were Democrats Women were given the franchise at statehood

Population.—The population of Utah in 1850 was 11,380; in 1880 it was 143,963; in 1910, 373,351; in 1940, 550,310, and in



BY COURTESY OF THE U. S. BUREAU OF THE CENSUS

URBAN AND RURAL POPULATION OF UTAH: 1870 TO 1950

The crosshatched part of the 1950 bar represents the population of the additional areas counted as urban under the new 1950 definition

1950, 688,862. This last figure represents an increase of 25.2% over the population in 1940. The population per square mile in 1950 was 8.4, as compared with 6.7 in 1940 and with 50.7 for the U.S. in 1950

Of the 1950 population, 472,518 or 59.9% lived in incorporated

places of 2,500 or more, as compared with 55.5% in 1940, when these places constituted the urban area. The entire urban population, under a new definition set up for 1950, which included also the thickly settled suburban area, or "urban fringe," adjacent to Salt Lake City, and three unincorporated places of 2,500 or more outside this fringe, amounted to 449,855, or 65.3% of the state total.

Area	Population			Per cent of increase	
	1950	1940	1930	1940–50	1930–40
The state	688,862	550,310	507,847	25.2	8.4
Urban	449,855*	305,401	266,204	47.3	14.7
Rural	239,007*	244,817	241,583	−2.4	1.3
Per cent urban	65.3*	55.5	52.4	.	.
Principal cities					
Salt Lake City	182,121	149,934	140,267	21.5	6.9
Ogden	57,112	43,688	40,272	30.7	8.5

*Final figures for 1950 based on new definition *See* comment in text

The number of households in 1950 was 188,085, as compared with 139,487 in 1940. The average population per household had declined from 3.9 to 3.6 in 1950.

Government.—The constitution of Utah was formed by a convention at Salt Lake City, March 4–8, 1895, submitted to the people on Nov. 5 and ratified by a vote of 31,305 to 7,687. It came into effect Jan 4, 1896, the day Utah was admitted to the union. It provides that no law can be passed restricting the freedom of the press or the establishment of religious sects. There is no imprisonment for debts unless the debtor absconds Males and females enjoy equal privileges in civil, political and religious rights One provision, which guarantees religious freedom, forbids sectarian control of public schools, prohibits polygamy and defines the relation of the state to the public lands of the United States, is irrevocable unless with the consent of the U.S government. All citizens of the United States who have lived in Utah a year, in the county four months and in the precinct 60 days have the right of suffrage Only those who have paid a property tax the year before may vote in elections levying a special tax creating indebtedness or increasing the state rate of taxation.

The powers of government are divided into three distinct departments, the legislative, executive and judicial. The legislative power is vested in (1) a senate and a house of representatives, and (2) the legal voters, who are given the power of initiating desirable legislation and of referendum on all laws not passed by a two-thirds vote of both houses No person is eligible for office in the legislature who is not a citizen of the United States, 25 years of age or more, a qualified voter in the district from which he is chosen, and a resident of Utah for three years and of his district for one year. Regular sessions of the legislature are held in odd-numbered years, opening on the second Monday in January. They cannot last more than 60 days except to try cases of impeachment. Representatives are elected for two years; senators for a four-year term, one-half the number retiring every two years. The number of senators must not exceed 30 and the representative body must be at least twice as large as the senate. In 1950 there were 23 senators and 60 representatives.

The executive officials are the governor, secretary of state, state auditor, state treasurer, attorney general and superintendent of public instruction. The auditor and treasurer are ineligible to election as their own successors. The governor and secretary of state must be at least 30 years of age, the attorney general at least 25 and in good standing at the bar. The governor has the right of veto unless overruled by the bill being repassed with a two-thirds majority in both houses. The governor, justice of the supreme court and attorney general compose the board of pardons. The board of examiners consists of the governor, secretary of state and the attorney general

The judicial power is vested in the senate sitting as a court of impeachment, a state supreme court, district courts, city courts, justices of the peace and other courts inferior to the supreme court as established by law.

Finance.—Major sources of the $79,926,327.38 in revenue receipts to Utah in the fiscal year ended June 30, 1950, were (1) emergency revenue tax, known more familiarly as the 2% sales tax, supplying $14,013,055.21 or 17.53% of total receipts; (2) federal grants, $12,031,184.42 or 15.05%; (3) motor use and fuel taxes and motor-vehicle registration and control fees, $10,118,495.10 or 12.66%; (4) property tax, yielding $6,729,599.05 or 8.42%; and (5) individual income tax, $4,105,477.44 comprising 5.1% of total receipts

Two other sources of revenue should be mentioned· (1) the state-managed liquor-control agencies, which supplied $12,540,917.79 or 15.69% of total state revenue; and (2) educational licences and fees, which amounted to $3,763,356.95 or 4.7% of total revenue. It should be noted, however, that these two sources of revenue did not represent net receipts Total liquor-control expenditures (including $1,000,000 allocated to cities, towns and counties) amounted to $9,786,537.98, leaving a net profit to the state of $2,754,379.81. The sum of $6,411,593.62, an amount $2,648,236.67 greater than the total collected by the state in the form of educational fees, was disbursed for universities and colleges A total of $14,827,478.97 was allocated to the school districts in accordance with a school law, passed by the 1947 legislature, which provided for a minimum expenditure of $3,300 per classroom unit throughout the state; this procedure being adopted to further equalization of educational opportunity. The property-tax levy for state school purposes in the calendar year 1948 was 8.9 mills. The mean local rate was 35.13 mills. Total assessed valuation of the state in 1949 was $823,749,300. Federal appropriations received by the state during the 1950 fiscal year were broken down as follows: (1) roads $3,893,688.74, (2) public health and welfare $6,105,398.61, (3) education $1,399,795.99 and (4) miscellaneous grants $632,301.08

Utah is one of the principal mineral-producing states of the country, and its mine occupation tax yielded $865,579.01 or 1.08% of total receipts. Proceeds from cigarette, corporation, franchise, beer and other taxes; fines and forfeitures and miscellaneous revenue receipts, including contributions from local governments ($134,859.81 or .17% of total receipts); teachers' contributions to the retirement fund, and all other items aggregated $15,758,651.51, which brought total receipts of the state during the fiscal year to $79,926,327.38.

The total disbursements were $76,366,125.10. Largest item was the total of $25,183,201.95 or 32.97% spent for schools and educational agencies. This included the amount allocated to school districts and disbursements to universities and colleges mentioned above. Next largest item was the $15,157,289 or 19.84% spent for public health and welfare. A total of $13,652,647.76 or 17.87% was spent on roads and aeronautics, aeronautics claiming $193,889.99 or .25%. Building commission projects disbursements totalled $2,572,233.76 or 3.36%, and $945,711.32 or 1.23% went for fish and game control administration. Liquor-control purchases, administration and allocations to cities, towns and counties comprised $9,786,537.98 or 12.81% of the state's expenditures. The remainder of the $9,068,503.33 (11.87% of all disbursements) went to maintain the courts and the penal, military and police needs of the state, to pay the salaries and expenses of the state officials and the legislature; and for other miscellaneous expenses incidental to government.

The outstanding bonded indebtedness in 1936 was $10,573,000, but in 1943 Utah became one of the few states out of debt. The 1943 legislature set aside $2,014,146.72 to retire the remaining bonded indebtedness of the state. Since the dates of maturity of the state bond issues were extended over a period of time from March 1939 to March 1955, it was not possible to redeem all outstanding issues immediately, but money was provided to redeem all bonds at the maturity dates In Nov. 1950 there remained $770,000 in bonds outstanding. To cover this amount the state had invested $1,150,000 in bonds. There was also $26,751.33 in cash on hand.

In 1950 there were 44 state and 11 national banks with total assets of $608,613,517.85. This amount compared with total assets of $198,862,061.75 in 1940. Total time deposits in 1950

amounted to $177,644,227.70, as contrasted with $64,348,859 in 1940. Demand deposits in 1950 totalled $387,180,462.43.

Education.—School attendance for at least 30 weeks annually is compulsory for all children from 8 to 18 years of age, unless they are lawfully excused. As a result, 150,586 pupils, or 91% of a school census population of 151,465, were enrolled in 1948–49; 88,100 of these were elementary pupils and 62,486 high school There were 2,521 elementary school teachers, 990 junior high school teachers and 1,150 high school teachers. Figures for 1947–48 showed that 5.5% of Utah's schools were one-room schools. Only one other state, New Jersey, with 4 9%, had a lower percentage There were 305 elementary schools, 28 junior high schools, 29 senior high schools, 58 combination elementary through senior high schools and 34 combination junior and senior high schools in the public system in 1948–49. In addition to Brigham Young university there were four private professional schools, two private colleges and six other private schools teaching from the elementary to the high-school level. There were four junior colleges and two area vocational schools, one at Salt Lake City and one at Provo, supported by the state. The expenditure for education in Utah increased from $92.46 per capita of school population in 1939–40 to $254 13 in 1948–49.

The income for elementary and secondary education in 1948–49 was $38,527,128 79 of which $14,359,802.64 was provided from the state funds and $23,061,693.41 from local sources. The expenditure for 1948–49 totalled $38,491,957.61 (including capital outlay and interest). Expenses for instruction were $17,268,584.21 and for operation and maintenance of school plant $3,344,931. The average salary for teachers, supervisors and principals was $3,054. Private and parochial schools, in addition to Mormon seminaries, in 1950 employed 215 part-time and full-time teachers for an approximate total enrolment of 4,966 students. This figure compared to an enrolment of 1,465 in 1939–40. The Mormon Church in 1950 maintained 77 religious seminaries near junior and senior high schools, with an enrolment of 19,547 as compared with an enrolment of 15,361 in 1939–40.

The University of Utah, at Salt Lake City, was organized in 1850 as the University of Deseret and placed under the control of a chancellor and board of 12 regents appointed by the governor. It closed in 1851 for lack of funds and did not reopen until 1867, though during all this period the board was regularly appointed and functioned in supervising the public schools. In 1869 the university was reorganized to include classical and normal schools, and in 1892 was given its present name. The registration in 1949–50 was 9,703 for the regular session with an additional 7,172 registered for summer school, evening residence classes and extension work. The Utah State Agricultural college at Logan had an enrolment in 1949–50 of 4,992 with an additional 1,281 enrolled in summer school and 1,195 in extension classes. The Church of Jesus Christ of Latter Day Saints (Mormon) maintains the Brigham Young university at Provo which had a regular enrolment in 1949–50 of 5,904 plus 1,525 enrolled in summer school and 1,380 students taking extefision classes. The Mormon Church at this time also maintained seven religious institutes with a total enrolment of 3,819 near the Uiversity of Utah and colleges and junior colleges. Other private schools are St. Joseph school at Ogden, College of St. Mary-of-the-Wasatch, Rowland Hall, Judge Memorial and Westminster college at Salt Lake City; Notre Dame de Lourdes at Price; and Wasatch academy at Mt. Pleasant. The four main private professional schools in the state in 1950 were the McCune School of Music and Art, the Latter Day Saint Business college, Henagers Business school and the Ogden Business college.

Charitable and Penal Institutions.—Final stages of the movement of the state prison from its old Sugarhouse location in Salt Lake City to the new, modern plant at the "point of the mountain" in Salt Lake county were completed in 1950. The number of prisoners for November of that year was listed as 561, including 3 women prisoners incarcerated at Canyon City, Colo. Prison labour cannot be let out on contract, but "honour prisoners" are allowed to work on roads and irrigation projects, on additions and repairs to prison buildings and on the prison farm surrounding the prison itself. The state industrial school at Ogden, established for delinquent boys and girls, endeavours to help them by teaching for delinquent boys and girls, endeavours to help them by teaching manual training, home economics, printing and mechanical repair work. A school for the deaf and blind, also at Ogden, teaches caning of chairs, broommaking and printing and linotyping. The Utah Trainng school at American Fork was built for mentally incapacitated children Utah permits sterilization of the mentally deficient; this is done before the children are released from the training school. The state mental hospital at Provo cares for the insane.

The state also maintains the Utah state tuberculosis sanatorium at Ogden.

Agriculture and Livestock.—In 1945 Utah farm lands made up 19 6% of the total land area of the state. Agriculture is, where possible, dependent almost entirely upon irrigation. Soil that can be watered is generally very rich In early days under the Mormon system, farm plots were only 5, 10 or 20 ac. Gradually the average size of farms grew until in 1900 it was 212 4 ac ; it dropped to 203 ac. in 1935, then increased to 392 ac in 1945 The total acreage in farms in 1945 was 10,309,107, compared with a figure of 6,239,318 in 1935. Total cropland in 1945 was 1,663,702 ac., approximately 3% of the state's total area. Roughly 1% of Utah's cropland is devoted to dry farming and 2% is irrigated. Total cash receipts from farm marketings in 1949 were $150,569,000 Receipts from livestock and livestock products, $103,114,000, amounted to more than two-thirds of the total. Market receipts from crops amounted to $47,455,000. Between 1935 and 1945 the acreage of farm land increased 4,069,789, but farm population fell from 138,242 to 99,989. The value of farm lands and buildings increased from $158,303,329 in 1935 to $261,817,649 in 1945.

The land area irrigated increased from 999,410 ac. in 1910 to 1,165,100 ac. in 1948. In the Strawberry project, water is brought from the east side of the Wasatch mountains through a four-mile tunnel and used in the Utah valley 45 mi. away. Plans were developed to increase the irrigated land acreage to a total of 1,772,500 ac. Projects proposed with land acreages to be benefited are. (1) Bear river, 235,000 ac., (2) Weber basin, 99,000 ac.; (3) central Utah, 409,200 ac.; (4) Virgin river, 21,200 ac.; (5) miscellaneous areas, 249,900 ac.

The most important crop is hay. In 1949, 562,000 ac. produced 1,219,000 tons of hay (2.17 tons per acre), valued at $25,599,000. This includes both cultivated and uncultivated hay. Of wheat, the production of which had almost doubled since 1940, 428,000 ac. yielded 9,440,000 bu. (22.1 bu. per acre) valued at $16,520,000. Potatoes in 1949 yielded 3,003,000 bu. on 15,400 ac (195 bu per acre). Their value was estimated at $4,354,000. The 1949 crop of alfalfa seed, another important product, was valued at $4,557,000. Sugar beets had declined in importance, in 1949, 462,000 tons, as contrasted with 683,000 tons in 1939, were produced The yield per acre was 16.5 tons, as compared with 12.9 in 1939. The production of oats in 1949 on 45,000 ac. was 2,115,000 bu. (47 bu. per acre) valued at $1,692,000. In 1949, barley production amounted to 6,063,000 bu. on 129,000 ac. with a value of $6,063,000. In the same year field corn to the extent of 900,000 bu. on 25,000 ac. was valued at $1,395,000. Sweet corn for canning, 25,200 tons, was valued at $567,000.

Livestock on farms and ranges in Jan. 1950 was estimated at 1,333,000 sheep, 560,000 cattle, 88,000 swine, 58,000 horses and mules and 3,536,000 chickens and turkeys. The farm value of livestock in Jan. 1950 was estimated at $108,686,000. Livestock and livestock products sold during 1949 brought market receipts of $103,114,000. Butter production amounted to 5,485,000 lb. in 1948 as compared with 10,436,000 lb. in 1939. Milk production for 1949 was 669,000,000 lb. The wool (shorn) production for 1950 was 11,104,000 lb. Utah stood fifth in the nation in 1950 in sheep and wool production.

Mining.—In 1949 Utah ranked high among the states in output of the five major metals, having a total production valued at $121,649,828. In that year approximately 22,000 persons were employed in smelting and mining in Utah In value copper is the leading mineral, the 1940 production being worth $51,962,598;

in 1949 this figure had grown to $77,714,530. The lead production in 1949 was valued at $16,770,752, silver at $6,086,356, gold at $10,992,030 and zinc at $10,086,160. Utah is very rich in copper, silver, gold and zinc, but because of the fact that the ores are always found in combination, it was long impossible to recover a sufficiently high percentage of each to realize much profit on the state's resources. The invention of new selective flotation processes between 1915 and 1925 worked a mining revolution in Utah and sent its production skyward. The output of copper for 1949 was 197,245 short tons, second highest in the nation. Utah also ranked second in the production of molybdenum and silver. Output of silver for 1949 was 6,724,880 fine ounces. Only two states outranked Utah in the production of gold and lead in 1949, the state producing 314,058 fine ounces of gold and 53,072 short tons of lead in that year. Zinc production at 40,670 short tons was seventh largest in the union in 1949.

The most important nonmetallic mineral in Utah is coal, 3,524,000 tons being produced in 1940 and 6,716,000 tons in 1948. By 1950 in terms of production and employment, Utah led every state west of the Mississippi in coal mining. Nine-tenths of the coal produced in the state comes from Carbon and Emery counties. Salt, another valuable product, is obtained by means of solar evaporation of the salt brine deposits in the Great Salt Lake regions; 113,779 tons were produced in 1948. During World War I, when potash was in demand, potassium chloride was mined on the salt flats near the Nevada border. In 1948 about 60,000 tons of potassium chloride were produced in Utah and in 1950 Utah accounted for about 6% of the national production of potash. With the construction of the Geneva Steel plant near Orem, iron mining became an important activity, Utah in 1948 producing 3,233,413 tons. Native asphalt to the amount of 99,192 tons, valued at $1,987,049, was produced in 1947. By 1948 there were two plants producing gypsum products in the state. Mining and stock-piling of uranium was greatly expanded after World War II. The two principal centres were Marysvale in Piute county and Monticello in San Juan county. Vanadium is also processed in the Monticello area.

Forests and Lumbering.—Heavy spring floods have caused vast damage, especially where cutting has left the slopes exposed to erosion. The interests of irrigation also demand that the water be retained on these slopes as long as possible in the spring. Thus, though not so valuable commercially, Utah's forests are highly important as soil conservers.

Seven national forests covered 7,870,185 ac. in 1950 and contained 93% of the timber of the state. Their merchantable timber stand was estimated at 3,662,000,000 bd ft. The total merchantable timber stand was estimated at 4,170,000,000 bd ft. Injudicious cutting between 1880 and 1900 almost bared the western slopes of the Wasatch range near Great Salt lake. The cut in 1889 amounted to 14,000,000 bd.ft. and in 1899 to 18,000,000 bd.ft. Under regulation the output in the year 1949–50 was 33,324,000 bd ft., with a value of $1,766,000. Income of all sources from national forests almost covered costs of protection and management.

Manufacturing.—During and after World War II a great industrial expansion took place in Utah. In 1939 there were 560 manufacturing plants in the state which employed 13,843 persons. In 1947 there were 772 manufacturing establishments with 24,816 employees; these were paid $63,804,000 during that year. The value added by manufacturing was $128,298,000, compared with a corresponding figure of $43,341,000 in 1939. Next to food processing, in which the value added by manufacture amounted to $42,948,000, the most important industry was the primary metal industry with a value of $34,099,000 added by manufacture (1947). Paramount in the metal industry of Utah is the production of steel. The largest industrial establishment in the state is the integrated steel plant at Geneva, built and operated by the Geneva Steel company, a United States Steel corporation subsidiary, for the Defense Plant corporation. By 1950 it was capable of operating at an annual steel production rate of 1,800,000 tons. Production in 1949 was 918,700 tons of pig iron and 1,001,200 tons of steel ingots and castings. Other industries in 1947, with amounts of value added by manufacture, are as follows: petroleum and coal products, $12,222,000, printing and publishing, $9,390,000; chemicals and allied products, $5,112,000; stone, clay, and glass products, $5,627,000; fabricated metal products, $4,212,000, apparel and related products, $3,433,000; and machinery, except electrical, $3,215,000.

In 1947, 373 or 42.6% of the 772 manufacturing plants of the state were located in Salt Lake county. This compared with 84 for Weber county, 77 for Utah county and 34 for Cache county. Figures showing the number of plants employing 100 or more employees for these counties were as follows: Salt Lake, 23; Weber, 12; Utah, 7; and Cache, 2.

Transportation.—The Old Spanish trail, the Great Salt Lake trail and the Overland trail all aided in the early development of the state. The Union Pacific was the first railway and continued to be the dominating one, sending its branches into nearly every important mining or commercial centre. Other railways are the Denver and Rio Grande Western, Western Pacific, the Southern Pacific and the Los Angeles and Salt Lake, operated by the Union Pacific. At the beginning of 1950 steam railroads within the state operated over 1,973 mi. of track, while electric railroads used 160 mi. In 1950 5,454 mi. of road within the state belonged to the state highway system. Of this, 4,553 mi. were surfaced, either paved or gravelled. The mileage of local and county roads in 1950 was 22,995, of which 8,521 mi. were surfaced (37%). State road expenditures totalled $11,423,075.69 in the fiscal year 1950.

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(G. E. F.; E. D. Th.)

UTAMARO (1754–1806), one of the best known of the Japanese designers of colour prints, was born at Kawayoye. As a painter, his landscapes and drawings of insects are most highly considered by Japanese critics; but his fame will always rest among Europeans on his designs for colour prints, the subjects of which are almost entirely women—professional beauties and the like. The colour prints of Utamaro are distinguished by an extreme grace of line and of colour. His composition is superb; and even in his lifetime he achieved such popularity among his contemporaries as to gain the title Ukiyo-ye Chūkō-no-so, "great master of the Popular School." His work had a considerable reputation with the Dutch who visited Nagasaki, and it was imported into Europe before the end of the 18th century.

See E. de Goncourt, *Outamaro (1891)*; E. F. Strange, *Japanese Illustration* (1897); and Japanese Colour-Prints, Victoria and Albert Museum *Handbook* (1904).
(E. F. S.)

UTE, a Shoshonean tribe of western Colorado and eastern Utah which gave its name to the latter state, and, with the Aztecs, to the great Uto-Aztecan family of Indians. The name was pronounced *Yoo-tah*, as preserved in the name of the state. Of the Utes, 1,900 remain.

UTICA, a city of ancient Africa, 15½ mi. N.W. of Carthage. The site of the town is covered with low-lying marsh lands. It was important as a commercial centre, and is mentioned in the commercial treaty of 348 B.C. between Rome and Carthage. Agathocles easily captured it in his expedition to Africa in 310. After the destruction of Carthage it received the rank of a *civitas libera* with an accession territory. After the battle of Thapsus in 46 Cato shut himself up in Utica for the final struggle against Caesar, and there committed suicide. Utica was the seat of a bishop from the 3rd century onward. It was captured by Gaiseric and the Vandals in 439, reconquered by the Byzantines in 534, and finally, in 698, it fell into the hands of the Arabs and was depopu-

lated Very little is left above the level of the ground In 1869 excavations revealed the fortifications, the acropolis, the quays of the commercial harbour and of the military harbour or Cothon; also the ruins of the amphitheatre, which was capable of holding 20,000 spectators, of the theatre, the baths, the reservoirs and the aqueduct which brought drinking water to the city.

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UTICA, a city of central New York, U S A., the county seat of Oneida county; on the Mohawk river and the State Barge canal, 85 mi. from Albany, with a municipal airport. Pop. (1950) 101,531 The city covers 16.45 sq mi , with a mean elevation of 550 ft It is the seat of a state hospital for the mentally ill (1836) and the state Masonic home (1893) The total taxable assessed valuation of Utica for 1950 was about $153,000,000. The water supply (municipally owned) comes from the Adirondacks. Hydroelectric power is developed at Trenton Falls (15 mi N.). Utica's industrial plants number about 250; their annual payroll exceeded $50,000,000 a year, and their finished products were valued at more than $150,000,000 annually at mid-20th century. The city maintains first rank in New York state in the manufacture of cotton cloth and knit goods, and stands in the forefront in the manufacture of heating and ventilating apparatus Also produced are warm air furnaces, yarn, sheets and pillow cases, beds, springs, mattresses, cutlery, air compressors, sprayers, fishing rods and tackle, paper products, corduroy, plush and velveteen, emblems, men's and boys' clothing, rayon yarn, sportswear, metal stampings, pliers, nippers, pneumatic and electric tools, radios and other diversified lines.

The site of Utica was in the 22,000 ac. manor granted by George II. in 1734 to William Cosby and his associates. During the Seven Years' War a palisaded fort was built there, at the ford of the Mohawk, and named after Col. Peter Schuyler Later, when Ft. Stanwix at Rome was renamed Ft. Schuyler, the Utica fort was known by the name Old Ft. Schuyler. In 1792 Cosby's manor was put up for sale by the sheriff, and was bid in by Gen. Philip Schuyler, Gen. John Bradstreet, John Morin Scott and others, for £1,387 (about 15 cents an acre). After the close of the Revolution settlers began to come in, largely Palatinate Germans from the lower Mohawk. In 1786 the proprietors had the manor surveyed, and in 1788 an inn was built New settlers came, from New England, among whom in 1789 was Peter Smith (1768–1837), later a partner of John Jacob Astor, and father of Gerrit Smith, born there in 1797. In 1792 a bridge was built across the Mohawk. In 1798 the name "Utica" was chosen by lot from slips of paper in a hat. Utica's first charter as a village was obtained from the legislature in 1798, and on March 15, 1798, Oneida county was founded. The city was incorporated on March 1, 1832. By 1860 it had a population of 22,529, which grew to 33,914 in 1880 and 56,383 in 1900.

In the next two decades it increased 32% and 26·5% respectively, and between 1910 and 1925 the area within the corporate limits was more than doubled.

UTILITARIANISM, the form of ethical doctrine which teaches that conduct is morally good according as it promotes the greatest happiness of the greatest number of people (Lat. *utilis*, useful). The term "utilitarian" was noticed by J. S. Mill, in a novel of Galt; but it was first suggested by Bentham.

It is in a clerical work written against Hobbes, Bishop Cumberland's *De Legibus Naturae* (pub. in 1672), that we find the beginnings of utilitarianism.

Another clergyman, John Gay, in a dissertation added to Law's translation of Archbishop King's *Origin of Evil* (pub. in 1731) expanded Cumberland's doctrine. Further advances along the same line of thought were made by Abraham Tucker in his *Light of Nature Pursued* (pub. 1768–74). Gay and Tucker supplied nearly all the important ideas of Paley's *Principles of Moral and Political Philosophy* (pub. in 1785), in which theological utilitarianism is summarized and comes to a close. Hume's *Inquiry concerning the Principles of Morals* (pub. in 1751), though utilitarian is very far from being theological. Hume, taking for granted that benevolence is the supreme virtue, points out that the essence of benevolence is to increase the happiness of others.

Bentham, the founder of political utilitarianism, took up the greatest happiness principle not as an attractive topic of study, but as a criterion to distinguish good laws from bad. Sir John Bowring tells us that when Bentham was casting about for such a criterion "he met with Hume's *Essays* and found in them what he sought." These opinions are developed in his *Principles of Morals and Legislation* (pub. in 1789) and in the *Deontology* (published posthumously in 1834). Philosophically Bentham makes but little advance upon the theological utilitarians. His table of springs of actions shows the same mean-spirited omissions that we notice in his predecessors; he measures the quantity of pleasures by the coarsest and most mechanical tests; and he sets up general pleasure as the criterion of moral goodness. These principles of Bentham were the inspiration of the philosophic radicals of the early 19th century. From Bentham the leadership in utilitarianism passed to James Mill, who made no characteristic addition to its doctrine, and from him to John Stuart Mill whose essay *Utilitarianism* (pub. in 1863) sums up in brief and perfect form the essential principles of his doctrine. The last writer who, though not a political utilitarian, may be regarded as belonging to the school of Mill is Henry Sidgwick, whose elaborate *Methods of Ethics* (1874) may be regarded as closing this line of thought.

Even before the appearance of Sidgwick's book utilitarianism had entered upon its third or evolutional phase, in which principles borrowed from biological science make their entrance into moral philosophy. The main doctrine of evolutional or biological ethics is stated with admirable clearness in the third chapter of Darwin's *Descent of Man* (pub. in 1871). The most famous of the systematic exponents of evolutional utilitarianism is, of course, Herbert Spencer, in whose *Data of Ethics* (1879) the facts of morality are viewed in relation with his vast conception of the total process of cosmic evolution. The best feature of the *Data of Ethics* is its anti-ascetic vindication of pleasure as man's natural guide to what is physiologically healthy and morally good. Leslie Stephen with his brilliance but more attention to scientific method worked out in his *Science of Ethics* (1882) the conception of morality as a function of the social organism.

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UTILITY. In economics the utility of a good is not conceived to be its usefulness, as judged by any objective standard, but its importance to a consumer. Capacity to excite desire rather than to yield benefits or bestow happiness is the measure of a good's utility, in this technical sense, and only as the conduct of life is completely rational and guided by adequate foresight are the two capacities the same.

The law or principle of *diminishing utility*, which serves in economics as a logical foundation for the laws of demand, is merely a general statement respecting an obvious aspect of the way in which men apportion their time and their means. Summarized, it is that progressively diminishing importance is attached by a consumer to successive additional increments of a good. Diminishing utility has two aspects: absolute and relative. One suit of clothes is more important than a second, and a second is more important than a third. It is more important that in a cold climate one should have coal enough to keep one room warm during the winter than that a second, or a third or a fourth room should be heated. It cannot be said, however, that

all luxuries and particularly such as minister to the "desire for distinction," have different uses which can be ranked in an order of diminishing importance.

Marginal utility is the utility of the last increment (not necessarily last in point of time) which the consumer thinks worth acquiring (*See* also ECONOMICS and VALUE) (A. Yo.)

UTMAN KHEL, a Pathan tribe who occupy the hills to the north of Peshawar in the North-West Frontier Province of India. They claim to be descendants of Baba Utman, who accompanied Mahmud of Ghazni in his expedition into India in 997 The Utman Khel are a tall, stout and fair race, but in dress and general customs follow the neighbouring peoples of Bajour.

UTO-AZTECAN FAMILY, perhaps the most numerous and important stock of North American Indians, is named after a representative northern and southern tribe, and it extended in a long irregular tract, broken only in Arizona, from Idaho to Tabasco, Mexico, and beyond as far as Panamá in scattered populational islets The bond of union was linguistic and geographic, not racial or cultural In customs there is little common to the lowly northern tribes and the barbarically advanced ones of southern Mexico. The organization is as follows, tribes separately treated being asterisked — I, Shoshonean sub-family: (*a*) Pueblo branch, *Hopi; (*b*) Plateau branch, comprising 1, *Ute, southern *Paiute, Chemehuevi, Kawaiisu; 2, *Shoshone *Comanche, Gosiute, Panamint; 3, Bannock, northern *Paiute (Paviotso). *Mono; (*c*) Kern river branch, Tubatulabal; (*d*) southern California branch, comprising 1, Serrano, 2, *Gabrielino, 3, Luiseño, Cahuilla, Juaneño, Cupeño II Piman or Sonoran sub-family: *Pima, *Papago, Sobaipuri, *Tarahumare, Opata, Mayo, *Yaqui, Tepecano, Tepehuane; Cora, *Huichol, etc III. Nahua (*see* NAHUATL) sub-family, in which the *Toltec and *Aztec were most conspicuous. (A. L. K.)

UTOPIA, an ideal commonwealth whose inhabitants exist under perfect conditions. Hence *Utopian* is used to denote a visionary reform, which fails to recognize defects in human nature The word first occurs in Sir Thomas More's *Utopa*, published in Latin as *De optimo Reipublicae statu, deque nova insula Utopia* (Louvain, 1516) It was compounded by More (*q.v.*) from the Greek *ou*, not, and *topos*, a place, no-where

The idea of a Utopia is, even in literature, far older than More's romance; it appears in the *Timaeus* of Plato and is fully developed in his *Republic*. The idealized description of Sparta in Plutarch's life of Lycurgus belongs to the same class of literary Utopias. A similar idea occurs in the Greek, and the mediaeval Norse, Celtic and Arab legends which describe an earthly paradise in the western or Atlantic ocean (*see* ATLANTIS). Few of these survived after the explorations of Columbus, Vasco da Gama and others in the 15th century; but in literature More's *Utopia* set a new fashion: the imaginary voyager arrives at the ideal state In Bacon's *New Atlantis* (1624–29) science is the key to universal happiness; Tommaso Campanella's *Civitas Solis* (1623) portrays a communistic society; James Harrington's *Oceana* (1656), which had a profound influence upon political thought in America, is a treatise rather than a romance, and is founded on the ideas that property, especially in land, is the basis of political power, and that the executive should only be controlled for a short period by the same man or men. With these may be compared the Christian Utopias, J V. Andreae's *Christianopolis* and S. Golt's *Nova Solyma* (1648). Bernard de Mandeville's *Fable of the Bees* is unique in that it describes the downfall of an ideal commonwealth. Other Utopias are the "Voyage en Salente" in Fénelon's *Télémaque* (1699), Vairasse's *Histoire des Sevarambes* (1716); Mercier's *L'An 2440* (1742); James Burgh's *Account of the Cessares* (1764); J. B. Say's *Olbie* (1800); Etienne Cabet's *Voyage en Icarie* (1848); Bulwer Lytton's *The Coming Race* (1871); Samuel Butler's *Erewhon* (1872) and *Erewhon Revisited* (1901); Edward Bellamy's *Looking Backward* (1888); William Morris's *News from Nowhere* (1890); H. G. Wells's *Anticipations* (1901), *A Modern Utopia* (1905) and *New Worlds for Old* (1908). Many Utopias, like the *Fable of the Bees* and *Erewhon*, are satires. Others are inspired by socialistic ideals; among these may be mentioned *Freiland, ein soziales Zukunftsbild* (1890) and *Reise nach Freiland* (1893), by the Austrian Theodor Hertzka (b. Budapest, 1845), portraying a commune in Central Africa.

UTRECHT, the smallest Netherlands province, has the Zuider Zee washing its very short northern frontier. Its area is 526 sq mi, and with a population of 406,960 (1930) it ranks third in the list of most densely-populated provinces This is also the position which it occupied at the beginning of the 20th century, but between 1900 and 1930 its average density increased from 470 per sq mi to 773 per sq. mile. Utrecht city (*q.v.*) has (1930) 154,882 inhabitants (fourth in the country) and Amersfoort over 38,500 The other settlements are relatively small.

The province falls entirely within the Rhine delta. (*See* HOLLAND: *Coast and Relief*) The southern limit of the Scandinavian ice passed diagonally through the province from northwest to southeast in the vicinity of Utrecht city, and the western part of the province consists of clay lands and, in the northwest, of low fen

The sand and gravel eastern region is covered with bare heaths and patches of woods, and the occupations of the scanty population are chiefly those of buckwheat cultivation and peat-digging. Amersfoort is here the only large town, but along the western edge of this tract there is a row of thriving villages, such as Amerongen, Driebergen, Doorn and Zeist

The southern area is picturesque with more extensive woodlands and has long been popular for country seats: Zeist provided a hunting-box for William III, and Doorn a retreat for ex-Kaiser Wilhelm II Veenendaal, on the south-eastern border, is a market for the local bee-keeping industry. Amersfoort, one of the chief seats of the Old Catholics, is now a thriving garrison town, with a variety of crops, including tobacco, growing on the sandy hills in its neighbourhood. It retains the Koppelpoort spanning the Eem, a gateway which is probably the finest and least altered mediaeval entry to any town in the Netherlands Within the town the old ramparts are now laid out as leafy promenades Baarn, farther downstream, is a popular summer resort for Amsterdam citizens, and on the east side of the Eem are the typical peaceful fishing villages of Bunschoten and Spakenburg.

At Maarsen, near Utrecht, is situated Zuylen castle, which is of some note. Rhenen was once the seat of an independent lordship, though afterwards joined to the bishopric of Utrecht. The ancient church has a fine tower (1492–1531) Wijk-by-Duurstede, originally a Roman settlement, was of considerable commercial importance as early as the time of Charlemagne, but decayed owing to Norman raids in the 10th century. The tower of the ruined castle of the bishops of Utrecht still stands.

Ecclesiastical History.—The province represents the bulk of the ancient see, founded in 722 by St Willibrord The bishopric was weak compared with Holland, Gelderland and Brabant, and the middle ages saw local wars. Holland's growth in the 14th century forced Gelderland and Brabant to relinquish their claims over the see Later, in the 15th century, her supremacy passed to the dukes of Burgundy and, still later, to the emperor Charles V. Notwithstanding the elevation of Utrecht to an archbishopric (1559), it was one of the seven provinces on the Protestant side which signed the Union of Utrecht (1579) against Spain. The chapter of the see was secularized and the power of the members of the five ecclesiastic colleges was severely curtailed Under the vicariate of de la Torre (1651), trouble began with Rome, which claimed the right of appointing successors It started in 1702 when Codde, the nominee of the Dutch secular clergy, was accused by the Jesuits of Jansenism (*q.v.*). Although innocent, he was deposed, and his chief opponent, de Kock, was appointed in his stead De Kock was expelled from the country by the States-General and the Church of Utrecht was without a head.

In 1713 the French Government enforced the bull *Unigenitus*, and in the following years many refugee priests entered Holland, including Dominique Varlet who settled in Amsterdam in 1720. Steenoven, in 1723, was elected archbishop by the chapter of Utrecht and his subsequent consecration by Varlet led to a general excommunication by the pope. The Jansenist Church of Holland has continued as an independent body accepting the general councils, but rejecting *inter alia* the Vatican council and the infallibility

of the pope. Two suffragan sees were created. Haarlem (1742), Deventer (1757); and though, in the following century, the Church lost membership, yet it has recently attracted numbers of the less rigid Roman Catholics At first the Jansenist church of Utrecht established close relations with the Old Catholic movement in Germany, but it subsequently viewed with strong disapproval the departures of the German members from Catholic tradition. The Jansenists refused to recognize the validity of Anglican orders, and in 1908 a singular offshoot of the Church of Utrecht was established in England when Dr. Gerard Gul (Jansenist archbishop of Utrecht) consecrated Arnold Harris Mathew, bishop of the Old Catholics in England. Meanwhile, in 1851, in Holland itself the Roman Catholic hierarchy had been restored, with Utrecht as the archiepiscopal see.

For general statistics see HOLLAND.

UTRECHT, a city of Holland, capital of the province of Utrecht, on the Crooked Rhine, which here divides into the Old Rhine and the Vecht. Pop. (1930), 154,882. It is the most important junction station of Holland, 22 mi. S SE. of Amsterdam by rail. It is a picturesque old town. The line of the ancient ramparts, demolished in 1830, is now only marked by the Singel, or outer canal, which surrounds the oldest part of the city, with gardens and promenades laid out on the inside. Two canals, the Oude and the Nieuwe Gracht, intersect the town from end to end. Utrecht is the seat of a university, and of a Roman Catholic archbishopric. It is also the seat of the archbishop of the Dutch Old Catholics. The Domkerk, dedicated to St. Martin, is a large Gothic building erected in 1254–1267 on the site of the original church founded by St. Willibrord about 720 and completed by Bishop Adelbold about 1015. An open space forming the heart of the square in which the church stands separates the solitary western tower (14th century) from the choir and transept, the nave having been blown down by a violent hurricane in 1674 and never rebuilt. In the crypt are preserved the hearts of the German emperors Conrad II (1039) and Henry V (1125). The Roman Catholic cathedral of St. Catherine dates from 1524 and has been restored in modern times. Other churches of very early foundation in Utrecht are the Pieterskerk and the Janskerk. Attached to the Domkerk by fine old Gothic cloisters is the university, which was founded in 1636 and enlarged in 1894.

Connected with the university are a valuable library, occupying the palace built for Louis Bonaparte, king of Holland, in 1807, and containing upwards of 200,000 volumes and mss ; a museum of natural history; a botanic garden; an observatory, etc. The archiepiscopal museum (1872) contains examples of all branches of sacred art in the Netherlands. In the Museum Kunstliefde is a small picture-gallery, chiefly remarkable for some pictures by Jan Scorel (1495–1562); the museum of antiquities contains a miscellaneous collection. Other buildings of interest are the museum of industrial art; the so-called "Pope's house," built in 1517 by Adrian Floriszoon Boeyens, afterwards Pope Adrian VI, and a native of Utrecht; the royal mint of Holland; the Fleshers' Hall (1637); the home for the aged, occupying a 14th-century mansion, and the town hall (1830).

The country round about Utrecht is pretty and plentifully studded with country houses, especially on the road to Arnhem. Close by, on the northeast, is the residential suburb of De Bilt, the seat of the Dutch meteorological institute. Four miles northwest of Utrecht stands the 13th-century castle of Zuilen, which was carefully restored in 1752, and is still in excellent preservation. Five miles east of Utrecht is the town of Zeist, the seat of a Moravian settlement established here in 1746 There are also a fine castle (1667) and grounds, a sanatorium for children and numerous modern villa residences. At Ryzenburg, close by, is a Roman Catholic seminary, founded in connection with the establishment of the Roman Catholic hierarchy in 1853 and practically serving as an archiepiscopal palace.

History.—Utrecht (*i.e.*, *Oude Trecht* or Old Ford, rendered in Latin documents *Vetus Traiectum*) is a city of great antiquity. The place is mentioned in the itinerary of Antoninus, but its importance began when St Willibrord (*q.v.*), the apostle of the Frisians, established his see there. The bishop's seat had to be fortified against the incursions of the heathen Frisians and Northmen, and the security thus afforded attracted population till, after the destruction of its rival Dorestad by the Normans in the 9th century, Utrecht became the chief commercial centre of the northern Netherlands. On the accession of Bishop Balderic (A D 918–976) to the see, Utrecht had just been sacked by the Northmen He succeeded in driving the raiders away, rebuilt the walls, and during the 58 years of his episcopate the town grew and prospered. Its gradual acquisition of civic rights followed the same line of development as in the German episcopal cities. Bishop Godebald (1122–1127) granted to the inhabitants of Utrecht and of Muiden, the neighbouring port on the Zuider Zee, their first privileges, which were confirmed (June 22, 1122) by the emperor Henry V. The magistrates, the *Schout* or high bailiff and his assessors, the *Schepenen* (*scabini*, *échevins*), were nominated by the burgrave from the order of knights. In 1196 we read for the first time of councillors as assessors of the magistrates, but these, who a little later were known as the *Raad* or council, were also nominated. As the 13th century advanced, the council, representing the wealthy and powerful gild of merchants, began to take a larger share in the government, and to restrict more and more the direct exercise of the episcopal authority.

The struggle between the town of Utrecht and its ecclesiastical sovereign reached its climax (1481–84) in the "groote vorlag," or great quarrel, between the citizens and Bishop David, the Bastard of Burgundy With the aid of John, burgrave of Montfoort, who had been called in, and endowed with supreme power for the defence of the town, the Utrechters defeated all the efforts of their bishop, aided by the Hollanders and an aristocratic faction. They only succumbed when the weight of the archduke Maximilian was thrown into the scale against them (1484). The struggle continued with intermissions till 1527 when Bishop Henry of Bavaria sold his temporal rights to the Emperor Charles V Utrecht took a leading part in the revolt of the Netherlands The union of the seven northern provinces, proclaimed at Utrecht in 1579, laid the foundation of Dutch independence (*see* NETHERLANDS) After the death of William the Silent, the Utrechters, jealous of the influence of their old enemies the Hollanders, elected a stadtholder of their own. The Roman Catholics had but little influence on the city, where the aristocrats inclined to the moderate (libertine) opinions advocated by the preacher Hubrecht Duifhuis, while the democrats were organized in the new church order introduced by the uncompromising Calvinist Petrus Dathenus (d. 1581). After the advent of the earl of Leicester as governor-general of the Netherlands in 1585, the previous dominance of the aristocrats was broken and the ultra-Calvinistic Adolph, count of Nuenar, who was elected stadtholder, placed the people in power. The English governor-general made the town his headquarters during residence in the Netherlands, and took it under English protection. His withdrawal from the Netherlands was followed by the return of the aristocratic party to power. From this time until the French Revolution, the democratic institutions of the city remained only a name.

UTRECHT, TREATY OF, the general name given to the important series of treaties which in 1713 and 1714 concluded the War of the Spanish Succession (*q.v.*).

The congress opened on Jan. 29, 1712. But it was not until July 10, 1712, that King Philip of Spain signed a renunciation of his rights to the succession of the crown of France. Then, England and France having concluded a truce, the pace was quickened and the main treaties were signed on April 11, 1713.

By the treaty between England and France Louis XIV. recognized the Protestant succession in England and undertook to give no further aid to the Stuarts. France ceded to England, Newfoundland, Nova Scotia or Acadia, the island of St. Kitts or St. Christopher, and the Hudson's bay territory, and promised to demolish the fortifications of Dunkirk.

The treaty between France and the United Provinces was mainly concerned with securing the barrier of fortresses. These arrangements were somewhat complicated and to a large extent provisional, as Austria and Bavaria, two countries deeply interested in the fate of the Netherlands, had not yet assented to

the terms of peace. By a commercial treaty concluded on the same day, France gave the Dutch privileges similar to those enjoyed by England. Other treaties concluded at the same time were between France and Savoy, France and Prussia, and France and Portugal By the first the duke of Savoy regained Savoy and Nice, and France undertook to obtain for him the island of Sicily and the title of king. By the second Prussia secured some small additions of territory, including part of Gelderland and Neuchâtel; in return France definitely and finally obtained the principality of Orange. The treaty between France and Portugal mainly concerned the Portuguese settlements in Brazil, her claim to these being recognized by France.

Other treaties were signed at Utrecht between Spain and the allies, Philip now concluding these as the recognized king of Spain. On July 13, 1713, a treaty was signed between England and Spain, which embodied certain commercial arrangements previously made between the two countries, Spain ceded to England Gibraltar and Minorca, and promised to give up Sicily to Savoy. She gave also to England the monopoly for 30 years of the lucrative slave trade with Spanish America, hitherto enjoyed by France: this was the famous Asiento treaty. The peace between Spain and the United Provinces was signed on June 26, 1714, but the conclusion of that between Spain and Portugal was delayed until the following February. The former was concerned mainly with commercial matters, Spain giving the United Provinces most-favoured-nation treatment.

The treaty of Utrecht also provided compensation for the Emperor Charles VI as soon as he surrendered his claim to Spain. He was to receive Naples and Milan, and also the Spanish Netherlands, henceforward known as the Austrian Netherlands

But the general pacification was still incomplete, as France and the empire continued at war. It was not long, however, before Charles VI realized that without allies he was no match for France.

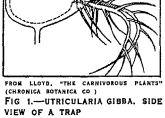
Accordingly, his representative, Prince Eugène, met the French marshal Villars at Rastatt in Nov. 1713, and here peace was made on March 7, 1714, Charles VI concluding the treaty without waiting for the assent of the states of the empire. This consent, however, was necessary, and a little later the representatives of some of the princes of the empire met those of France at Baden, where, on Sept. 7, 1714, the treaty of Baden, the last of the treaties included in the general peace of Utrecht, was signed. This dealt entirely with the question of the frontier between France and the empire, which was restored as it was before the war except that France gained Landau.

One other important matter was dealt with at Utrecht. A second barrier treaty between England and the United Provinces was signed on Jan. 30, 1713, and a third treaty signed at Antwerp on Nov. 15, 1715 clinched the matter. Seven fortresses were to be garrisoned by a total of 35,000 men, three-fifths of the cost being borne by the imperial government and the remainder by the United Provinces

The treaties were bitterly assailed by the Whigs, and after the accession of George I four of its Tory authors, Bolingbroke, Oxford, Ormonde and Strafford, were impeached for concluding it, the charges brought against them being that they had corresponded with the queen's enemies and had betrayed the honour and interests of their own country.

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UTRICULARIA, A genus of the family Lentibulariaceae containing about 150 species, all carnivorous ("insectivorous") Closely related are the genera *Biovularia* (2 species) and *Polypompholyx* (probably four species). They are commonly called "bladder-worts" because of their numerous small hollow traps, first regarded as bladders and thought, erroneously, to serve for floating the plant. Since land forms also have "bladders," this view was obviously open to question, and was shown to be false. These plants live either submerged, usually in still fresh waters, though two species are known which live attached to stones or other firm surfaces in rapidly running streams.



FROM LLOYD, "THE CARNIVOROUS PLANTS" (CHRONICA BOTANICA CO.)

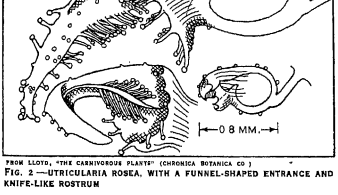
FIG 1.—UTRICULARIA GIBBA. SIDE VIEW OF A TRAP

In the latter the traps are, literally, streamlined, and are thus adapted to moving water. Or they grow in wet soils, usually of quartz sand or mud, or in wet moss or creeping on leaves in wet jungles. Some species take intermediate stations, growing either in the water or on wet mud One or two species grow in the water held by the leaf rosettes of certain epiphytic bromeliads (related to the pine-apple) in South America They are of world-wide distribution, from Greenland to Australasia and around the globe in both latitudinal hemispheres. North America has about a dozen species including a number of land forms (*e g*, *U. subulata*). Europe has about four species, all submersed or partly submersed forms. The largest common to both hemispheres in the temperate regions is *U. vulgaris*. Floating in quiet waters, this attains a length of 3 ft. or more, with several branches and with finely dissected leaves bearing the numerous traps, 2–3 mm. long, which serve to catch minute animals, such as water-fleas (Crustacea), larvae of flies, including mosquitoes, small spider-like creatures, etc.

It is a common experience to find minute algae (*e g.*, *Euglena*) living apparently happily within the traps. The prey serves as a source for nitrogenous food, and probably for salts of various kinds.

A few land forms are of considerable stature, as *U. globulariaefolia*, of Trinidad and *U. remifolia*, with large showy flowers, of the Organ mountains of Brazil. The latter is showy enough to be grown in greenhouses, where it is usually segregated with the orchids, less for its superficial resemblance than for its similar requirements of high humidity and temperature. But the vast majority of land forms are small and very inconspicuous save for their flowers which, though often small, are quite readily seen The larger, though having small vegetative parts, have tall inflorescences, the flower stalks in *U. cornuta* being a foot high. The smaller are inconspicuous among the mosses, etc., in which they grow, except for their showy, small flowers. Still others are almost microscopic in size.

The plant's body consists of a more or less horizontal stem (a



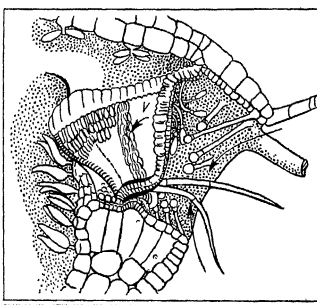
FROM LLOYD, "THE CARNIVOROUS PLANTS" (CHRONICA BOTANICA CO.)

FIG. 2.—UTRICULARIA ROSEA, WITH A FUNNEL-SHAPED ENTRANCE AND KNIFE-LIKE ROSTRUM

stolon) bearing simple or divided leaves placed in a variety of relations, not following any obvious rule A peculiar and significant feature, noted by Karl Goebel, is that the leaves face away from the apex of the stolon which bears them, the reverse of the usual condition. Correlated with this is the occurrence of the axial bud in a correspondingly reversed position

In *Utricularia* the calyx has two members, a dorsal and a ventral one. In *Polypompholyx* there are two additional, in lateral positions. The corolla is entire and two-lipped, of the personate type, with the mouth closed by a palate, and provided with a spur from the lower moiety. The spur is very large in *U. menziesii* and vestigial in *U. minor*, and is represented by a wide poculate expansion in *U. cymbantha*. The spur is a nectary, but nectar glands occur also in the bowl-shaped condition. The colour of the corolla may be white, very often yellow, pale blue to purple, and in one species, brilliant crimson, variously marked on the palate with other colours. Reproduction is by means of seeds, by winter or resting buds and by adventitious growth from various parts, as from leaf buds The inflorescence is a raceme, and in some floating kinds, is held up in position by means of a whorl of floats, which are leaves in which the midrib is much inflated, as in the American *U stellata*. Expansions of the stolons lead to the formations of tubers, which, containing sap and starch, can serve to tide over dry periods and for reproduction

But the most noteworthy feature of all three genera here considered is the occurrence of traps, usually, but hardly correctly, called bladders From the time of Darwin and Ferdinand Cohn (1875) until that of Frank Brocher (1911) they were thought to be passive traps, consisting of a hollow, bladder-like sac guarded by a curved, flexible door or valve. This, it was interpreted, would be pushed in by an intrusive animal of suitable size, and permit easy entrance; but since the valve is a check valve, permitting movement in only one direction, the animal remained captive, balked of escape by a now resisting wall This idea was shown to be quite inadequate by Brocher, a Swiss entomologist,



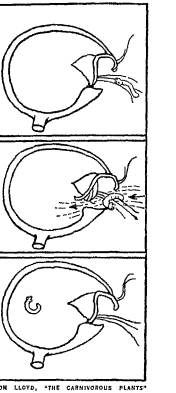
FROM LLOYD, "THE CARNIVOROUS PLANTS" (CHRONICA BOTANICA CO.)

FIG. 3.—UTRICULARIA GIBBA

Diagram of the entrance in longitudinal section. The outer surface of the door and the sides of the entrance bear mucilage glands. The arrows point at the tripping bristles and indicate the direction of the prey's approach. V indicates Velum

who, during a study of mosquitoes and utricularia in relation to each other, discovered that, when a larva is caught, the sides of the trap, erstwhile inpressed and concave, were then definitely expanded This could be explained only as the result of an inflow of water, and that the prey was washed into the trap thereby This indicated that the valve or door was fixed in a position of unstable equilibrium which was upset by impact of the prey on certain bristles, four in number, projecting from the door surface

This was later confirmed (E. M. Merl, Th. Czaja) and it was shown also that the action could be repeated, 14 repetitions of the action having been counted. This could be explained only when it was discovered that the wall of the trap constantly excretes water from the inside of the trap to the outside and that the door is so postured that it can resist the relatively increased water pressure on the outside Later it was found that the door posture of itself is insufficient to render it watertight, which it must be to allow the maintenance of reduced water pressure on the inside. It was then found that, in addition to the door, there is a second valve, the "velum," which consists of a membrane attached to the valve seat on which the door edge rests, applied against the lower zone of the door in such manner as to prevent the inleakage of water under it, as can readily occur at the side reaches of the door edge (F. E. Lloyd). The valve seat, called by Darwin the "collar," is a stout, curved weal of tissue, lined with a soft cellular lining, the cells of which supply the velum by exfoliation of their cuticles, which remain attached to each other and to the front edge of the collar. After action, the valve or door reseats itself on the upper surface of the collar, and the velum folds upward over the door edge. The trap is then sealed, and, after sufficient excretion of the inner water, will again react.



FROM LLOYD, "THE CARNIVOROUS PLANTS" (CHRONICA BOTANICA CO.)

FIG. 4.—UTRICULARIA GIBBA: THREE STAGES IN CAPTURE OF PREY

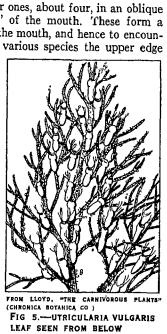
Above, door being sprung by larva. Middle, door opening. Below, larva caught and door again closed

In order to set the trap into action, the door is provided with a trigger mechanism. In *U. vulgaris* and the like, this consists of four to six stout, curved bristles which, when disturbed by the impact of prey, bend, and in doing so, twist slightly the edge of the door, releasing it from its delicate equilibrium, and allowing the external water pressure to push it in, carrying the prey with it. The inward swing of the door is followed, as the pressure of the insurging water decreases, by a return to approximately the original posture, the whole occupying about one thirty-fifth of a second. The walls of the trap are now more or less bulging, due to the greater contained volume of water. The trap is now in the relaxed state. The set state is reached in 15 to 30 minutes (*U. vulgaris*), during which time the door changes its posture somewhat, because of the now increased water pressure, and is again ready for repetition. As the result of somewhat different mechanical conditions in the traps of many species, the change in posture of the door from the relaxed to the set state is very marked and readily observed (*U. capensis; Polypompholyx.*)

The excretion of water from the inside to the outside of the trap through the walls demands a mechanism, and this is found in two sets of trichomes, one on each surface, whose capital cells are bare of cuticle. These are, on the inside, the quadrifid and bifid hairs, as Charles Darwin called them, and on the outside hairs with rounded or elongated capitals. Since the rest of the wall surfaces are covered with cuticle, this seems to be the only reasonable conclusion. The quadrifid hairs are numerous in *U. vulgaris*, and few, but relatively much larger in small traps such as those of *U. subulata.*

The trigger mechanism is widely different in various species, but is always composed of trichomes of various shapes and dispositions. Aside from these, the remaining appendages of the trap consist of variously shaped and disposed emergencies, rang-

ing from branching arms to extensive wings. In *U vulgaris* there are two curved arms extending from the upper corners of the entrance Between them on the edge of the entrance stand several delicate, long bristles, with similar ones, about four, in an oblique row extending along the "cheek" of the mouth. These form a sort of guiding funnel leading to the mouth, and hence to encounter with the trigger bristles In various species the upper edge of the entrance may be strongly developed into a single, or a bifurcate rostrum, armed with large glandular trichomes The single rostrum may be broad and rounded, or may have the shape of a knife blade. Again, a rostrum may arise from the lower edge of the entrance and extend far forward and upward, as in the American *U. purpurea*. In Australian species, the rostrum may be much branched and in such case the trap bears two ventral wings extending obliquely toward the entrance and acting as guides thereto. Again, the whole margin of the entrance may be drawn out to form a deep funnel lined with radiating rows of glandular hairs, which it has been suspected secrete, beside mucilage, some substance or substances attractive to prey, thus acting as a lure. Convincing evidence is, however, lacking.



FROM LLOYD, "THE CARNIVOROUS PLANTS" (CHRONICA BOTANICA CO.)

FIG 5.—UTRICULARIA VULGARIS LEAF SEEN FROM BELOW

The genus *Polypompholyx* has traps which have thick and massive walls three in number, so that the trap is triangular in section. The entrance is blocked in front by a swelling of the stalk, so that approach to it must be made from the sides. Wings and rows of bristling hairs serve to guide the prey appropriately. These plants are all found in central south and southwestern Australia.

Biovularia has two species, one in Cuba and one in South America. They are characterized by the possession of only two ovules, in contrast to the 100 or more of *Utricularia*. Certain species of Africa, because of the fact that only three ovules occur, have been regarded as belonging in *Biovularia*, but the traps are like those of *Utricularia*. Those of *Biovularia* have six tripping bristles set at about the middle point of the door instead of near the lower edge, as in *Utricularia*.

It is not satisfactorily determined whether the dissolution of captured organisms in the traps is the result purely of secreted enzymes, of bacterial action, or both. Much of the difficulty of deciding the question arises from the small size of the traps.

See F. E Lloyd, *The Carnivorous Plants* (1942). (F. E. L.)

UTTAR PRADESH: *see* UNITED PROVINCES.

UTTOXETER, a market town of Staffordshire, England. Pop. of urban district (1951) 7,440. Area, 5.2 sq.mi. The town lies on high ground near the river Dove. The boundaries were extended in 1934. Uttoxeter (Wotocheshede, Uttokeshather, Utcester, Uttoxater) belonged to Algar, earl of Mercia; at Domesday it was held by the king; later it passed to the Ferrers family and in the 12th century Earl Robert constituted Uttoxeter a free borough.

Uttoxeter, with the rest of the honour of Tutbury, escheated to the crown in 1266; it was regranted to Edmund Crouchback, and belonged to the duchy of Lancaster until 1625. In 1308 Thomas, earl of Lancaster, obtained the grant of a fair on the vigil, day and morrow of St Mary Magdalene The market was the greatest in that part of England for cattle and provisions. The market place was remodelled in 1935. The church of St. Mary has a fine Decorated tower and spire. Alleyne's grammar school was founded in 1558. At Denstone, 5 mi. N., is Denstone college (1873). Industries include the making of biscuits, agricultural implements and condensed milk.

UVALDE, a city of south central Texas, U.S.A., the county seat of Uvalde county, located about 85 mi. S W of San Antonio. It is served by the Missouri Pacific and the Southern Pacific railroads, by U S. highways 83 and 90 and by state highway 55. Pop. (1950) 8,674; (1940) 6,679

Uvalde's principal industries include the production of honey, sheep, goat and cattle ranching, dry and irrigated farming. There are asphalt mines near by.

Juan de Ugalde, an 18th century Spanish soldier, gave his name to Uvalde, although the *g* in his name was replaced with a *v*. Settlement began in the city about the middle of the 19th century.

UXBRIDGE, market town and urban district of Middlesex, Eng., 15¼ mi. from London by the G.W.R. and the London Passenger Transport board. Pop. (est. 1951) 55,944. Area, 16 sq.mi. Near the Grand Junction canal are sawmills, and wharves for timber, coal and slates. There are also flour mills, a brewery and engineering works. Uxbridge is said to date from Alfred the Great, but is not mentioned in Domesday Here negotiations were begun, on Jan. 30, 1645, between the commissioners of Charles I and the parliament, but were broken off on Feb 22. A part of the "Treaty House," in which they were carried on, remains. In 1647 the parliamentary headquarters were in the town. It remained a garrison town until 1689 It was granted a market by Henry II. There are two fairs

UXBRIDGE, a town of Worcester county, Massachusetts. Pop. (1950) 7,005; 1940 federal census 6,317 It is in a picturesque region of low hills and small lakes. The principal industry is the manufacture of woollen goods

Uxbridge was divided from Mendon and incorporated as a town in 1727.

UXMAL, the ruins of an ancient Mayan capital city of the new empire about 50 mi. S. of Merida, in Yucatan, Mexico; in 89° 42′ W. and 20° 18′ N. It was one of those frontier Mayan cities that did not rise to prominence until shortly before A D. 1000 when the League of Mayapan was formed with three cities, Mayapan, Chichen-Itza and Uxmal, dominant in "the New empire" of the Mayas. With the earlier fall of the Old empire in Guatemala and southern Mexico the Itza established themselves at Chichen (The Mouths of the Wells), the Cocom made Mayapan their capital, and the Tutul Xiu, a kindred tribe, settled at Uxmal. The period subsequent to the formation of the League of Mayapan constitutes the golden age of the New empire of the Mayas, when peace and plenty provided favourable opportunity for the development of trade and religion and science and art, particularly architecture.

Great stone temples and colonnades elaborately carved and ornamented rose in every city; religion flourished; the sciences, especially astronomy and mathematics, were fostered; and a renaissance of culture held sway for over two centuries. The buildings of this period at Uxmal surpassed those of the other cities in their grandeur and elegance. When the New empire crumbled under internal dissension and the conquest of the Aztec-Toltec imperialists from central Mexico, about the middle of the 15th century, Uxmal succumbed with the rest, and it is reasonably certain that only vagrant tribes lingered about the old ruins at the time of the Spanish conquest.

The region of the Uxmal ruins, like most of Yucatan, is a dry grass savanna, in places rather heavily wooded as about Uxmal. The relief is negligible, the terrain for the most part being as level as a floor, though a range of low hills lies between Uxmal and Ticul, the railway station about 20 mi. eastward. The water-supply of the city was furnished by "cenotes," or wells, within the city, or by pools some distance to the west, now partly filled up and vanished, but in the rainy season so marshy as to be the breeding-places of myriad mosquitoes that spread malaria, fever and disease. It may have been some of the mosquito-borne pestilences that destroyed the Mayan civilization.

The main ruins occupy an area not much over 160 ac., but outlying remnants indicate a residential district much larger, for which the central group, massive and extremely impressive, merely constituted the religious and civic nucleus. The stone used in the structures is the pale, yellowish and reddish-gray limestone, obscurely marbled, which was probably obtained not far from the

city, though the quarry has not yet been definitely located The body of the walls and the framework of the temples is generally of fragmental stone set in a whitish mortar of excellent composition made of lime burned in the neighbourhood. The facings and ornaments are all cut exquisitely yet daringly, and in view of the fact that the Mayan artisans laboured without metal tools, the excellence of their work is amazing The faces and edges are graved and hewn with perfect precision and the joints are in many cases so perfect as to conceal the mortar Much plastering was done, and nearly all surfaces, and apparently even the intricate details of mouldings and sculptures, were smoothed painstakingly by white plaster and finished in many colours

The walls are massive, averaging 3 ft. in thickness, but in some ruins 9 ft , approximately vertical on the exterior to the full height, and to the spring of the arch inside Few recesses or projections disturb the smoothness of the exterior walls, but elaborate ornamentation relieves the monotony. Rigid mouldings divide the walls into upper and lower zones, the latter faced with smooth stone except for a narrow band of design near the base, and the former, a development of the entablature, compositely graven and bordered by a heavy band of mouldings at the top. The shoe-shaped coping stones held the level cement roof. The corners of the buildings were square or rounded. No windows or other openings admitted air or light (or mosquitoes) The doorways, confined to the lower panel of the wall, were simply constructed and of medium to large size The jambs were faced with cut stone and the longer lintels were of zapote wood dressed square or partially so.

The buildings were generally long rectangular with one, or more usually two, ranges of rooms; and as a rule these buildings were arranged in groups of four forming a quadrangle. None of the buildings was over one story in height, and nearly all were built on terraces or pyramids of varied ground plan and profile The rooms were high and spacious, with vaulted ceilings formed of the usual wedge-shaped arch built from horizontally laid stones corbelled and bevelled with the slope Stairways were numerous, wide, steep and well built of cut stone.

Five principal buildings or groups of structures were the pyramid-temple of the Magician crowning a majestic pyramid 80 ft. high and 240 by 180 ft. at the base; the Nunnery quadrangle composed of four large rectangular buildings enclosing a court, all on a terrace 300 ft. square and 15 ft. above the level of the plain, and all divided into numerous small rooms probably occupied by the priesthood; the Governor's palace, an imposing structure set upon a triple terrace, and said to be the most important single unit of its kind in America; the House of the Turtles, a smaller structure distinguished by a frieze of sculptured turtles on the moulding; and the House of the Pigeons, a quadrangle like the Nunnery quadrangle, of which one building carries a peculiar roof-comb of colossal size perforated by hundreds of openings which make it appear like a great dovecot, and which may have been occupied by statues like the roof-combs of Palenque. Besides these a number of smaller or less important ruins or groups of ruins dot the locality and help to create a scene of ancient power, prosperity and culture, probably unsurpassed in Yucatan and certainly rivaled only by Mayapan and Chichen-Itza.

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(W. E. E.)

UZ, JOHANN PETER (1720–1796), German poet, was born at Ansbach on Oct. 3, 1720. He studied law, 1739–43, at the university of Halle, where he associated with the poets Johann Ludwig Gleim (*q.v.*), and Johann Nikolaus Götz (*q.v.*), and in conjunction with the latter translated the odes of Anacreon (1746). In 1748 Uz was appointed unpaid secretary to the *Justizcollegium*, an office he held for 12 years; in 1763 he became assessor to the imperial court of justice at Nuremberg, in 1790 was made a judge and, on the annexation of Ansbach to Prussia (Dec. 2, 1791), entered the Prussian judicial service, and died shortly after his appointment as *Landrichter*, at Ansbach on May 12, 1796. Uz wrote a number of graceful lyrics in Gleim's style, and some patriotic odes; he is the typical representative of the rococo period in German poetry. In 1749 the first collection of his *Lyrische Gedichte* was anonymously published, followed by *Der Sieg des Liebesgottes*, in alexandrines (1753), an imitation of Pope's *Rape of the Lock.*

UZ, a land, the scene of the story of the book of Job. Its precise location is uncertain, but the name in the Old Testament appears to be associated with three districts.

(1) *Northern Mesopotamia,* a district to which Uz, son of Aram, is commonly referred (Gen. x, 23).

(2) *Damascus* and the country lying to the south of it. Josephus (Antiq i, 6, 4) commenting on Gen x, 23, remarks that Uz founded Trachonitis and Damascus.

(3) *Edom.* In Gen. xxxvi, 28, Uz appears in the genealogy of Seir in the land of Edom, and in Lam. iv, 21, Uz stands as a parallel to Edom.

The suggestion has been made that if the name is so widespread, the explanation may be that it is tribal rather than territorial. The transcription of the name in the Greek version suggests the Arabic *Audh* a well-known deity, and might well be a tribal designation. Lam. iv, 21 appears to be the sole passage, which gives a clear indication of locality, and it is emphatic for Edom. *See* S. R. Driver and G Buchanan Gray, *The Book of Job* (1921), p. xxvii *seq*

(E. Ro.)

UZBEK or **UZBEG REPUBLIC,** one of the constituent republics of the U.S.S.R. in central Asia, created in 1924. Area 66,409 sq.mi. Pop. (1939) 6,282,450 (urban, 1,445,064; rural 4,837,386). Afghanistan lies to the south, the Turkmen S.S.R. to the west, Kazakstan to the north, and the Kirghiz S.S.R. and the Tajik S.S.R. to the east. It includes the oasis of Khwarezm, Khorezm or Khiva, Samarkand, and most of the former khanate of Bokhara, with the Ferghana valley. Tajikistan, as an A.S.S.R., and the Gorno-Badakhshan Autonomous area were until 1929 included in the Uzbek S.S.R.

Physical Characteristics.—The region is an ancient centre of oasis cultivation dependent on irrigation from glacier fed streams which are fullest at the time of the melting snows and are thus peculiarly favourable to agriculture. Its life depends on the Syr Darya, Amu Darya and Zarafshan rivers, on the spongy loess soil, and on the clear sunshine and heat of summer which combine to give rich harvests of grain and fruit to the cultivator The climate is continental, with little rain or cloud, and with intense bright sunshine in the six summer months. Extremes of temperature range between −13° F. and 117.5° F. or more, the contrast being greatest in the plains and least in the hill regions The severe winter prevents the growth of perennials, but annuals flourish in the summer heat Rainfall is always inadequate, but varies greatly from year to year.

The Zarafshan feeds the oases of Samarkand and Bokhara, the former getting the first and freshest supplies. It rises in a glacier in the Alai mountains of the Tadzhik A.S.S.R. and flows through a longitudinal valley with the Turkistan range to the north and the Hissar range to the south, its total length being 400 mi. and its average gradient 21 feet per mile Formerly it reached the Amu Darya, probably near Charjui, but now 12 mi. of sand, the Sundukli desert which connects the Kyzyl Kum from the north, and the Transcaspian Kara Kum from the south, intervene, and the river is lost in the creeping wind-blown sands which are slowly advancing on the little town of Kara Kul, the last settlement dependent on the "gold-strewer," as the Zarafshan is called.

The Kara Darya and the Naryn in the northeast unite near Namangan to form the Syr Darya and upon them depends the Ferghana valley with Andizhan, Marghelan, Ferghana, Khokand and Leninabad (Khojent) in the Tadzhik S.S.R. Tashkent lies to the north on the Chirchik tributary of the Syr Darya. A short portion of the Amu Darya forms the southern boundary of Uzbekistan and receives the right bank Surkhan tributary; the river then flows northwest through the Turkmen S.S.R. until it re-enters Uzbekistan and feeds the oasis of Khiva (*q.v.*), now suffering from difficulties caused by the increasing desiccation of the region and from the perpetual eastward shift of the river on its course to the Aral sea. Formerly the river entered the Caspian by the Sary-kamysh depression and the oasis was then much

more prosperous. Desert everywhere encroaches on the oases, in the northeast the famine steppe or Bak-pak-dala, with its salty dark gray clay soils, approaches close to Leninabad The Kara Darya and Naryn bring down vast quantities of sand which is deposited near their banks and especially on the banks of the Syr Darya, in the region where it cuts its way through the Leninabad-Ajar ridge

Under the influence of the southwesterly winds this vast expanse of sand everywhere steadily encroaches on cultivated lands In the northwest the Kyzyl Kum is advancing toward the Kamimikh district, and the oasis of Khiva lies between the Kyzyl Kum and the Kara Kum deserts Even in the fertile Ferghana valley there are stretches of rubble and stony, as well as of sandy, desert. The whole area is undergoing geological change; rivers have changed their courses and lakes their outlines, while in some cases they have dried up altogether. Traces of dried-up lakes and of river beds which were the main arteries of prosperous regions within the period of written history, are evident. Bokhara and Khiva owe part of their decay to this gradual desiccation Earthquakes occur, more especially on the line from Leninabad to Vyernyi (Alma-Ata) in the Kazakstan A S S R. In some regions, especially in the Urta Chul district between the western slopes of the Hissar range and the Amu Darya, there is stony steppe land, and steppe surrounds some of the oases and thus lessens the advance of sand. The juniper is common on the hill regions, and poplars and willows grow by the streams. The Russian government established a plant testing station to select shrubs to plant by the railway and thus prevent it becoming sand-covered, and at Marghelan there is a government forest station from which poplars and other young trees are distributed to cultivators, the quick growth of the poplar making it specially suitable for planting round orchards and fields. The former prairie fauna of the steppe regions is giving way to the drought-resisting plants of the semi-desert steppe, among these the *saxaul* scrub is particularly useful in a region deficient in fuel.

Agriculture.—During the civil wars and disorders following the 1917 revolution, the irrigation canals, which need constant cleaning and repairing, were neglected, and the sown area much diminished. This period was followed by a complete disorganization of the former system of water distribution, a disaster where every drop of water is precious. Only in 1925 was order restored and a new system introduced, based largely on the confiscation of water rights from former wealthy owners, and the redistribution under government control of water and of land from the large estates In a region where life was based on tribal and traditional systems, with recognition of the chieftain as owner and controller, this change, following on the disorders of civil war, made life difficult, especially as most of the inhabitants were illiterate and therefore found new laws particularly difficult to understand However, the age-long skill of the cultivators, primitive though their methods may be, and the great fertility of the region, resulted in the revival of agriculture.

The Russian government attaches particular importance to cotton cultivation for the supply of raw material to the cotton factories of the Moscow region. Efforts were therefore made to discourage the growing of rice, which demands a great deal of water; only on the left bank of the Chirchik in the Tashkent area can rice be cultivated without loss of water to other crops. Cotton from Uzbekistan, and especially from the Ferghana and Andizhan district, ordinarily supplies a large percentage of the requirements of the Russian cotton mills. The number of small cotton cleaning workshops has been reduced In 1926–27 a large cotton factory was built with 40,000 spindles. This was the first textile factory in central Asia. In 1926 a cement factory was opened at Khilkov.

The impact of industrialism on this region of immemorial tradition is already felt, especially among the women, some of whom have abandoned the veil and have formed co-operative clubs, especially in Tashkent and Samarkand. Products of the region include wheat, alfalfa, maize, sorghum, barley, melons, cucumbers, fruits, vines, oilseeds, millet and opium poppy The almond is common in the Ferghana valley. In the small areas not dependent on irrigation, wheat and barley are the chief crops In 1925 a government grant was made for the introduction of more modern agricultural implements, especially for cotton cultivation, which had developed by 1939 into a large-scale industry. Raising of sheep, goats, working cattle, horses, camels, asses, mules and pigs forms an important item among the nomad and semi-nomad tribes. Cattle and sheep breeding continues to be developed successfully, and the lamb fleece (Astrakhan) before World War II reached the world market in great quantities. Silkworm breeding is also an old and important occupation.

The republic has some mineral wealth, little developed as yet Naphtha near Ferghana gives an annual output of about 28,000 tons and coal, formerly exploited by peasants in a primitive way, but now under government control, yielded 101,000 tons from the mountains near the town of Andizhan. This development is due to the efforts of the soviet government to encourage local supply so as to leave the Donetz coal for the factories in European U S S R. Ozokerite is worked in Ferghana. Radioactive ores have been found at Tyuya Muyun in the Ferghana valley and are being exploited. Iron, silver, lead and copper are mined by the peasants for local use, but have little economic importance. The budget of the republic for 1940 was fixed at 1,476,300,000 roubles ($92,239,224 U S), for 1941 at 1,604,000,000 roubles

Industry and Communications.—Peasant industries everywhere supply local needs and supplement income. They include the making of clothing and of felt for the tents of the herdsmen, of leathern bottles and shoes, paper, woollen and silk goods (including carpets and shawls), and metal goods Dried fruits are an important export. Brick-making is unnecessary, for the loess, owing to its lime content, hardens, and loess mud huts are common

Many types of life are found within the republic. There still exist some purely nomadic herdsmen seeking different pastures according to opportunity, but their numbers are rapidly diminishing; others are semi-nomads with fixed summer and winter quarters. In the foothills there is some mixed farming with cattle raising and grain cultivation dependent on rain, while in the oases there is intensive grain and fruit cultivation under irrigation.

City life, with ancient trading bazaars and more recent beginnings of factory industry, is well developed Tashkent has a population of 585,005 (1939), Samarkand of 134,346 (1939). Khiva is much reduced and has 21,595 inhabitants. For an account of the ancient importance and present conditions of these famous cities *see* the separate articles on them. Other large towns, with their populations in 1939, are Kokand 84,665, Andizhan 83,691, Namangan 77,351 and Bokhara 50,382. Marghelan is under 50,000. It should be noted that all, with the exception of Khiva, are on the railway, a vital factor in their revival. The two main lines are the Chkalov-Tashkent and the line from the Caspian which meet at Tashkent. A branch goes along the Ferghana valley with a north and south loop from Khokand, and a branch from Bokhara goes south to Termez on the Amu Darya, with a loop toward Samarkand. Air communication is an important development since the revolution, and Tashkent, Samarkand, Termez and Stalinabad (in the Tadzhik S S.R) are linked by regular air services. There is no railway to Stalinabad and the road is difficult, so that the value of this air link which brings Stalinabad into touch with Tashkent and the railway by a six hours' flight cannot be overestimated. In this region of sharp contrasts, the camel caravan still crosses the desert and depends on wells which yield somewhat salty water, or on the rare freshwater springs

The Population diminished markedly during the civil war. The most densely peopled regions are the Andizhan and Ferghana districts and the Tashkent and Khiva oases. The total population of the latter oasis is little more than that of Tashkent city.

Uzbegs form about 76%, and other nationalities include Tadzhiks, Russians, Ukrainians, Kazaks, Kirghiz, and Jews. The latter are possibly descendants of Jewish prisoners brought here by Assyrian and Babylonian kings. They speak Iranian, but retain their ancient customs and are known as Bukhara Jews, because of the numbers in that city. The name Uzbeg dates back to the reign of Uzbeg Khan, a chief of the Golden Horde, who

died in 1340 and who introduced Islamism among his subjects; his coins have been found minted at all the towns of the Horde which struck money up to that date. Before the Mongol invasion, the Turks, of whom the Kazaks, Uzbegs, Turkmens and Osmanli are the four chief groups, occupied Dzungaria and the Mongolian desert. The great effect of the Mongol invasion was to push the Turks westward, and it was apparently Turkish tribes who adopted the name of Uzbeg from their Mongol ruler who introduced Islamism. The term Uzbeg is used by 14th and 15th century writers to indicate Mohammedan as opposed to Shamanistic Turks.

Klaproth gives four divisions of the Uzbegs, the Naiman, Kipchak, Kungrad and Mangut. The Kunkurats or Kungrads were driven from their original home near Lake Dalai Nor by the Mongols, and their name survives in the town of Kungrad on the Amu Darya delta. The Kipchaks form an important element in Khokand, while Tatar Uzbegs predominate in Khwarezm, where they founded an independent principality but allowed the Kurt and Turkmen cultivators to remain. In the 15th century Timur defeated the Uzbegs and sacked Samarkand, but the struggle between the Uzbegs and the Kalmucks in the early 16th century resulted in the former again occupying Samarkand

The Uzbeg (Jagatai Turkish) tongue, though closely related to Turki, seems to have had a separate origin and development Various indications connect it with the old Uighur dialect found in the *Kudatku Bilik* (AD 1070); an Uzbeg tribe in the Andijan district is called Uighur. At the present time, mainly as a result of the long illiteracy of the general population, there are numerous Uzbeg dialects, the four chief being those of Bokhara-Samarkand, Ferghana, Tashkent and Khiva, others being those of the mountain Uzbegs, of the Kashka Darya and Surkhan, the Afghan and the Kashgar districts Their variety reacts to-day by adding to the difficulties of education.

So much admixture of Mongol and Turk and original cultivators of the oases has gone to produce the Uzbeg, that the physical type is by no means uniform. The different proportions of Tadzhik, Sart, Persian and Afghan blood, as of Mongolian and Turkish, have led travellers to give most diverse accounts of the physical type of the Uzbegs. The Kuramas of the Chirchik (Tashkent district) seem to have much Kazak blood The name *Sart*, from old Turkish *to wander*, is found in the *Kudatku Bilik* in the sense of merchant as opposed to nomad and then indicated an Iranian people. In later times it denominated the original Iranian cultivators and ultimately has been used loosely of the peasant cultivators in the oases; it has no strict ethnological significance. The Persian speaking Tadzhiks were the aboriginal cultivators of the fertile parts of Turkistan and are tall and dark, with straight noses and much facial hair. They form a striking contrast to their Mongol and Turkish neighbours and are specially numerous in the towns For the history of the struggle between Turk and Mongol and Persian in this region and the varying fortunes of the khanates *see* H. Howorth, *The History of the Mongols* (1876).

History.—One of the earliest records of relations with Russia is the sending of envoys by the Uzbegs of Khiva to Tsar Feodor (1584–1598). In the previous reign an English merchant Jenkinson travelled to Bokhara, Ivan IV. (1533–1584) having granted an English company trading rights with Persia. Khiva was for long a slave market where in the 18th century as many as 10,000 Russian and Persian slaves sold in its markets by Kazaks, Turkmens and Kalmucks were working in the fields and on the irrigation canals. The Uzbegs became less hostile to the Russians after Peter the Great's campaign against their enemy, Persia, though a force which he sent against Khiva was annihilated.

In the 19th century Russian scientists and travellers visited the region, among whom was the famous Russian geographer Semenov, later called Semenov-Tian-Shansky. In 1847 Russian troops established a fort on the Sea of Aral at the mouth of the Syr Darya and in 1853 a steamer was launched in the hope, which was not fulfilled, owing to navigation difficulties, of establishing trading communication with Ferghana. In 1853 Ak Metchet (Perovsk) was captured and in 1864 Tashkent was occupied by the Russians, and two years later Khojent fell. In 1867 General Kaufmann was appointed governor of the newly created Turkistan province and in the next year Samarkand was captured. In 1870 the emir of Bukhara submitted to the Russians; since Bukhara is entirely dependent on Samarkand for its water supply a struggle would have been disastrous Khiva, however, secure in her desert fastnesses, still defied the Russian power. A Russian expedition under General Perovsky in 1869 was compelled to retreat by the difficult winter conditions in the Ust Urt plateau desert, with a loss of 3,000 men and most of the transport animals. In 1873 a triple attack from Tashkent, Chikishliar and Chkalov was organized and the city was captured. Khiva and Bukhara remained nominally independent vassal states of Russia until the 1917 revolution.

Soviet Government.—After that year they declared themselves independent republics and treaties with the Soviet government in 1920 and 1921 were signed in which their independence was recognized. Their form of government, however, was not socialist and soviet in type and civil war, complicated by the intense religious feeling of these Sunnite Mohammedan peoples, broke out. Finally in 1924, after prolonged civil fighting and disorder, the two republics disappeared and were merged in the Uzbeg S.S R. The creation of the new republic did not, however, imply a unity of feeling among its subjects. The Uzbegs themselves are divided into about 80 tribes with varying branches that bear at least 150 different names. The other races noted above complicate the problem and the difference of speech, custom and type of life will make amalgamation a slow and difficult process, and the difficulty is increased by the poor school provision.

The gulf between the materialist view of the Soviet government and the religious fanaticism of the Sunnite Mohammedans, especially of the town centres, will not be bridged quickly, though the first vigour of the Soviet attack on the Islamic faith has died down and many children in this region attend Mohammedan schools or *madrasas*. The encouragement of publication in the vernacular and of research in the institutes of Tashkent especially is producing a scientific and literary outlet for the more cultured Turkish peoples and the adoption of the Latin script in place of the more difficult Arabic makes for the increase of literacy, with an ultimate possibility of improving sanitary and social conditions.

UZÈS, a town of southern France standing on a height above the Alzon Pop (1936) 3,322. Uzès, the seat of an episcopal see from the 5th century to 1790, has a cathedral flanked by a 12th-century round tower of five stories. The Duché preserves a 14th-century donjon; the main building, flanked by a Gothic chapel, is Renaissance in style.

UŽICE, the capital of the Užice department of Serbia, Yugoslavia Pop (1931) 7,481. Užice (meaning "the narrow places") is built in a narrow, lonely glen, 1,385 ft. above sea level, on a stream spanned by two mediaeval stone bridges. Though poor, it has a well-built school, in the entrance to which is a Roman altar stone, and also a girls' school where weaving is taught. The surrounding heights produce excellent tobacco, and there are linen and cotton mills. Commerce is retarded by the bad roads.

In the 13th century Užice was the seat of St. Sava, the first archbishop and patron saint of Serbia.

UZZIAH, more correctly called Azariah, was seated on the throne of Judah in succession to his father Amaziah by popular choice at the age of sixteen (2 Kings xiv. 21 *sq.*, xv. 1–7). The records assign to him a reign of fifty-two years, covering roughly the first part of the 8th century B.C., but during part of this time his son Jotham, who succeeded him *c.* 740 B.C., acted as regent, because Uzziah had become a leper. He was for some years contemporary with Jeroboam II. of Israel, and both kingdoms flourished. Uzziah repaired the walls of Jerusalem and recovered and rebuilt the port of Elath on the Gulf of Akaba. The account of his military reorganization and successful campaigns in 2 Chronicles xxvi. is probably not without historic basis. The Chronicler explains his leprosy as a punishment for infringing priestly prerogatives. A certain Azriau of Yaudi appears in the inscriptions as leading a combination against Tiglath Pileser III. *c.* 739. It has been contended that the reference is to Azariah of Judah. Despite the striking coincidence of names, it seems probable that the leader was king of Y'di, a small independent kingdom mentioned in the Aramaic inscriptions found at Zenjirli. (W. L. W.)

THE history of this letter is identical with that of *U*, from which it was not differentiated till the 15th to 17th century. The letter passed out of Latin having a majuscule pointed form V and a minuscule rounded form u and doing duty for two sounds, the high rounded vowel (English *oo*) and the voiced labial spirant (English *v*). The consonantal sound was that most usually occurring when the letter was initial, in which position the majuscule form V would most generally be used. Thus the pointed form V became identified with the consonant, the rounded form with the vowel. A minuscule *v* and a majuscule *U* were then adapted as required. (B. F. C. A.)

VAAL, a river of South Africa, chief affluent of the Orange (*q.v.*). It rises at an elevation of over 5,000 ft. above the sea in the Drakenberg mountains, of the Transvaal, about 170 mi. in a direct line west of Delagoa bay. It flows in a general S.W. direction, with a markedly winding course, across the plateau of inner South Africa, joining the Orange in 29° 3′ S., 23° 36′ E. The river valley is 500 mi. long, the length of the river being 750 mi.

The first considerable tributary is the Klip (80 mi. long), which rises in the Drakenberg and flows N W., its junction with the Vaal being in 27° S, 29° 6′ E, 12 mi. S.W. of Standerton. From this point to the eastern frontier of the Cape, the Vaal forms the boundary between the Orange Free State and the Transvaal. The river is usually shallow and is fordable at many places, known as *drifts*. But after the heavy summer rains the stream attains a depth of 30 or more feet. At such times the banks, which are lined with willows and in places very steep, are inundated. As a rule little water is added to the Vaal by its tributaries. On the north the basin of the Vaal is contracted by the Witwatersrand and the Magaliesberg ranges, and its trubutaries are few

The Mooi rises in the Witwatersrand west of the Klip and, after running almost due S 75 mi., unites with the main stream about 90 mi. below Vereeniging. In its course through Griqualand West, the Vaal flows in a wide rocky channel, with banks 30 ft. high, through an alluvial plain rendered famous in 1867–70 by the discovery of diamonds in the bed of the river and along its banks. The diamonds are washed out by the water and found amid debris of all kinds, frequently embedded in immense boulders. The last affluent of the Vaal, the Riet river, rises in the Beyers Bergen S.E. of Reddersburg and flows N W. 200 mi. through Orange Free State, being joined, a mile or two within the Cape frontier, by the Modder river (175 mi.), which rises in the same district as the Riet but takes a more northerly course. The united Riet-Modder joins the Vaal 18 mi. above the Orange confluence.

The name Vaal is a partial translation by the Dutch settlers of the Hottentot name of the river—Kai Gariep, properly Garib (yellow water) which refers to the clayey colour of the stream. The Transvaal is so named because the first white immigrants reached the country from the south by crossing the Vaal.

VAALPENS (dusty-bellies), a little-known nomadic people of South Africa, who lived in small groups in the Zoutpansberg and Waterberg districts of the Transvaal, especially along the Magalakwane river. The Vaalpens were so called by the Boers from the dusty look of their bodies, due, it is said, to their habit of crawling along the ground when stalking game. But their true colour was black. In height the men averaged about 4 ft., *i.e.*, somewhat less than the shortest Bushmen. The Vaalpens lived entirely by hunting and trapping game, and dwelt in holes, caves or rock shelters. They wore capes of skins, and procured the few implements they needed in exchange for skins, ivory or ostrich feathers. Their speech was full of clicks.

VACARESCU, the name, according to tradition, of one of the oldest noble families in Walachia. The first member of historical importance was IANACHE (b. 1654), the grand treasurer of Walachia, who was killed with his master, Prince Brancovan in Constantinople, 1714. His grandson through his son Stephan, also called IANACHE (or "Enakitza the Ban," 1730–1796), started a line of Rumanian scholars and poets; he was the author of the first known Rumanian grammar in the vernacular, printed in 1787. While in exile in Nicopolis he wrote the contemporary history of the Turkish empire in two volumes (1740–99). He was also the first to attempt Rumanian versification. Greater as a poet was his son ALECU (Alexander), who died as a prisoner in Constantinople in 1798. In 1796 a collection of his poems appeared in Rumania. His brother Nikolaes (d. 1830) also wrote some poems, but they remained in ms. until 1860, when they were published.

By far the greatest member of the Vacarescu family in the male line was IANCU (1786–1863), the son of Alexander. An ardent patriot, he sided with the national movement in 1821, and assisted in establishing the Rumanian theatre, translating many books and plays from German and French into Rumanian, notably the *Britannicus* of Corneille, a literary event of no small importance at the time. He inaugurated modern Rumanian poetry. In 1830 appeared his first volume of verse He died in 1863 A niece of Alexander was the gifted writer ELENA VACARESCU (Hélène Vacaresco) (1866–1947), maid-of-honour to the queen of Rumania, and Rumanian delegate to the League of Nations, who inherited the talent of her family and enriched Rumanian literature with her *Bard of the Dimbovitza*, and other poems and novels in Rumanian and in French, including *Chants d'Aurore*, which was crowned by the French academy; *L'Âme Sereine*, and *Rumanian Ballods*, which obtained the Prix Jules Favre at the French academy. (M. G)

VACARIUS (1120–1200?), Italian civilian and canonist, the first known teacher of Roman law in England, was of the school of Bologna, though of a later generation than the hearers of Irnerius. He was taken to Canterbury, possibly by Thomas Becket, together with a supply of books upon the civil law, to act as counsel (*causidicus*) to Archbishop Theobald in his struggle, which ended successfully in 1146, to obtain the transfer of the legateship from the bishop of Winchester to himself. Vacarius is next heard of as lecturing at Oxford, in 1149, to "crowds of rich and poor," and as preparing, for the use of the latter, a compendium in nine books of the Digest and Code of Justinian, "sufficient," it was said, "if thoroughly mastered, to solve all legal questions commonly debated in the schools." It became a leading textbook in the nascent university, and its popular description as the *Liber pauperum* gave rise to the nickname *pauperistae* applied to Oxford students of law. Nearly complete mss of this work remained in existence, notably in the cathedral libraries at Worcester and Prague and in the town library at Bruges Fragments of it were also preserved in the Bodleian and in several college libraries at Oxford

The new learning was not destined to make its way without opposition. King Stephen silenced Vacarius and ordered the destruction of the books of civil and canon law which had been imported by Theobald The edict to thus effect seems, however, not to have been in force after the death of its royal author in 1154 ("eo magis virtus legis invaluit quo eam amplius nitebatur impietas infirmare," Joh. Sarisburiensis). Whether or not Vacarius ever resumed his Oxford lectures after their interruption by Stephen is not known. In any case he was soon called to practical work, as legal adviser and ecclesiastical judge in the northern province, by his old friend and colleague at Canterbury, Roger de Pont l'Évêque, after the promotion of the latter, in the year of Stephen's death, to the archbishopric of York. Thenceforth the name of "magister Vacarius" is of frequent occurrence in papal letters and the chronicles of the period, as acting in these capacities. He was rewarded with a prebend in the collegiate church of secular canons at Southwell, half of which he was allowed in 1191 to cede to his "nephew" Reginald. He is last heard

of in 1198, as commissioned, together with the prior of Thurgarton by Pope Innocent III to carry into execution in the north of England a letter with reference to the crusade It is doubtless to the second half of the life of Vacarius that the composition must be attributed of two works One of these, *Summa de assumpto homine*, is of a theological character, dealing with the humanity of Christ; the other, *Summa de matrimonio*, is a legal argument to the effect that the essential fact in marriage is neither, as Gratian maintains, the *copula*, nor, as Peter Lombard, consent by *verba de praesenti*, but mutual *traditio*

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VACCINATION, strictly speaking, is the implanting of the living virus of cowpox in a person to protect him against smallpox The procedure was introduced to supersede "inoculation," the artificial implanting of smallpox virus, in order to protect against smallpox acquired in the natural way The inoculated smallpox commonly gave only a sparse general eruption of pocks, with a fatality rate much lower than that of the natural smallpox, which otherwise was a hazard to be expected by everyone in the 18th century.

Edward Jenner (*q v*) in his original publications of 1798–1800 did not use the term "vaccination" but spoke of "inoculation for the cow-pox." In devising a Latin term for this disease, previously without medical description, he called it "*Variolae* [plural noun meaning 'smallpocks'] *vaccinae*" (adjective meaning "of the cow," from Latin *vacca*, a cow). From this Latin of Jenner's the French in 1800 coined the term "vaccination," half in derision, for the implantation of cowpox. To the French and to those versed in Latin, "vaccination" would mean "en-cowing." "Vaccine," an adjective meaning "of the cow," then "of the cowpox," later became a noun meaning the material used for vaccination

Jennerian vaccination against smallpox was the first, and for nearly a century the only, successful immunizing procedure against any disease, other than by inoculation with, or exposure to, the real disease itself.

In 1881 Louis Pasteur demonstrated immunization against anthrax by the injection of a comparatively harmless attenuated culture of the bacillus causing that disease He then used the terms "vaccine" and "vaccination" for prophylactic inoculation in general as homage, he said, "to the merit and to the immense services rendered by one of the greatest of Englishmen, Jenner." Four years later Pasteur developed rabies vaccine His work led to wide extension of immunizing methods against many diseases with correspondingly widened meanings of the terms "vaccination" and "vaccine," applying them to the use not only of living but also of dead material.

The present article deals with vaccination in its original and stricter sense; that is, vaccination against smallpox. This is still approximately the most perfect method of immunization against any disease, judged by the security and duration of protection in proportion to its inconvenience.

Jenner, trusting too much to the stories of the country people in his neighbourhood, believed that the cowpox, and perhaps the smallpox, originated in an infection of the heels of horses. The evidence accumulated, however, that the natural occurrences of cowpox started from the hands of milkers afflicted with smallpox when the latter disease was widely prevalent. The infection was disseminated through dairy herds by other milkers on whose hands it took the changed form of cowpox. Strains of good cowpox virus were artificially started, chiefly in Germany, by transfer of smallpox virus to the cow, more readily through other animals, such as the monkey or the rabbit, first. Such strains propagated from smallpox virus were called variola vaccine.

Smallpox virus is not so easily transmitted to lower animals as is vaccine (cowpox) virus. The different establishments preparing vaccine virus have had the habit, when their particular strain showed signs of weakening, of reinforcing it with strains of virus from other establishments. Thus the strains can hardly be traced back to any one particular source. Jenner himself lost strain after strain, using new ones from time to time derived from natural cowpox found in dairy herds or their milkers. The from natural cowpox found in dairy herds or their milkers. The remarkable fact is that his descriptions and pictures of the day-to-day appearance of the vaccinated arm, and the descriptions and pictures of the most careful observers since his publication, have coincided exactly with the appearance of arms vaccinated with good strains of modern vaccine virus, particularly the rapid spread of the area of redness surrounding the vesicle after the seventh day in a previously unimmunized person This is different from the appearance after any other sort of inoculation, and such an inoculation has always given protection against smallpox anywhere in the world Even the obsolete inoculation with smallpox virus itself produced a different course of events as to the inoculated arm, besides later giving rise to an eruption of pustules over the other areas of the body

Originally the virus was carried from arm to arm, the vaccinated persons being told to return on the seventh day so that the contents of the clear vesicles at that time could be transferred to the arms of the next set to be vaccinated. Crusts of the dried vesicles, or vesicle contents dried on quills or threads or ivory points, were also used. Later, strains of vaccine virus were carried back to the cow for one or more passages in an attempt to make them stronger This was called "retrovaccination." By the early years of the 20th century nearly all vaccine virus was propagated on calves (carabao in the far east), suspended in glycerine solution and distributed in hermetically sealed capillary tubes Occasional passage through other species, such as the rabbit, appears to aid in maintaining the purity and the potency of the virus. In Spain rabbit-brain virus was used instead of calf virus, and many essays have been made to substitute growth in the chick embryo (fertilized egg) for growth on the bovine skin A theoretical objection to such procedures—not without some confirmation in experience—is that the virus should not be adapted to deep proliferation in the layers of body tissue; human vaccination is safest from disagreeable results when it is as superficial as possible Dried virus has also been used, and, though inconvenient and expensive to dilute unless many are to be vaccinated at one time, it has served a useful purpose where prolonged transportation to warm climates is necessary. The greatest advance in the prevention of smallpox in the 20th century was the cold storage of the vaccine virus (below freezing) up to the time of use.

Need.—Increased global travel, the presence of virulent strains of the disease in various parts of the world (*see* also SMALLPOX OR VARIOLA), its great contagiousness and the fact that no population is sufficiently vaccinated to be proof against a smallpox epidemic are sufficient reasons for keeping up vaccination in spite of the remarkable decline in smallpox cases. Vaccinations regularly carried out are preferable to emergency vaccination of a population at risk. All foreign travellers in both directions need the successful application of fully potent vaccine before undertaking the journey.

Efficacy and Time of Vaccination.—Jenner was misled into thinking that one successful vaccination gave lifelong protection. It is possible that the continual exposure to smallpox to which people were subject in his day tended to keep up the immunity initiated by cowpox Vaccination every five years is a safe general rule, but for nurses, physicians and hospital attendants constantly in danger of exposure, and for foreign travellers in similar danger, once a year is safer There is always the danger that the tube of vaccine used may not have been constantly refrigerated; this explains accounts of smallpox after recent vaccination. A case of smallpox within two years after a successful vaccination is extremely rare even though exposure is ample, and such a case of the disease is mild There are great differences between individuals in the firmness of holding on to immunity toward smallpox, just as there are toward other infections A not inconsiderable proportion of a population might be protected against smallpox for life by one vaccination, though they would lose their immunity to vaccinia (cowpox) more readily. Long after complete protection subsides, a former vaccination modifies the severity of an attack of smallpox.

There are great advantages in having the first vaccination performed during the early months of life. Infantile vaccination, if properly performed and cared for, is milder than a later first vaccination, usually giving rise to no inconvenience whatever; it makes the subsequent vaccinations, if decades are not allowed to pass without revaccination, much milder affairs Protection is gained not only against smallpox but also against accidental vaccination from the arm of a playmate or associate, and the scar of such an early vaccination becomes much less noticeable than if the first vaccination is performed later. The first spring of a child's life is probably the most favourable time for vaccination

Disadvantages.—The former and cruder methods of preparing the vaccine and performing the inoculations, together with the stern measures with which compulsory vaccination was enforced, naturally aroused opposition. One cannot expect something for nothing, and the remarkable protection which vaccination bestows is bound to entail a slight risk, at least of inconvenience. With proper vaccine, procedure and care, the risk is negligible compared to the advantage to the community and the individual. Clean technique, with a small adequate inoculation in only the most superficial layers of the skin, on an arm which is kept dry and cool, covered by no dressing except the loose clean sleeve of the child's garment, ensures for the great majority of vaccinations a perfectly satisfactory course. No practical cleansing can remove all the bacteria from the skin, however, and occasionally, especially in leg vaccinations, the vesicle may become purulent on this account and the drying process be delayed or even require attention Eruptions soon after the maximum reaction are seen at times but disappear rapidly without treatment. Tetanus following vaccination formerly occurred once in a while, but later was entirely prevented by proper technique and particularly by allowing the vesicle of vaccination to dry naturally without dressing, shield or bandage Authentic cases of demyelination encephalomyelitis have been reported after vaccinations as after other inoculations or infections, but never where the above precautions were followed and the first vaccination was performed in early infancy.

Course.—In a first vaccination on a child with good vaccine and good technique, nothing is usually seen until the third day, when a papule (pimple) appears at the site The central part of this papule soon develops into a vesicle (that is, contains fluid) and is surrounded by a narrow red zone It is the behaviour of this red zone which constitutes the characteristic and important detail in the course of the reaction. While the vesicle is enlarging at the rate of about a millimetre a day in diameter, the red zone remains of moderate size until about the 7th day, when it rapidly begins to enlarge, reaching its greatest diameter between the 8th and the 14th day after vaccination, then disappears as rapidly The vesicle meanwhile continues to enlarge slowly, but before the height of the reaction is reached starts drying from the centre, forming a dark crust (scab) which drops off about three weeks after vaccination, leaving a clean pink scar which becomes white in about a year. A day or two of fever is often observed without particular relation to the course of the reaction. Care should be taken (as in bathing) to keep moisture away from the vesicle and crust until the latter comes off. The reaction above described is called primary vaccinia.

In more than half the revaccinations performed with fully potent vaccine on a group of people who had their previous vaccinations 10 to 40 years before, the appearance of the arm on successive days will be somewhat similar to that described in the preceding paragraph except that the course will be accelerated to give the greatest diameter of the red zone between 72 hours and seven days after vaccination; usually the spread and subsidence of the redness is more gradual than in vaccinia. Such a reaction is called vaccinoid and indicates partial protection against smallpox.

In what may be called the early reaction of vaccination the broadest redness occurs within 72 hours after vaccination and there may or may not be a vesicle. One is not justified in saying that this indicates previous complete immunity against smallpox unless full potency of the vaccine can be assured; the history of the cold storage and the results with that batch of vaccine are seldom sufficiently known. Practically an exact counterpart of the early reaction or even one simulating the vaccinoid reaction may be given on a person with little or no immunity when vaccine of less than full potency is used.

If observation is thorough, every adequately performed vaccination with potent vaccine will be found to give a reaction which can be classified in one of the above categories: vaccinia, vaccinoid or early reaction.

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(J. P. L.)

VACCINE THERAPY. Vaccine therapy results in the induction of a state of active immunity in an individual, either for the purpose of preventing the development of a specific infectious disease, or in some cases as a means of treatment of an already established infection The actively immune state is induced in the person or animal being immunized by the introduction into the body of a vaccine composed of suspensions of living or dead microorganisms of a specific kind, or of some of their metabolic products. These substances in the vaccine stimulate the body cells to modify normal globulin molecules so that they acquire a very high degree of specificity against the disease-producing micro-organisms or their products from which the vaccine was originally prepared The altered globulin molecules or antibodies, as they are called, are the immune substances in the blood, and distributed throughout the body, which combat the subsequent invasion of the microorganisms, or help control the multiplication and spread of infectious agents already established in the body.

The principle of using a less virulent, or attenuated, microorganism to induce active immunity for protection against a particular disease originated in the orient. In ancient times the crusts from lesions of very mild cases of smallpox, containing the weaker virus, were applied in one of several ways to the skin or nasal mucous membranes of persons who wished protection against a severe case of smallpox The Turks accomplished the same purpose by scratching the crusts from lesions of mild smallpox into the arm of the person to be immunized This procedure, known as variolation, was introduced into England by Lady Mary Wortley Montagu (1689–1762). The practice was not free from risk, and some persons developed a virulent generalized case of smallpox and died.

To Edward Jenner, a British country physician, goes the credit for his discovery, reported in 1798, that infectious material (vaccinia virus) from lesions of cowpox (vaccinia) could be inoculated artificially into the skin of man, and thus induce immunity against smallpox Hence the terms vaccination and vaccine were originally used only in relation to immunization against smallpox with vaccinia virus. Louis Pasteur and others later applied the same principles to the prophylaxis of other virus, bacterial and rickettsial infections. Consequently, the term vaccine came to be used in a broader sense, including suspensions of living attenuated or dead infectious agents, emulsions of their cellular constituents and solutions of their altered metabolic products (toxoids). Sir Almroth Wright extended the principles of active immunization to include not only the prevention but also the treatment of infectious diseases. Regardless of whether the desired result of active immunization is the prophylaxis or therapy of a particular infectious disease, the procedures of vaccine preparation and immunization are essentially the same The person to be immunized is usually inoculated with the vaccine by intradermal, subcutaneous or intramuscular injections at regular, specified intervals. The degree of immunity resulting from the administration of a vaccine is quite variable; it depends on several factors including the antigenic potency of the preparation, the dosages given, the time interval

between injections and the degree of ability of the person to produce anibodies when properly stimulated

Early successes in the development and use of vaccines in the prevention of smallpox, anthrax and rabies encouraged attempts to develop actively immunizing agents for many other diseases. Effective vaccines were also developed for active immunization against typhoid and paratyphoid fevers, cholera, plague, tuberculosis, undulant fever, whooping cough, tularaemia, chronic staphylococcal and streptococcal infections, diphtheria, tetanus, influenza, yellow fever, Japanese B encephalitis, Russian tick-borne encephalitis, St. Louis encephalitis, equine encephalomyelitis, Rocky mountain spotted fever, typhus and against several important diseases of animals.

A true evaluation of the efficacy of vaccine prophylaxis is exceedingly difficult to obtain for many diseases It may be readily understood that it is often impossible to arrange experiments involving sufficient numbers of individuals in the inoculated and uninoculated or "control" groups to assure statistically significant analyses of the results This is particularly difficult in diseases which have relatively brief incubation periods, or in which exposure to the disease is irregular and unpredictable, such as those diseases which do not ordinarily occur in epidemic form in the population. At mid-20th century, adequate statistical data concerning the effectiveness in humans of some of the virus vaccines was still lacking, although protection tests in experimentally infected animals indicated their probable value. The difficulty in correctly evaluating the effectiveness of vaccines is even greater when they are employed in the treatment of individuals already suffering from an established infection. Such cases must be judged separately; other therapeutic measures and the possibility of coincidence must be seriously considered when attempting to form a correct estimate of the value of vaccine therapy. In many diseases, such as typhoid and paratyphoid fevers, there is overwhelming evidence for the high degree of protection established by vaccination; in other diseases there is evidence of definite value from vaccination, even though it may not always be protective, as in whooping cough; in still others, the results of vaccination are equivocal. However, there is no question concerning the importance of specific active immunization.

Types of Vaccines.—There are two main types of vaccines—stock or heterogenous, and autogenous. Stock vaccines are prepared from microorganisms previously isolated from persons having a particular infectious disease After identification of the causative agents, they are cultivated or stored in the laboratory. Since bacteria of the same species may exhibit biological variations and minor differences in antigenic structure, stock vaccines may be composed of several different strains of the same species, thereby rendering the vaccine polyvalent. Treatment with such polyvalent stock vaccines is of distinct value particularly in certain chronic infections. Obviously stock vaccines must of necessity be used only in an attempt to immunize the normal individual prior to exposure to infection by the corresponding infectious agent.

Autogenous vaccines are prepared from the actual microorganism isolated from the particular patient being treated. Such preparations are definitely superior to even polyvalent stock vaccines in the treatment of chronic infections, such as sinusitis or pyoderma, since the resulting antibodies developed are entirely specific for the particular agent causing the disease.

For the prevention of tetanus and diphtheria, diseases in which the chief symptoms and pathology result primarily from the effects of the bacterial toxins in the body, the modified toxins, or toxoids as they are called, comprise the vaccine, and stimulate the production of immunity which is antitoxic rather than antibacterial.

Preparation of Vaccines.—Bacterial vaccines, whether stock or autogenous, are prepared in a manner somewhat as follows: the selected microorganism is grown, usually on a solid culture medium under conditions which are optimum for maximum growth. The resulting bacteria are suspended in a sterile physiological solution of sodium chloride, washed by centrifugation and resuspended in more of the sterile saline solution. If the vaccine is to be composed of intact bacterial cells, the microorganisms are usually killed, either by heating in a water bath at 60° C. for one hour or by the addition of some chemical The number of bacteria per unit volume of suspension is determined by any of several ways. by density determinations, by chemical analyses or by direct or proportional microscopic counts The bacterial suspension is then adjusted to the desired standard by either dilution or concentration, as the need may be, and cultured to ensure its sterility. The standardized sterile vaccine is stored in sterile glass vials or ampuls and is ready for use.

If the vaccine is to be composed of fragments of bacterial protoplasm, rather than of the intact bacteria themselves, the bacteria are killed by disrupting the cells, after their concentration is standardized, either by repeated rapid freezing and thawing of the suspension, by grinding in a ball mill, by ultra-violet irradiation or by ultrasonic vibrations The resultant mixture of bacterial antigens is tested for sterility to ensure its noninfectivity, and a preservative, such as phenol, is added in proper concentratidn.

Virus and rickettsial vaccines are prepared in a manner somewhat similar to the above, except that these microorganisms must be cultivated in the presence of living animal cells. Ernest Goodpasture's development in 1931 of the embyronated hen's egg as a culture medium for many viruses and rickettsiae provided the opportunity for producing vaccines of many of these infectious agents.

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(J. W R.)

VACCINIUM, a genus of shrubs of the heath family (Ericaceae, *q.v.*), comprising about 130 species found widely throughout the northern hemisphere, and extending to Madagascar and the Andes

They are erect or creeping shrubs, with deciduous or evergreen leaves The small flowers bear much resemblance to those of the true heaths (*Erica*), from which they differ in having the ovary inferior. The fleshy, often delicious, berries are usually edible. Four species occur in Great Britain: *V. myrtillus*, the bilberry, blaeberry or whortleberry; *V. uliginosum*, the bog bilberry; *V. vitis-idaea*, the red whortleberry or cowberry; and *V. oxycoccos*, the cranberry (*q.v.*), all of which are found widely distributed throughout large areas in Europe, Asia and North America, being especially abundant in cool northern and mountainous regions.

In North America some 40 species occur, more abundant in the northern and mountainous parts of the continent. In the eastern states and adjacent Canada several species, commonly known as blueberry (*q.v.*), are prized for their fruits. In northern Canada the red whortleberry, commonly called mountain cranberry, is gathered for cooking purposes. *V. macrocarpon*, the American cranberry, is extensively cultivated Several species occur in the Rocky Mountain region and about ten are found in the Pacific states, the latter including *V. occidentale*, the western blueberry; *V. parvifolium*, the red bilberry; and *V. ovatum*, the California blueberry.

VACUUM, empty space, specifically, an enclosed space devoid of matter. Physically, the condition of complete absence of matter is never realized; even the most nearly perfect vacuum contains gas or vapour in a state of great rarefaction—how great may be realized by considering that the lowest practicably attainable pressure in a tight vessel is of the order of 10^{-7} mm. of mer-

cury, whereas atmospheric pressure is about 8.75×10^5 mm.—the height of the mercury column in a barometer. The ratio of these pressures is about 1.3×10^{-10}; in round numbers, therefore, the pressure in the vessel, as well as the number of molecules of gas in it, has been reduced by a factor of 10,000,000,000. In each cubic centimetre of gas at normal atmospheric pressure there are 2.7×10^{19} molecules. Reducing the pressure to the practicable limit therefore reduces the number of molecules by a factor of, say, 10^{10}, leaving behind 2.7×10^9 molecules, or roughly 3,000,000,000, in each cubic centimetre of space within the vessel. Whereas at atmospheric pressure the mean free path (average distance covered between collisions) of a molecule in air is about 9.5×10^{-6} cm., this becomes 14 m. at the low pressure mentioned.

During the years between the World Wars I and II, and particularly during the prodigious scientific and technological efforts in the United States and Great Britain brought forth by the exigencies of World War II, great strides were made in the application of high-vacuum technology to many problems and situations, both in the laboratory and the factory, in fields of great diversity in pure and applied science.

It is general knowledge that Thomas A. Edison's incandescent electric lamp required that its glass envelope or bulb be "pumped out" to prevent its carbon filament from uniting with the oxygen of the air and chemically burning out. The commercial needs of rapidly exhausting the air from light bulbs resulted in improvements in methods of pumping. The "Edison effect"—forerunner of the Fleming valve, the Deforest audion, and the multitude of modern electronic tubes—was discovered because it had become possible by 1883 to pump the air out of a lamp bulb to the point where a current through the residual gas could be detected. The rapid growth of the radio industry, accompanying the development of broadcasting methods and of means for broadcast reception, which occurred in the decade beginning about 1920, could not have occurred without the concomitant development of techniques for exhausting the radio valves, or vacuum tubes, to the requisite high vacuum by methods that were technically and economically feasible

Metallurgical processes by which such rare metals as tantalum and tungsten are produced in pure state from their ores depend for their success on high-vacuum furnaces in which the vacuum can be rapidly produced and readily maintained while the metallic bars, at white heat, are giving off great quantities of gas. Practically all optical instruments used in World War II were greatly improved in their ability to transmit light by having the optical surfaces of their lenses and prisms coated or "bloomed" with a hard, transparent mineral layer a few molecules thick, to reduce the reflection and therefore loss of light at these surfaces. The coating process is carried on in a high vacuum, and its development to commercial practicability comprises many highly ingenious procedures. In the optical field also, the best first-surface mirrors are produced by a vacuum distillation process, in which the metal is vaporized by electric heat and caused to condense on the glass surface from which light is to be reflected. The mirrors of practically all astronomical reflecting telescopes are now prepared by evaporation and condensation of metal—usually aluminum—in a high vacuum.

The production of vitamin A from fish-liver oil, by fractional distillation in a high-vacuum still, is now a highly successful commercial process; but this is only a single example of a well-developed technology in the fields of nutrition and pharmacology yielding useful and valuable and sometimes unexpected returns. High-vacuum technology plays an essential role in the production, in commercial quantities, of penicillin, and in the rapid dehydration of blood plasma and serums

In the basic science laboratories, particularly those of physicists, the availability of apparatus for the rapid production of high vacuum has profoundly influenced the success of many researches. It has, in fact, been the *sine qua non* of some of the most fundamental experiments in electronics, nuclear physics and X-rays Without high vacuum there would be neither radio broadcasting nor radio reception; and without it, television could not have been developed. For it is only in high vacuum that the electrons may be given off and controlled to make tubes and circuits possible in which a weak signal may be amplified ten-millionfold and more; and it is in high vacuum that light may cause useful emission of electrons from a photosensitive surface which constitutes the heart of the television transmitter. The cathode-ray oscillograph, one form of which is essential to the production of a visible image in a television receiver, likewise depends on high vacuum. The cathode-ray oscillograph may be said to have saved England, for it is one of the essential components of radar. The cyclotron, the betatron, the electron microscope, the mass spectrograph—all are useful, practicable instruments because of high vacuum. The separation of U-235, the fissionable atom of uranium, from its isotopes of atomic weights 234 and 238, was accomplished in high vacuum, in a magnetic field, by applying the principle of the mass spectrograph.

These examples from industry and the research laboratory have been cited to show the importance of vacuum, and particularly of modern high-vacuum technology. The requirements of the innumerable situations in which high vacuum is an essential factor have given rise to a modern technology that may be designated "high-vacuum engineering" This comprises a knowledge of the means for producing high vacuum, namely, the several kinds of vacuum pumps, formerly called air pumps; the means for measuring vacuum—the several kinds of manometers or vacuum gauges; and the unusual methods and artifices that must be employed in order that a vacuum system—consisting of the pump or pumps, the vessels or containers being exhausted, the measuring and controlling devices and the tube-lines connecting all together properly—may function most effectively These several aspects of production and measurement of high vacuum and the management and control of vacuum systems will be discussed in this article.

Rotary Oil-Sealed Pumps.—About 1920 the reciprocating-piston vacuum pump was displaced by the rotary mechanical types Some ten years earlier the Gaede *Kapselpumpe* had appeared It was characterized by a cylindrical rotating member, or rotor, eccentrically mounted within a cylindrical housing, or stator, of somewhat larger diameter (fig. 1). The rotor A contained two diametrically opposite slides, S and S′, bearing against the inner surface of the stator B under spring pressure and centrifugal action Air in the space V_0 ahead of the slide S′ is swept out through an exhaust port, as the volume of the space decreases; whereas, behind the slide S the volume increases, causing air to enter through an intake port from the vessel being exhausted. Air in the space V between the two slides, at the pressure of that in the vessel being exhausted, is compressed, as soon as slide S′ has passed the exhaust port and V has become V_2, to atmospheric pressure, and is expelled through the valve E to atmosphere. Small clearance and an oil film at C keep the compressed gas in V_2 from entering V_1. Many rotary pumps of various specific designs but employing the same principle have appeared and are in common use in shops and laboratories. The Gaede rotary *Kapselpumpe* was designed to serve as a primary or forepump (Ger.: *Vorpumpe*) in series with the Gaede rotary mercury pump with which high vacuum could be slowly produced. More recent designs of rotary pumps have been used in large numbers as forepumps with the mercury vapour diffusion or condensation pumps, and with the oil-vapour pumps of this type.

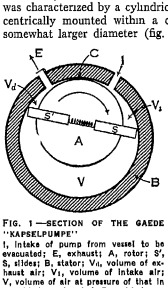


FIG. 1—SECTION OF THE GAEDE "KAPSELPUMPE"
I, intake of pump from vessel to be evacuated; E, exhaust; A, rotor; S′, S, slides; B, stator; V_0, volume of exhaust air; V_1, volume of intake air; V, volume of air at pressure of that in vessel being exhausted; C, seal between stator and rotor

The type of rotary pump, which was responsible for displacing the reciprocating air pump from laboratories generally, is a series known as "Hyvac"—with displacements ranging from about 170 cc. to 17,000 cc. per second. These represent the first rotary,

oil-sealed pumps capable of producing a vacuum—with exclusion of vapour from the system—of better than 0·001 mm of mercury In principle this type differs from the pump of fig 2 in having its rotor eccentrically mounted on a shaft, and in having a single vane in the stator to separate the high-pressure from the low-pressure side.

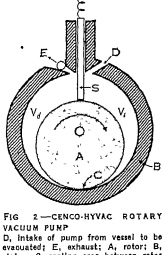


FIG 2.—CENCO-HYVAC ROTARY VACUUM PUMP
D, intake of pump from vessel to be evacuated; E, exhaust; A_1 rotor; B, stator; C, sealing area between rotor and stator; S, slide; V_d, intake volume; V_d, exhaust volume

In fig 2 Rotor A is eccentrically mounted on a shaft concentric with the cylindrical cavity of stator B At C the surface of the rotor is ground, for a short distance, on a radius almost equal to that of the stator cavity, to provide sealing contact over a finite area rather than along a cylindrical element, or line The slide S is maintained in contact with the rotor by spring pressure. The intake is at D, the exhaust port at E; the latter is provided with a ball valve With rotation as indicated, the space V_i increases and V_d decreases at each cycle from the instant of passage of the sealing area C beyond the slide S. In its practical embodiment, this pump may consist of two pumping units in series. They are arranged side by side, separated by a common wall, ground plane-parallel, through which a hole is drilled that constitutes both the exhaust port of the high-vacuum unit and the intake port of the forepump unit. While the space V_d in the former is decreasing, it is expelling the air into the space V_i of the latter. Thus the air in the space V_d of the high-vacuum unit is not compressed appreciably. As a result, leakage into the high-vacuum side is minimized. In illustration of the effectiveness of such an arrangement, a single-stage pump of this type produces a vacuum of about 0·05 mm, whereas the two-stage pump produces about 0.0005 mm., two orders of magnitude better.

Pumps Utilizing Liquid Mercury.—In the second half of the 19th century various types of mercury pump were introduced, which were used in all the early experiments on the discharge of electricity through gases at low pressure. The principle of all these pumps is to connect the receiver with a Torricellian vacuum created by the pump, the equalization of pressure will then bring part of the air in the receiver into the Torricellian space. The receiver which is being exhausted is then cut off from the vacuous space, and the vacuum re-created Thus process can be carried out in various ways. The simplest and earliest form of apparatus is that described by Heinrich Geissler in 1862. This consists simply of a vessel connected by a flexible tube to an open reservoir of mercury, the vessel can by means of a two-way stopcock be connected either with the outside air or with the space to be exhausted. The stopcock being turned so as to give passage to the air, the reservoir is raised until the vessel is full of mercury; the stopcock is then turned so that the vessel is cut off from the air and connected to the space to be exhausted, and the reservoir is lowered. This tends to create a Torricellian vacuum in the vessel, into which the air from the space being exhausted rushes. The cycle can be repeated as often as desired, the fraction of air removed each time depending upon the relative volumes of space to be exhausted and the vessel.

A type of pump possessing many advantages over the Geissler pump was devised by August Töpler; it avoids all stopcocks, the connections and disconnections being made by the mercury itself. An improved form of Töpler pump is shown in fig. 3, from which the working of the pump can easily be understood. V is a cylindrical vessel connected by the tube S to the space to be exhausted. M is a mercury reservoir which must be of somewhat greater capacity than V. When the mercury levels are as in fig. 3, V contains gas at the same pressure as S. The reservoir M is then raised; the mercury rises in the tube Z, cutting off V from S, and fills the vessel V, driving the gas from it down the tube T. The gas being thus expelled, M is lowered again, and the vacuous space V is once more in connection with S The process is repeated as often as may be required. A valve at C, consisting of a glass float, the top of which is ground to fit on a seating at O, serves to prevent the mercury ever passing over into the vessel S, while the inclined position of the cylindrical vessel V has, among other advantages, that of lessening the shock of the rising mercury against the top of the vessel. Pumps of the Töpler type were widely used for producing a vacuum in the researches of the first ten years or so of the 20th century, but were then gradually superseded by rotary and other types. Pumping with them was a tedious business. By mid-20th century they were used only when it was desired to collect the gases which were being pumped out, a purpose for which they are excellently adapted.

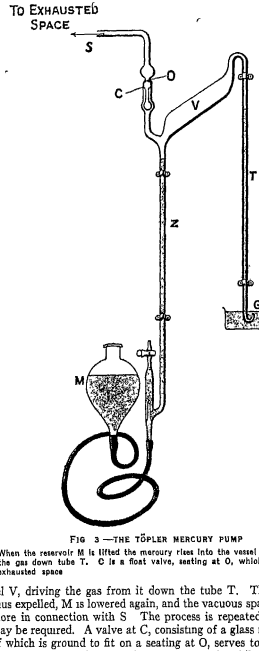
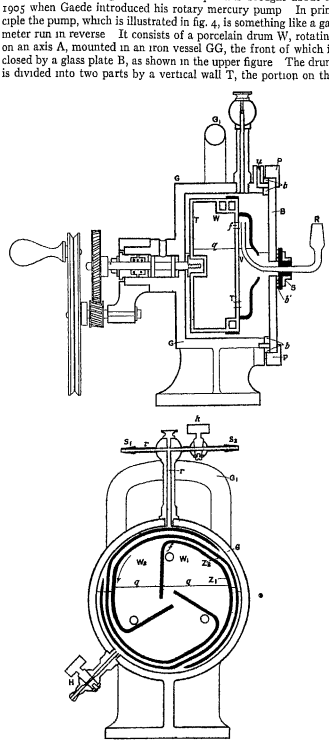


FIG 3.—THE TÖPLER MERCURY PUMP
When the reservoir M is lifted the mercury rises into the vessel V, and expels the gas down tube T. C is a float valve, seating at O, which cuts off the exhausted space

To avoid the tedious raising and lowering of the reservoir, a process which may have to be carried out for an hour or two to obtain the desired vacuum, automatic mercury pumps were devised. The earliest was that of Herman Sprengel, which consists essentially of a narrow tube down which mercury flows in a succession of drops, filling the bore of the tube, from a reservoir; the top of the tube is connected to the space S to be exhausted. If the tube is of barometric height the pressure at the top will be zero, air will pass into it from S, and will be carried down as bubbles by the mercury and discharged into a collecting vessel or into the air, as desired. This type of pump was much improved by Gimingham in 1877, and in this form used by Sir William Crookes in his ex-

tensive investigations on electrical discharges in vacuum tubes These pumps were not strictly automatic, in that the reservoir gradually emptied and had to be refilled by hand Devices were introduced by which the reservoir could be kept automatically refilled, a typical pump of this kind was that of G W. A Kahlbaum (1894), in which the flow of mercury was maintained by the help of a water-operated filter pump of ordinary type The Sprengel type of pump, which came to be extensively used, like the widely known Töpler type, was the subject of many modifications.

A revolution in high-vacuum technique was brought about in 1905 when Gaede introduced his rotary mercury pump In principle the pump, which is illustrated in fig. 4, is something like a gas meter run in reverse It consists of a porcelain drum W, rotating on an axis A, mounted in an iron vessel GG, the front of which is closed by a glass plate B, as shown in the upper figure The drum is divided into two parts by a vertical wall T, the portion on the right of this wall enclosing a space V which communicates through the tube R with the vessel to be evacuated The portion to the left of the wall is divided into three compartments by walls of the shape shown in the lower figure. The pump is filled with mercury up to the level qq When the drum rotates in the direction of the arrow the compartment W_1, which communicates with V by the hole f, is filled with gas from the receiver, while the gas in the compartment W_2, drawn from the receiver just before, is displaced by the mercury and ultimately passes into the space between the revolving drum and the casing The action is continuous It is, however, clearly necessary that the pressure prevailing in the space between drum and casing shall not exceed a few millimetres or so of mercury; the pump must therefore be run in connection with a suitable foreepump, which first reduces the pressure to a value at which the rotary mercury pump can be put in operation, and subsequently removes, as long as necessary, the gases displaced by the mercury pump. The forepump is connected to the tube S_2, the other branch S_1 being connected to a rough mercury gauge



BY COURTESY OF E LEYBOLD, KÖLN

FIG. 4.—GAEDE'S ROTARY MERCURY PUMP

As the drum W rotates, the air is displaced from the chamber W_2 into the space between drums and casing G, and is drawn from the receiver into the chamber W, through opening f. The chamber W, moves into the position of chamber W_2, and the process is repeated

With mercury pumps of this type a pressure as low as 10^{-5} mm , as measured with the McLeod gauge, can be attained There is, however, always the pressure of the mercury vapour itself, amounting to about 0.001 mm at ordinary room temperature, unless special precautions are taken to trap the vapour between pump and receiver. Moreover, the pump cannot deal with condensable vapours, such as water vapour, for the decrease of volume of the chamber during the expulsion of the gas leads to condensation of the saturated vapour in the drum. The pump requires about 40 lb. of mercury. It has, however, the advantage that it can be stopped without detriment to the vacuum already attained, which cannot be done with other types of pump to be described. The speed is about 100 cc. per second over a wide range, an exceedingly slow rate as compared with modern pumps

Aspirators and Ejectors.—When water flows through a pipe with a constricted section, the pressure in the region of higher velocity, at the narrow section, is lower than it is in the larger sections of the pipe. Because of the reduced pressure, air or other gas may be drawn into the stream through an opening in the pipe at the reduced section. This simple application of Bernoulli's principle is the basis for the water aspirator, a form of air pump usually attached to a water tap, and operated by opening the cock A side arm, with the opening into the section at reduced pressure, provides means for connection of the receiver to be exhausted A well-designed aspirator is rapid and produces a pressure of between 15 mm and 25 mm., depending on the temperature of the water, the attainable limit being the vapour pressure of the water This simplest of air pumps is useful for many operations in the laboratory that do not demand high vacuum, but it is not adapted to serving as a forepump for condensation and diffusion pumps (*see* PUMP).

In principle the steam ejector resembles the water aspirator, except that the operating fluid is steam. The gas being pumped is drawn into the high-speed jet of steam. Such an ejector, operating into atmospheric pressure, may produce a pressure of the order of 50 mm. to 100 mm. To produce lower pressure by the same means, two ejectors may be used in series, with a resultant pressure of about 25 mm to 50 mm Still lower pressure is thus attainable by adding another ejector to the series, usually with a condenser interposed between the second and third ejector This condenses the working steam from the ejectors operating at lower pressures. With three ejectors, a pressure of 0.1 mm. has been achieved; with five in series, a pressure of 0.03 mm has been reached. This is sufficiently low for many industrial uses.

If the steam ejector worked on exactly the same principle as the water pump, the lowest pressure obtainable would be that in equilibrium with steam at room temperature, or 15 mm to 20 mm. Hg That much lower pressures are obtainable is evidence that all the molecules of steam in the high-vacuum jet have been given a velocity so far in excess of their normal thermal velocity that few can return into the evacuated space.

Ejectors employing steam or oil vapour are employed as forepumps and booster pumps in modern vacuum systems.

Mercury Diffusion and Condensation Pumps.—In 1915

Gaede once again appeared with an idea for making the processes developed on the basis of the kinetic theory of gases work toward the production of a high vacuum The scheme of operation of his diffusion pump may be understood by reference to fig 5. A stream of mercury vapour passes upward in a tube which has a side branch closed with a porous plug or narrow slit through which gases may diffuse The branch connects a vessel containing air at reduced pressure. The pressure of the mercury vapour may be of the order of 1 mm , corresponding to the temperature at which evaporation occurs. Some of the vapour diffuses through the barrier into the space containing air and this, in greater part, condenses; at the same time, air diffuses in the opposite direction, where the molecules are entrained in the blast of vapour. The rates of diffusion in opposite directions depend on the respective molecular weights, the mean size of the capillary passages in the diffusion barrier, and the partial pressures on opposite sides of the barrier of the two gaseous mediums Thus the diffusion of the air into the vapour stream will continue so long as there is air in the vessel connected to the side arm, and theoretically approaches a perfect vacuum. Although the mercury continues to diffuse in the opposite direction, its vapour pressure on the right of the barrier remains low, corresponding to the low temperature of its surroundings, namely that of the cooling jacket surrounding the exhaust tube

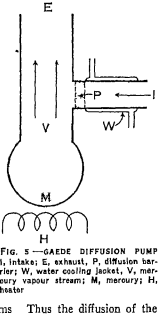


FIG. 5.—GAEDE DIFFUSION PUMP I, intake; E, exhaust, P, diffusion barrier; W, water cooling jacket, V, mercury vapour stream; M, mercury; H, heater

Because of the manner in which diffusion takes place in a gas, the porous plug or Gaede's equivalent of it, a narrow slit, is not necessary In Gaede's original pump, the blast of mercury vapour was made to pass a narrow slit through which the air diffused into the stream of vapour. According to his reasoning, the greatest speed of pumping was attained when the width of the slit was of the same order as the mean free path of the air molecules. The mercury vapour diffusing through the slit was immediately condensed on a cooled surface opposite the slit. Although the pump produced a vacuum higher than had heretofore been attained, its speed was slower than that of the Gaede rotary mercury pump.

By eliminating the slit and arranging for cooling of inner wall surfaces in such a manner that the mercury vapour could not diffuse back into the vessel being exhausted, or prevent the air from diffusing rapidly into the stream of vapour, Irving Langmuir greatly increased the speed of exhaust and rendered the pump less subject to variations in performance with changes in temperature of the boiler Langmuir reasoned that the mercury molecules could readily be prevented from diffusing in the direction opposite that of the air molecules by cooling the walls of the tube at a point just beyond the tube through which the air is diffusing into the vapour stream. Thus, the air molecules are rapidly carried away from their outlet, the vapour is rapidly condensed, and the temperature in the vicinity of the outlet is maintained so low that practically no mercury is re-evaporated in this region Because of the dependence upon condensation of the mercury vapour for proper functioning, Langmuir designated this type as a condensation pump, as distinguished from Gaede's diffusion pump. However, both types depend upon both diffusion and condensation for operation. Gaede's has a restricted area through which diffusion takes place, whereas Langmuir's has a large area. Modern refinements in condensation pumps have given them extremely high pumping speeds, speeds limited only by the physical dimensions that are practicable in specific cases.

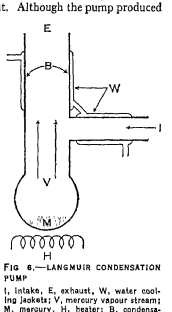
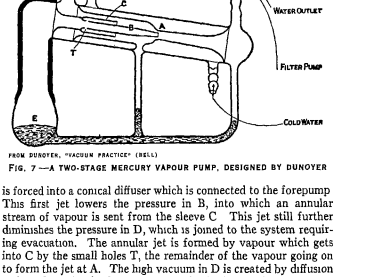


FIG 6.—LANGMUIR CONDENSATION PUMP I, intake; E, exhaust, W, water cooling jackets; V, mercury vapour stream; M, mercury, H, heater; B, condensation surfaces for mercury vapour

Mercury Vapour Pumps.—Two- and three-stage mercury vapour pumps, in which the stages are arranged in series, so that the high pressure side of one is the low pressure side of another, are made for rapid work. Since at very low pressure the mercury vapour stream loses its jet form, the stream in a diffusion pump exerts no action such as the steam jet does in an ordinary injector However, at higher pressures the Bernoulli effect comes into operation, and is utilized in the preliminary stage or stages of a multiple stage pump, where, because of the higher pressure, the diffusion principle is less effective. One of the early two-stage mercury vapour pumps as designed and built by Dunoyer which will work against a forepressure of 25 mm. or 30 mm. is illustrated in fig. 7. The first mercury jet A acts like the steam injector, and is forced into a conical diffuser which is connected to the forepump This first jet lowers the pressure in B, into which an annular stream of vapour is sent from the sleeve C This jet still further diminishes the pressure in D, which is joined to the system requiring evacuation. The annular jet is formed by vapour which gets into C by the small holes T, the remainder of the vapour going on to form the jet at A. The high vacuum in D is created by diffusion and condensation in the same way as in the Langmuir pump



FROM DUNOYER, "VACUUM PRACTICE" (BELL)

FIG. 7.—A TWO-STAGE MERCURY VAPOUR PUMP, DESIGNED BY DUNOYER

Oil Vapour Pumps.—For many years mercury was the only pumping fluid used in diffusion and condensation pumps. Beginning about 1929 C. R Burch in England and K. C. D. Hickman in the United States prepared some organic oils which proved to be useful as pumping fluids Some of these have extremely low vapour pressures, a property which was exploited to obtain lower pressures. The principles underlying mercury vapour pumps are also basic to oil vapour pumps Recognizing that oils contain components which, because of their different vapour pressures, boil at slightly different temperatures, Hickman developed the fractionating pump. Two of the first practicable fractionating pumps are shown in Pl. I, figs. 2 and 4 The two-stage fractionating pump seen in Pl. I, fig 4 is made of glass and is capable of producing a vacuum of the order of 10^{-7} mm. in a closed system This is made possible by a design which by application of known principles of distillation and condensation controls the passage of oil and oil vapour through multiple boilers. After the unit has run for a short time, the extreme volatiles have been distilled into the alembics of the vertical tube. The condensed oil from the jets returns to the first boiler (boiler under the vertical tube) where the high-

est relative temperature is maintained. The more volatile constituents in the oil are vaporized and stream from the jet. The material of lower vapour pressure passes through the connecting tube to the second boiler. The second stage produces better vacuum at high speeds because the oil which reaches it has been rectified in the first stage; *i.e.*, fractions of higher vapour pressure have been eliminated. The small boiler at the end of the pump serves as a still in which the dark-coloured nonvolatile residue collects while the more active components are distilled and returned to the other two boilers by the overhead glass tubes leading to these boilers The addition of another boiler and jet as seen in Pl I, fig 2 broadens further the use of the principle of fractionation and realizes the ultimate possibilities of oils as pumping fluids

A metal fractionating oil pump is illustrated in Pl I, fig. 3, and in fig. 8. This pump is not so efficient in fractionating the oil as is the horizontal glass pump described above but it does afford considerable self-conditioning of the pumping medium, is robust, compact and capable of reaching pressures of 10^{-6} mm. and lower. This design of pump may be built in different sizes resulting in a series of pumps with a wide range of pumping speeds.

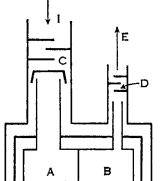


FIG. 8.—SECTION OF AN ALL METAL, TWO-STAGE, FRACTIONATING PUMP

I, Intake; E, exhaust; C, high vacuum section; D, forevacuum section; A, high vacuum boiler; B, forevacuum boiler; L, pumping fluid; H, heater

The boiler of this pump is divided into two sections, A and B in fig 8. The high vacuum section C has an umbrella jet and the forepressure section D has an upright jet There are baffles in each section above these jets to provide cool areas for oil vapours to condense on and be returned to the boilers The two stacks of this pump may be either air-cooled or water-cooled The stacks in Pl. I, fig. 3 are air-cooled; external fins enlarge the cooling surface. In the forepressure boiler B there are small dams making the oil pass over a longer path enabling the more volatile constituents to evaporate in this boiler and allowing the less volatile constituents to get over to the high-vacuum boiler which serves the high-vacuum jet

Similar to the multijet mercury diffusion pumps, oil diffusion pumps may be made as nonfractionating one-, two- or three-jet types However, most oil pumps are designed to produce some partial fractionation of the oil, since the employment of this principle always results in a more efficient pump. In a three-stage oil diffusion pump, as shown in Pl. II, fig 3, the condensed vapour enters the circular boiler from the outside edge. The chimney is common to the three jets, supplying the jets with vapour in a manner similar to the mercury vapour condensation pump previously described. There is built into the forepressure arm a series of alembics for collecting the highest volatile substances and preventing their return to the pumping fluid In another type of upright, three-jet oil diffusion pump, there are three separate concentric chimneys for the three jets. The outside chimney feeds the lowest vacuum jet and the inside, the highest. The condensed vapour enters from the outside edge into the boiler and on its passage to the centre chimney the higher volatiles are boiled off into the higher vacuum jets This results in a semifractionation of the oil.

The pumping speeds of mercury vapour and oil vapour pumps range from 1 l. per second up to many thousands of litres per second at 10^{-4} mm. and under proper conditions will attain an ultimate pressure of 10^{-7} mm

Booster Pumps.—With the development of the oil diffusion pump, certain limitations in its use were soon discovered. Although higher speeds at lower pressures were obtainable because of improved pump construction and lower vapour pressure of the oils, it was noted that the pressures into which the oil diffusion pump would satisfactorily discharge the gases were comparatively lower. Another way of stating the same thing is that the forepressure breakdown, or pressure into which or against which the oil diffusion pump would operate, was low. This resulted in low speeds in the regions of pressure between the optimum working pressure for the mechanical pump and the optimum forepressure for the high speed diffusion pump. To overcome this difficulty it was necessary to develop another type of pump which would discharge into a region of comparatively high forepressure These pumps are known as "booster pumps" (Pl. II, figs 1, 2 and 4) They operate on the diffusion-condensation and jet ejector principles and will maintain a low pressure into which a high-speed diffusion pump may exhaust.

Measurement of Low Pressures.—*Vacuum Gauges.*—Pressures down to a few millimetres of mercury can be measured by an ordinary mercury manometer, consisting of a U-tube having one side closed at its upper end and filled with mercury. When the other branch is connected to the vessel in which the pressure is to be measured the difference of level in the two branches, which may be read with vernier attachments or with a cathetometer, indicates the excess pressure in the vessel above the Torricellian vacuum in the closed branch Such manometers are commonly used for rough readings, since, in the vacuum range of 1 mm and less, this small difference in levels cannot be measured with great accuracy. A more sensitive mercury manometer is one in which the two mercury surfaces are kept precisely in contact with fine vertical pointers. The difference of pressure is measured by the angle through which it is necessary to tilt the manometer in order to restore the level when it is disturbed by the presence of gas on one side. This gauge has been used to measure pressures from 1 5 mm. to 0 001 mm. Another way of measuring very small displacements of the mercury surface in a U-tube manometer is by means of a little float on the surface supporting one end of a lever carrying a small mirror; the tilt of the mirror is measured by a lamp and scale.

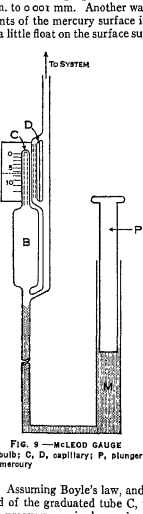


FIG. 9.—MCLEOD GAUGE

B, bulb; C, D, capillary; P, plunger; M, mercury

The first successful special device for measuring pressure too low to be accurately measured by the ordinary U-tube manometer was the gauge invented by McLeod in 1874, and known by his name. It consists in principle of a bulb B, some 250 cc in capacity, provided with a fine calibrated vertical capillary C, fig. 9. The mercury surface can be adjusted to any desired height by the device of a mercury reservoir with displacement plunger P connected to the apparatus. The bulb B is connected to the space in which the pressure is to be measured. The mercury surface is raised, cutting off a known volume of gas, at very low pressure, in B, and then forcing it into the capillary C. The pressure which the amount of gas present exerts in this confined space is then observed. To avoid error due to capillarity in measuring the pressure a side-tube D is provided of exactly the same bore as C, and the difference of levels h in C and D measured. The level in D is opposite the top of the capillary C. Assuming Boyle's law, and knowing the volume of the bulb B and of the graduated tube C, the original pressure in B, which is the pressure required, may be calculated from $p = ah^2/V$, where p is the pressure of the gas in mm., a is the cross section of the capil-

lary C, h is the head of mercury which is compressing the gas (difference of level in C and D) and V is the combined volume of the bulb B and the capillary C.

The McLeod gauge was by mid-20th century the standard instrument for the accurate measurement of pressures down to 10^{-6} mm. with certain gases and proper precautions. Many other types of gauges are calibrated using this gauge as the standard of reference. The accuracy of the gauge depends upon the closeness with which the gas in question obeys Boyle's law, perfect compliance with which is assumed in the deduction of the equation for the pressure. The gauge cannot be used with condensable vapours, such as those of water or ammonia, which tend to liquefy on the walls, even with carbon dioxide the readings are not reliable With such gases as hydrogen and nitrogen, on the other hand, the gauge works down to its limit of pressure measurement.

Since McLeod gauges cannot be used with such gases as chlorine, which are chemically very active and attack mercury, various types of membrane manometer have had to be devised. Very thin spiral glass tubes, working on the principle of the Bourdon gauge used for steam pressures, have been used for such gases, the displacement of the end of the spiral being measured with mirror and scale Such gauges are not sensitive to pressures less than about 0·1 mm. The mechanical deformation of a very thin metal or glass membrane has been used to measure small pressures One side of the membrane is exposed to the gas or vapour, while on the other side the vessel is evacuated by a high-vacuum pump. The very small movements produced are measured by an interference method, and results have been obtained down to 0·001 mm., but the instrument is difficult to manipulate

The exceedingly low pressures produced by modern techniques have led to the construction of a whole class of new manometers, depending for their operation on the behaviour of gases at low pressures; *i.e.*, the behaviour of gases when the mean free path of the molecule is comparable with the linear dimension of the vessel The thermal conductivity and the viscosity are properties which are independent of the pressure so long as the mean free path is small, but change rapidly with the pressure when the pressure is very low, becoming proportional to the pressure below a certain value of pressure, depending upon the nature of the gas and the dimensions of the vessel. Again, at low pressures, the radiometer effect manifests itself; that is, there is a mechanical repulsion between a warm surface and an opposing colder surface when gases at low pressure lie between them Further, with simple forms of triode vacuum tubes, as long as (1) the pressure is low enough for the electrons to have a free path greater than the distance between the hot wire and the surrounding grid and (2) the potential fall accelerating the electrons which is well above the ionization potential of the gas, the ionization produced between the grid and the surrounding cylinder is proportional to the pressure. All these effects have been utilized in the construction of special low-pressure gauges.

Two types of viscosity gauges may be mentioned In one, devised by Langmuir and Dushman, a very light horizontal disk of mica hangs suspended by a quartz fibre directly above a second horizontal disk This second disk is carried on a vertical shaft which can be set in rapid rotation by a rotating magnetic field outside the glass vessel. The drag of the rotating disk on the suspended disk, which is proportional to the speed of rotation and to the pressure of the gas between the disks, is measured with the aid of a mirror attached to the suspended disk. The effective viscosity depends not only upon the pressure but also upon the nature of the gas, so that the gauge requires special calibration. Because of secondary effects this gauge is not reliable at extremely low pressures, and on account of the lack of proportionality between drag and pressure it cannot be used at pressures above 0.02 mm. Hg. The gauge has not found wide use.

A much simpler form of viscosity gauge, developed by Langmuir, consists merely of a vertical quartz fibre, rigidly fastened at the upper end to the top of the vessel. When the vessel is tapped, the fibre is set in vibration, the amplitude of which decreases at a rate determined by the pressure of the residual gas in the vessel. The gauge can be used down to pressures of 10^{-4} mm. Hg.

The Pirani gauge is based on the physical principle that the thermal conductivity of a gas is related to its pressure by the approximate relation, $K = C \times p$, for pressure below values where the thickness of the gas layer is of the order of the mean free path K is the thermal conductivity of the gas, p its pressure and C is a constant The thermal conductivity is indirectly measured by ascertaining the change with pressure in the resistance of a hot filament in the vacuum chamber. As the pressure about the filament alters, so the speed at which heat is conducted away from the filament changes The heat is conducted away from the filament by molecules of gas colliding with the filament and, in turn, colliding with cooler surrounding surfaces. The more of these collisions (higher pressures) the greater the cooling effect on the filament and hence the lower resulting temperature of the filament. The change in temperature effects a change in the resistance. These resistance changes are measured by a Wheatstone bridge arrangement, fig. 10 The filament used should be of a metal with as high a variation in resistance with temperature as possible; tungsten and platinum wire and a "thermistor" unit are satisfactory in this respect

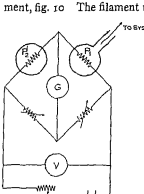


FIG 10.—PIRANI GAUGE

In fig 10, P_1 is the gauge filament which is enclosed by a housing attached to the vacuum system, P_2 is an identical filament whose housing has been evacuated to an extremely low pressure. The instrument has to be calibrated against a McLeod gauge.

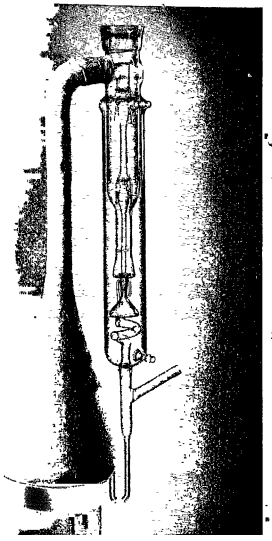
The total pressure is indicated by the gauge, *i.e.*, it shows the pressures of condensable gases and vapours, for example, water vapour. Unfortunately the heat loss of the filament is determined by the nature of the gas molecule and so the gauge can be accurately calibrated for only one particular gas. It is very important, therefore, to avoid the introduction of water or other vapour when measuring air pressures However, despite this fault it has the virtue that it will indicate the presence of unsuspected vapours which the McLeod gauge would completely fail to reveal. The other advantage is the ability to indicate the pressure instantaneously and continuously.

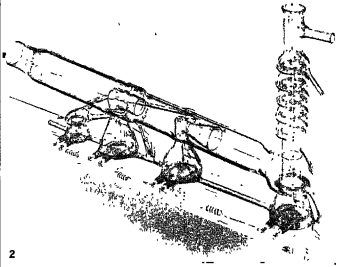
The useful range of the Pirani gauge is from 10^{-1} mm. to 10^{-4} mm This gauge is widely used

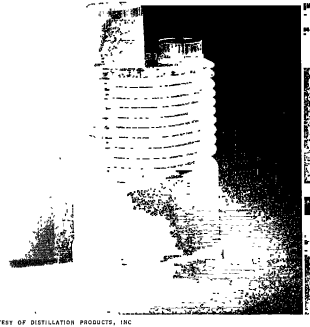
Another conductivity gauge is the thermocouple gauge, which, in operation, closely resembles the Pirani gauge, and is subject to the same operating conditions. It differs from the Pirani gauge in its utilization of thermoelectromotive force in place of change of electrical resistance as the actuating means A thermoelectric junction of small dissimilar wires, fig. 11, is supported inside a glass bulb. A small heating element, spot-welded to the junction, is also supported inside this same glass bulb. The bulb is joined to the system in which the pressure is to be measured. A current of the order of 0–100 milliamperes is passed through the heating element. The thermoelectric current developed is measured by a sensitive meter. Since the temperature attained by the junction depends on the conductivity, and hence on the pressure, the surrounding gas pressure is indicated in terms of meter deflection, and the scale of the meter may be calibrated in pressure units if desired The useful range of the gauge is between 10^{-1} mm. and 10^{-4} mm.

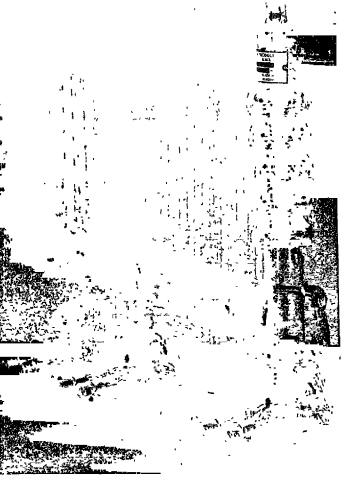
The ionization gauge, fig. 12, in its usual form is similar to a three-element vacuum tube. The electrons from a heated filament are accelerated toward a collecting electrode which may be either the grid or the plate of the tube. The positive ions formed through bombardment of gas molecules by this electron stream are collected on the third electrode; *i.e.*, on the plate if the electron current is collected on the grid. The positive ion current varies with the pressure in the region of the grid and plate.

In fig. 12 the grid is the electrode which collects the electron current. The grid is positive with respect to the filament and nega-





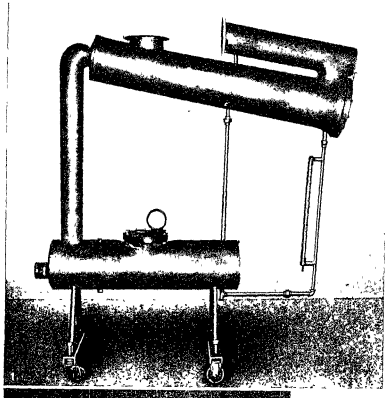


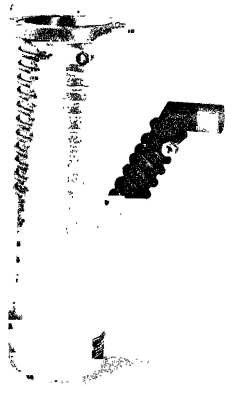


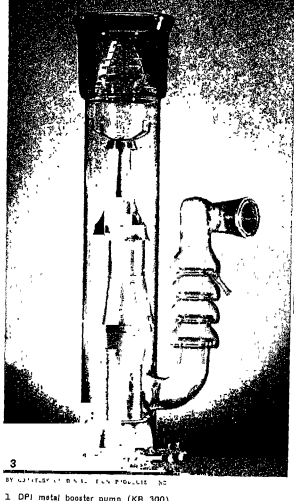
BY COURTESY OF DISTILLATION PRODUCTS, INC

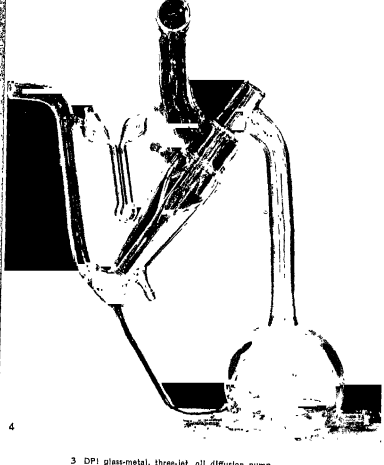
1. DPI three-jet mercury vapour pump
2. DPI three-stage fractionating oil diffusion pump (Hickman)
3. DPI-VMF series, all metal, two-stage fractionating oil pump
4. DPI two-stage fractionating oil diffusion pump (Hickman)

VACUUM









1 DPI metal booster pump (KB 300)
2. DPI metal booster pump (MB 100)

3 DPI glass-metal, three-jet, oil diffusion pump
4. DPI glass, two-jet, booster pump

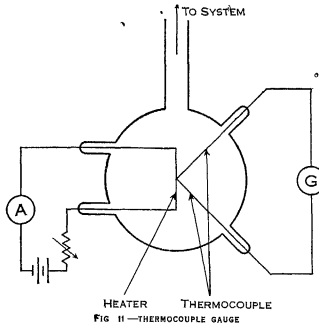


FIG 11 —THERMOCOUPLE GAUGE

tive with respect to the plate Some of the electrons after receiving energy caused by the voltage drop between the filament and the grid pass through the grid openings into the region between the grid and the plate In this region the electrons bombard gas molecules and produce positive ions which migrate to the plate. The equivalent current is read on the microammeter

In a second arrangement the plate is positive with respect to the filament and the grid is negative The negative plate arrangement is the more sensitive method but the procedure when using the negative grid is the easier

The electron or filament emission current is about 10 milliamperes whereas the ionization current is about 50 microamperes. Below 10^{-4} mm. the pressure is directly proportional to ionization current With the emission of 10 milliamperes the plate voltage needs to be about −20 v and the grid voltage of the order of 200 v For given pressure, anode voltage and anode current, the ionization current is proportional to the number of free electrons in the gas Thus the gauge is selective and needs to be calibrated for each gas used The lowest pressures attained, of the order of 10^{-8} mm, have been measured with an ionization gauge. The extremely low limit of pressure capable of being measured with it is the great advantage of the gauge. The two principal disadvantages of the gauge are its low maximum pressure reading, and the fact that it needs calibration for each gas used By the same token, for accuracy of reading, vapours must be excluded Because of possible oxidation of the hot tungsten filament the gauge should not be operated above 10^{-2} mm

Calibration is done by means of the McLeod gauge Great care needs to be taken to ensure purity of gas and equality of pressure throughout the system during this calibration.

The cold-cathode ionization gauge, fig. 13, uses a cathode glow-discharge as the means for ionizing the gases in the envelope of the gauge tube. A permanent magnet is used in some designs of cold-cathode gauges to increase the length of the electron-molecule collision path. The electrons ejected from the surface of the cathode by the high potential gradient at the cathode ionize the gas in the gauge envelope. The electrons resulting from this ionization are either collected by the anode and the resulting cathode-

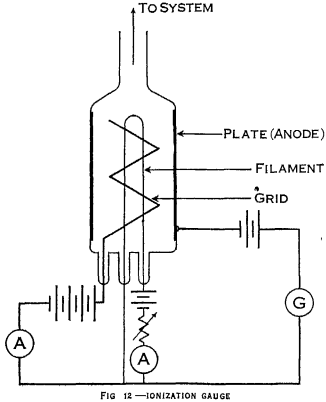


FIG 12 —IONIZATION GAUGE

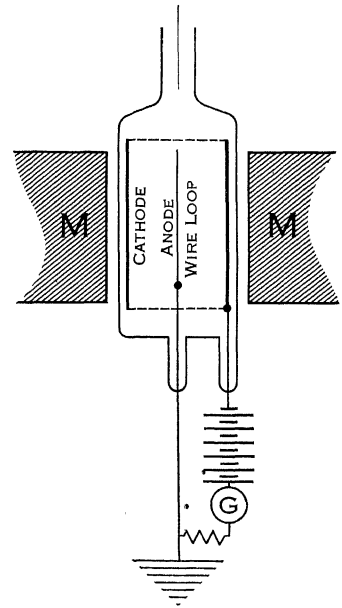


FIG 13 —DISCHARGE IONIZATION GAUGE

anode current measured by a sensitive meter or the electrons produce further ionization which results in more electrons. The additional electrons are collected by the anode and the total electron current measured. There is a proportionality between number of gas molecules and electron current produced by ionization.

In some designs of the cold-cathode gauge the electron paths from cathode to anode are made several hundred times longer than the direct path by applying a magnetic field across the tube causing the electrons to move in a spiralling or sinuous path. Increasing the travel of the electron will, in proportion, increase the probability of an electron ionizing the molecules of the residual gas, and so an ionization current is obtained several times greater than would prevail if the electrons travelled in straight lines from cathode to anode impelled by the electric field only. Since the cold-cathode gauge does not depend upon a hot tungsten filament for its operation it may be used at higher pressures than the hot-filament ionization gauge. Also, it cannot measure extremely low pressures The range of the cold-cathode ionization gauge is from 0 0001 mm to 0 003 mm. Opening the gauge to atmospheric pressure does not harm it

Fig 13 shows the electrode and circuit arrangement for the cold-cathode ionization gauge with magnetic field The anode and cathode are shown in their relative positions. Magnet M maintains a strong magnetic field The voltage across the tube is of the order of 2,000 v. D.C and the magnetizing field around 400 oersteds. The cathode is made of zirconium, thorium or other material giving a copious supply of electrons under the "cold" discharge The gauge should be calibrated against a McLeod gauge for each gas used This gauge coupled with the Pirani or thermocouple gauge makes a very useful combination because the two cover the range from a few millimetres to approximately 10^{-4} mm. pressure.

A third type of ionization gauge, in many ways like the cold-cathode gauge, is the alpha-ion gauge Ionization of the gas molecules in the gauge is accomplished by the alpha particles which are discharged at constant rate by a radium source. The radium is sealed into the gauge housing. The range of this gauge is from 0 001 mm. to 10 mm. It extends to higher pressure ranges than the cold-cathode gauge and also is not damaged by opening to atmospheric pressure Calibration of the cold-cathode and alpha-ion gauge is made using a McLeod gauge as the reference.

The Knudsen gauge provides continuous readings from 10^{-2} mm. to 10^{-7} mm It is an absolute gauge and needs no calibration against a McLeod. The gauge consists of an aluminum vane suspended from a fine tungsten wire within a metal casing, fig. 14. The deflection of the vane is measured by an optical system in which a beam of light is reflected onto a translucent scale from a small mirror attached to the vane. Two electric heaters are located parallel with the vane on opposite sides near the edges, so that gas molecules accelerated by the heaters strike the vane, causing it to rotate. The amount of rotation is proportional to the pressure, other conditions remaining constant, and the distance between the vane and heaters being small in comparison to the mean free path of the molecules at the existing pressure The damping magnets eliminate erratic movement of the vane caused by normal vibration without appreciably affecting its sensitivity.

The equation for calibration of the Knudsen gauge is given by

$$P=\left(\frac{2\pi^2 I}{rA\beta^2}\right)\left(\frac{D}{d}\right)\left[\frac{1}{\left(\frac{T_1}{T}\right)^{\frac{1}{2}}-1}\right]$$

If T_1 and T are fairly high temperatures on the absolute scale, and if their difference is small,

$$P=\left(\frac{4\pi^2 I D}{rA\beta^2 d}\right)\left(\frac{T}{T_1-T}\right) \text{dynes per square centimetre}$$

where: I = moment of inertia of moving vane
r = mean radius of moving vane
$2A$ = total area of the vane opposite heaters
t = period of oscillation of the vane
D = scale deflection
d = scale distance

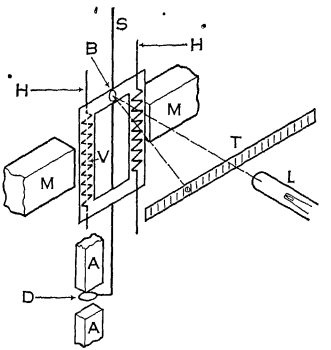


Fig 14 —THE KNUDSEN GAUGE

S, tungsten wire, H, heater, A, internal damping magnet, B, mirror, D, damping vane, M, external damping magnet, V, impact vane, L, lamp, T, scale

T = absolute temperature of residual gas in gauge
T_1 = absolute temperature of heating elements H.

Since all these quantities can be measured directly, it follows that the device can be used as an absolute manometer, without the necessity of calibrating against any other gauge It is also evident that the indications of this gauge must be independent of the gas to be measured.

Pumping Speed.—In the preceding discussion three principal types of vacuum pumps—the oil-sealed mechanical pump, the diffusion pump and the booster pump—have been described. Usually some combination of two of these pumps is needed and there are occasions where all three types together constitute the pumping unit for the vacuum system.

One important characteristic of any pump is its pumping speed. The speed of exhaust of a closed vessel may be measured at constant pressure, and defined as the volume of gas pumped from the vessel at that pressure in unit time. Expressed mathematically

$$S_1=-\frac{dV}{dt}$$

where S_1 is the pumping speed and dV is the small change of volume in the short time dt By applying Boyle's law for a perfect gas this definition may be written as

$$\frac{dp}{dt}=-\frac{S_1}{V}p$$

where p is the instantaneous pressure at the time t in a closed volume V being exhausted by a pump having a speed S_1. In 1913 Gaede published some of his work with vacuum pumps, which indicates that he originated the concept of pumping speed. In 1916 Langmuir introduced the concept of limiting pressure p_0 for a pump which modifies the Gaede equation by substitution of $(p-p_0)$ for p. The equation above then becomes

$$\frac{dp}{dt}=-\frac{S_1}{V}(p-p_0)$$

The solution of this modified equation is

$$t_2-t_1=\frac{2}{S_1}3V[\log_{10}(p_1-p_0)-\log_{10}(p_2-p_0)]$$

where t_2-t_1 is the time required to reduce the pressure in the volume V from p_1 to p_2 using a pump of speed S. It should be noted that the vessel being evacuated is connected directly to the intake of the pump. Pump speed S_1 is the pumping speed

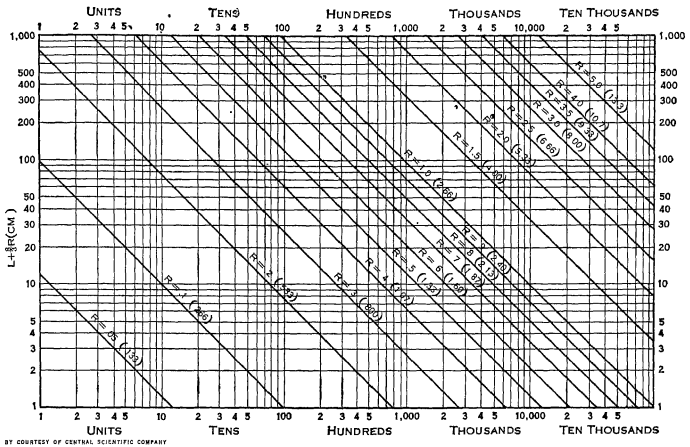


FIG 15.—CHART OF CONDUCTANCE OF CONNECTING TUBES FOR AIR AT LOW PRESSURE

at the pump intake

Usually a connection of some length is required between the pump and the vacuum chamber. Under such circumstances the pump speed S_1 is not the controlling factor. In making "pump-down" calculations, particularly if pressures below 10^{-2} mm. are involved, the speed of evacuation S rather than pump speed S_1 determines the period of cyclic operations.

When the pump is operating in the high-vacuum range, the flow of gas through a tube is substantially molecular in character. The hydrodynamic component of gas flow, being proportional to pressure, becomes relatively unimportant. In other words, at extremely low pressures the gas removed from the system is largely confined to those molecules which, because of their thermal kinetic energy, happen to wander into the low pressure region created by the pump, and by the action of the pump become trapped and prevented from again entering the chamber being evacuated

From experiments over a large range of pressures with different gases, Knudsen in 1909 derived the following semiempirical relation which holds at all pressures.

$$Q=\left[aP+Z\frac{(1+\alpha P)}{(1+\beta P)}\right](p_1-p_2)$$

Where $a=\dfrac{\pi R^4}{8\mu L}$ (coefficient of hydrodynamic flow—Poiseuille's constant)

$$Z=\frac{\sqrt{2\pi}}{\rho'}\frac{4}{3}\frac{R^3}{L}\text{ (coefficient of molecular flow)}$$

$$\alpha=\frac{2\sqrt{\rho'}R}{\mu}$$

$$\beta=\frac{2.47\sqrt{\rho'}R}{\mu}$$

where Q = volume of gas, measured at pressure P, which flows per second through the tube

p_1-p_2 = difference in pressure at the two ends of the tube

$P=\dfrac{p_1-p_2}{2}$ = average pressure

R = radius of tube

L = length of tube

μ = coefficient of viscosity of the gas

$\rho'=\dfrac{\rho}{P}$ where ρ = density of the gas

ρ' is a function only of the kind of gas and the temperature.

For ordinary pressures this equation assumes the form commonly known as Poiseuille's law,

$$Q=\frac{\pi R^4}{8\mu L}P(p_1-p_2)$$

while at extremely low pressures it becomes

$$(1)\quad Q=\left[\frac{\sqrt{2\pi}}{\rho'}\frac{4}{3}\frac{R^3}{L}\right](p_1-p_2)$$

The quantity enclosed by brackets in the above equation is a factor applying only in the case where one is considering the quantity of gas, Q, flowing per second through a tube of length L and radius R with a difference of pressure at the ends of p_1-p_2 Effects of the various end conditions that may be applied to the tube have not been considered. Hence where we have a tube of length L and radius R connecting two vessels at low pressures, the quantity of gas Q flowing per second from the vessel at pressure p_1 through the tube into a second vessel at pressure p_2 is given by

$$(2)\quad Q=\left[\frac{4}{3}\left(\frac{\sqrt{2\pi}}{\rho'}\right)\left(\frac{1}{\dfrac{L}{R^3}+\dfrac{8}{3R^2}}\right)\right](p_1-p_2)$$

It will be observed that the form of the last two equations is similar to Ohm's law, where Q is similar to a current, (p_1-p_2)

similar to a potential drop and the bracketed term similar to a conductance. It must be remembered that the bracketed term in the equation (1) considers only the gas flowing through a tube, neglecting end effects. For a long tube this is sufficiently accurate in most cases. The bracketed term in equation (2) is for the case of a tube terminating at a thin wall, the circular opening in the wall being of the same diameter as that of the tube. This expression for the conductance has been used in plotting the curves shown in fig. 15 Other types of end configurations would introduce other correction factors into these equations. For different gases the value of the conductance varies as the reciprocal of the square root of ρ'.

Some of the references given in the bibliography give further discussion to the problem of flow of gases in pipes at low pressures.

The system speed of evacuation S is related to the speed of the pump S_1 and the conductance of the connecting tubing Z by the following relationship.

$$\frac{1}{S}=\frac{1}{Z}+\frac{1}{S_1}$$

On rearranging the terms,

$$S=Z\left[\frac{S_1}{Z+S_1}\right]=S_1\left[\frac{Z}{Z+S_1}\right]$$

These expressions have important significance The fractional term in either expression is less than 1. Consequently, the speed of evacuation S can never be greater than the conductance Z nor can it be greater than the speed of the pump S_1 The second expression suggests that the speed of evacuation approaches the speed of the pump only when Z is very large in comparison with S_1. This expression shows that the performance of a high-speed pump may be seriously impaired by the use of ill-chosen connections. For a well-designed pipe line, pumping speed (speed of evacuation) S in a system should not be much less than 80% of the speed S_1 at the intake of the pump.

When several lengths of tubes of different diameters are connected in series between the pump and exhaust chamber the conductance Z for the combination is given by

$$\frac{1}{Z}=\frac{1}{b_1}+\frac{1}{b_2}+\frac{1}{b_3}+\ldots+\frac{1}{b_n}$$

where b_1, b_2, etc. are the respective conductances of the tubes.

Traps or Condensers.—A trap is an obstruction placed in a vacuum system for the purpose of collecting solid particles, liquids, vapours or gases. If vapours are involved, the trap must be cooled The cooling may be done by mechanical refrigeration, by a mixture of solid carbon dioxide (dry ice) and alcohol or acetone, or by liquid air. Typical traps are shown in fig. 16. Certain "permanent" gases may be removed by using a trap of activated charcoal cooled with liquid air.

The conductance of a trap in the vacuum system may be quite important Hence traps are preferably constructed with large passages to avoid undesirable reduction in pumping speed.

Refrigerated glass traps are commonly used between a McLeod gauge and the vacuum system to prevent contamination of the mercury and the glass parts of the gauge and to prevent diffusion into the vacuum system of mercury vapours from the gauge. Such a trap is also frequently used between the pump and the vacuum system, either to trap vapours which might contaminate the pumping fluids, or to prevent passage of oil vapours from the pump into the vacuum system.

MANAGEMENT OF THE VACUUM SYSTEM

In industrial use, high vacuum is considered to begin in the range of pressures corresponding to 1 mm. Probably this would not be considered high vacuum by the experimental or research man working in the laboratory where pressures of the order of 10^{-3} mm. are obtained. Attainment of a good vacuum requires thoughtful selection of equipment, care in assembly and manipulation of the apparatus.

The elements of a vacuum system have been discussed in the preceding sections. They consist of forepump, diffusion pump,

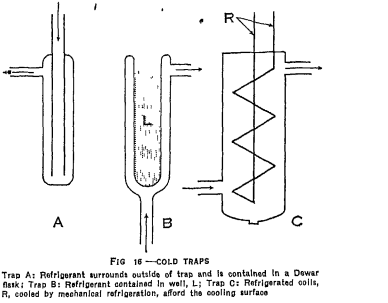


FIG 16.—COLD TRAPS

Trap A: Refrigerant surrounds outside of trap and is contained in a Dewar flask; Trap B: Refrigerant contained in well, L; Trap C: Refrigerated coils, R, cooled by mechanical refrigeration, afford the cooling surface

cold traps, valves, plumbing, gauges and the apparatus or equipment to be evacuated A number of factors must be considered in selecting a pumping system. The choice will be largely influenced by the arrangement of the equipment, the volume of the vacuum chamber, the quantity of gas to be handled at low pressures and the importance of time in cyclic operations. One consideration that is generally common to various arrangements is the speed of the forepump. This is directly related to the speed of the diffusion pump and the ratio of pressures at the discharge and intake of the diffusion pump. On the assumption that a particular diffusion pump has a speed of 100 l per second at 10^{-6} mm. and that the pump operates satisfactorily at a fore-pressure of 10^{-2} mm, the ratio of pressures is 1 to 10,000. This means that a forepump capable of handling 0 0001 of 100 l. per second or 0 01 l per second is theoretically sufficient for the job This suggests that a relatively low-speed forepump would be sufficient. However, there are usually other factors that must be considered

Fluids used in diffusion pumps often deteriorate if their temperatures are elevated when in contact with air at pressures of 0.1 mm and above. Unless appropriate steps are taken, this means that a certain amount of time is lost in heating and cooling the boiler in a cyclic operation To avoid this loss of time, various techniques are used. In some instances, two parallel pumping systems are installed. One consists of a high-speed forepump either directly connected or connected through a cold trap to the vacuum chamber and a second independent connection in which a relatively small forepump backs a diffusion pump During the preliminary pumping period or when air is admitted to the vacuum chamber the intake to the diffusion pump is closed but all the pumps are permitted to operate. In operation the high-speed forepump withdraws the air from the chamber to the low millimetre range after which the diffusion pump is opened to the system so that the reduction in pressure continues without interruption In another arrangement only one forepump is used. More vacuum valves are required because the high-speed forepump is first connected to the vacuum chamber and later placed in series with the diffusion pump

Valves and plumbing must be free from leaks and of high conductance. The question of system speed (speed of evacuation) has been discussed and the methods for calculating conductance outlined. As part of the steady improvement in vacuum techniques, by which the lower limit of pressure has been pushed steadily downward, it became increasingly important to detect and locate even the microscopic leak in the walls of the vessels, connecting tubes, junctions of parts, all of which constitute the barrier between a region of high vacuum and one of atmospheric pressure. The final vacuum attained in a system is an equilibrium condition between pumping speed, on the one hand, and the rate of leak into or evolution of gas within the system, on the other.

Various methods of leak detection have been employed. With the rapid advances in vacuum techniques made during World War II many new methods were developed. Older methods employ the Tesla coil, discharge tube, Pirani and ionization gauges. Newer methods make use of the differential Pirani gauge and the mass spectrometer. Oddly enough, the most sensitive method is also the most rapid; *i.e.* the mass spectrometer method

Vacuum systems are constructed from glass and metal. Depending upon the conditions a system may be either all glass or all metal. Glass can be easily cleaned and welded at junctions. It has high electrical insulating quality, may be baked out and sealed off to give a more or less permanent vacuum. Metal systems are made from steel or brass. The parts may be machined and fitted together with rubber gaskets or soft-soldered, silver-soldered or brazed. Glass or metal vacuum valves can be fitted permanently or with tapered joints, into the system.

Where the highest degree of vacuum is desired considerable outgassing of glass and metal parts must be done. Outgassing removes gases adsorbed to the surface of glass and metal. Prolonged heating of glass at 150° C. to 200° C. in vacuum removes most of the gases adsorbed on the surface, metals strongly heated in a vacuum give off adsorbed gases as well as absorbed gases and gas arising from the decomposition of oxides near the surface. Metal parts within the evacuated chamber are outgassed by heating to a high temperature with high frequency induced currents. When an apparatus has been reduced to its lowest pressure by continued pumping and heating and is sealed off from the system, the pressure may be further lowered by a getter. Getters remove gases by chemically combining with them and by absorbing them.

Further detailed information on procedures in the management of high vacuum systems will be found in the references given in the bibliography.

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HIGH-VACUUM COMMERCIAL APPLICATIONS

High vacuum as employed in industry generally falls within two ranges of pressures:

(a) 1 to 1000 μ (1 μ = 0.001 mm Hg.),

(b) 10^{-3} mm. to 10^{-3} mm Hg.

The extremely low pressures are found almost exclusively in the electronics industry, while pressures in the micron range find applications throughout the chemical and metallurgical fields. By undertaking processes under an appropriate range of gas pressures, one or more of the following advantages may be gained. (1) oxidation is prevented, (2) distillation temperature is reduced, (3) absorbed and adsorbed gases may be removed, (4) dehydration may be performed at low temperatures, (5) gaseous ionization may be prevented or controlled, (6) thermal conduction of gases may be reduced, (7) radiant energy absorption may be reduced.

Vacuum Metallurgy.—The use of free air pressures below 100 μ has found many applications in the production, purification and treatment of metals.

Thermal Reduction.—Metal oxides may be reduced under vacuum and distilled from the hot reaction zone in highly purified form. Magnesium has been commercially produced from calcined dolomitic limestone by the following reaction:

$$2(MgO\ CaO) + \tfrac{1}{3}FeSi_2 \xrightarrow{2,150^\circ F} 2Mg + (CaO)_2SiO_2 + \tfrac{1}{3}Fe\ .$$

With appropriate reducing agents other metals such as calcium, lithium, barium, caesium, rubidium, sodium, and potassium may be produced in pure form from their salts

Distillation of Metals.—Through the use of pressures of 1 to 100 μ the lower melting metals (magnesium, zinc, lead, tin, cadmium, lithium, barium, etc.) may be purified by distillation. Impure magnesium as formed by the carbothermic process has thus been distilled in vertical electrically heated retorts, of several-ton capacity. Separations of lighter melting metals by fractional distillation (*i.e.*, zinc and tin or zinc and aluminum) has also been accomplished

Vacuum Sintering.—This technique is employed chiefly in the production of tungsten, molybdenum, tantalum and columbium. Bars of the pressed powdered metal are electrically heated in vacuum and after sintering, rolled to size.

Heat Treatment.—Through the use of a vacuum furnace, dies, tools, etc., may be heat-treated without the usual oxidation, the vacuum serving as a true neutral atmosphere

Vacuum Melting.—Dissolved gases may be removed by maintaining metals above their melting point at low pressure. Gas-free metals, particularly copper and iron, are useful in the electronics industry for the fabrication of parts sealed in vacuum. Copper so treated has greatly increased ductility and improved thermal and electrical conductivity. Highly reactive metals like titanium have been melted and cast at air pressures of 10 μ.

Vacuum Dehydration.—Vacuum evaporation is commonly used in the chemical industry for the removal of water or other solvents from many products. By the use of extremely low air pressures (*i.e.*, less than 10 μ) moisture can be rapidly removed from heat-sensitive materials.

Three pumping methods are normally employed for the removal of water vapour at low temperatures: steam ejectors, refrigerated condensers and chemical absorption systems. In the case of steam ejectors, partial air pressures below 50 μ are feasible on a commercial scale and very large volumes of water vapour may be handled at slightly higher pressures. In other systems, the free air is removed with steam ejectors or mechanical pumps, alone or in combination with oil diffusion pumps. The water vapour is then (a) condensed or (b) absorbed. Free air pressures as low as 1 to 10 μ are possible and under such conditions moisture can be removed at temperatures in the product as low as −75° C.

The possibility of low-temperature drying has been applied for many years to the preservation of biological products on a small scale. It was only after recent advances in vacuum engineering that low-temperature high-vacuum dehydration was applied on a commercial scale.

Blood Plasma.—In order to prevent changes in composition, and to preserve a so-called lyophilic structure capable of rapid rehydration, blood plasma is vacuum dried from the frozen state.

Biologicals, etc.—Low-temperature drying has also been applied to penicillin, sera, vaccines, bacteria, nerves, etc.; through the use of the very low temperatures made possible by high vacuum, cellular structure may be preserved throughout the drying cycle and the biological properties maintained after reconstitution even though the product in dried form is stored for long periods.

Foods.—The vacuum dehydration of food products had, by 1951, offered one of the most promising solutions to the production of a high-quality product. The original structure may be maintained, flavour and colour are relatively unimpaired, and sufficiently low moisture content may be produced (0.5% to 1%) to ensure a satisfactory storage life. Because of the relatively high costs involved, vacuum dehydration at air pressures in the micron range has been applied to such relatively expensive materials as orange juice and soluble coffee. The vacuum process for producing a 4:1 concentrate of frozen orange juice had by 1950 become a $100,000,000 a year business. Vacuum drum driers operating at moderate vacuums (10 mm. to 50 mm.) are used for a variety of products such as tomato paste, soups, coffee, etc.

Vacuum Evaporation.—Through the use of pressures below 10^{-4} mm., a variety of metals and salts may be evaporated and their vapours subsequently condensed on a surface.

Low-Reflection Coatings.—So-called low-reflection coatings are

produced by evaporating magnesium fluoride, or material of comparable refractive index, in a vacuum system and depositing the vapour to a controlled thickness (one-quarter of a wave length) on a lens or other optical surface

Reflecting Surfaces.—This same technique may be used to produce front surface mirrors on glass, plastics or other material Aluminum is commonly employed and evaporated from a heated tungsten filament. Chromium, gold, rhodium, silver, etc., are also used for special applications.

Decorative Coatings.—For decorative purposes, plastic sheeting and cloth may be continuously coated with metals by vacuum evaporation. In the case of plastic and paper sheeting, the metal-coated product is used for the manufacture of electrical condensers. Gold leaf may also be made in this manner, by stripping the metal foil after applying to a thin surface

Other Coatings.—There are many applications for electrically conducting coatings. Piezo quartz crystals are coated with silver in order to improve frequency characteristics and stability. Conducting layers can also be applied to plastic insulated wave guides, quartz fibre suspensions for instruments, etc.

Vacuum Sputtering.—Vacuum sputtering involves coating (usually of nonconductors) by means of a gas discharge at 1 mm to 0·01 mm. The surface to be coated is placed near the Crookes dark space and a cathode formed of the material to be sputtered.

Vacuum Distillation.—At low pressures the boiling point or distillation temperature of all chemical products is materially reduced. In most commercial processes, pressures of 25 mm to 100 mm. are sufficient. This range is economically attained on a large scale with conventional steam ejectors and the fractionation of petroleum oils is one of the largest operations under such conditions

High Vacuum Distillation—Through the use of noncondensible gas pressures below 50 microns and vapour paths of low impedance, between evaporating and condensing surface, the distillation point of many high boiling products—waxes, higher alcohols, esters—is sufficiently reduced to permit purification with some fractionation without undue decomposition.

Molecular Distillation.—If the residual gas pressure is reduced to less than 10^{-3} mm Hg., a point will be reached where any further reduction has substantially no effect on the rate of distillation. If at these pressures the distance between distilling and condensing surface is small and unimpeded, so-called molecular distillation takes place. By such a technique many materials of high molecular weight may be distilled, which otherwise could be handled only with excessive decomposition, if at all

Commercially, this method has been successfully applied to the production of vitamin concentrates, by direct distillation of vitamin-bearing oils.

Electronics.—The electronics industry has long been concerned with the production of extremely low pressures. With the exception of large continuously pumped systems used with high-voltage X-ray tubes, large magnetrons, etc., high vacuum must be maintained in a closed space for long periods of time. Pressures as low as 10^{-8} mm. to 10^{-5} mm. Hg are required for many electronic devices, the lowest being necessary to prevent formation of positive ions as in cathode ray and other tubes employing high-voltage electrons Most electronic devices are now evacuated with oil diffusion pumps. In some cases (*e.g.*, receiving tubes), residual gases are absorbed with "getters" such as barium, magnesium or other reactive metals

Vacuum Impregnation.—High-vacuum techniques are commonly used as an aid to impregnation processes. Products to be treated are usually placed in a vacuum chamber and the pressure reduced to something less than 1 mm. The chamber is subsequently filled with the impregnation medium which in turn displaces the entire volume previously exhausted. This method of processing finds wide application in the electrical industry where it is a common practice to vacuum impregnate condensers, coils, transformers, cables, etc, with waxes, resins, oils or other materials of appropriate insulating characteristics.

Miscellaneous.—Industries of a wide variety employ high vacuum in one or more stages of product manufacture. In the manufacture of refrigerators it is necessary to remove all traces of water from the entire compressor system, including the small valves, pipes and fittings This is accomplished by vacuum treatment at pressures of 10 to 200 μ.

A similar procedure is employed in the manufacture of bellows-type barometers and vapour operated thermometers. In the latter case, proper calibration can be achieved only with the complete removal of both condensible and noncondensible gases prior to filling with the operating fluid. (R. S Mc)

Other applications of vacuum techniques formed the basis for such new industries as the production of citrus juice concentrates. Diffusion pumps of huge size have been employed in the metallurgical industries and the television industry. The low cost of television receivers would be impossible without the routine production of high vacuum by methods which were formerly considered a sophisticated laboratory art. The huge particle accelerators, such as the cyclotrons, the synchro-cyclotrons, the cosmotrons and the linear accelerators, all depend on diffusion pumps having speeds of tens of thousands of litres per second. (P. E K)

The manufacture of all vacuum bottles of course depends upon the maintenance of pressures below 10 μ for thermal insulation. Vacuum spectrographs permit industry to carry on spectrographic research and production control operations in the ultra-violet regions of the spectrum (R. S. Mc)

VACUUM BRAKE, a form of brake utilizing the force exerted on a piston by the pressure of the atmosphere. So long as a vacuum is maintained in the system the brake blocks are kept off the wheels.

However, when air is admitted this presses against one side of the piston and applies the blocks. (*See* BRAKE; *Railway Brakes and Motor Car Brakes.*)

VACUUM CLEANER. An appliance for extracting and removing dust from fabrics, such as carpets, upholstered seats, cushions, etc, by suction, designed for the primary purpose of carrying out this operation without the necessity of displacing the articles to be cleansed from the positions which they normally occupy when in use.

It is also used to remove dust from such surfaces as those of floors, shelves, walls, etc It was so named by its inventor, H C. Booth, who made and patented the first successful appliance in the year 1901.

A vacuum cleaner consists essentially of an air suction pump, or exhauster, connected by a pipe or tube or directly to a nozzle having a slot-shaped orifice which is passed over the material being cleansed, the surrounding lip of the orifice being kept in close contact with the material.

An air filter which cleanses the air either before or after its entry into the exhauster serves at the same time as a chamber, or receptacle, for collecting the dust, which can be removed therefrom conveniently and without dispersal.

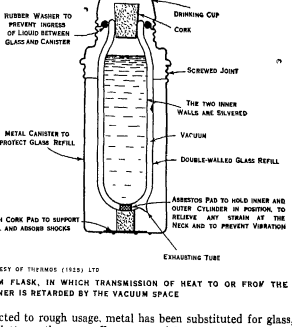
In the light portable or domestic types, this filter is often of cloth in the shape of a bag. In operation, suction from the air exhauster causes air to rush violently into the nozzle through the interstices of the fabric being cleansed and to carry away with it the imprisoned dust. (*See* also HOUSEHOLD APPLIANCES.)

(H. C. Bo , X)

VACUUM DISTILLATION: *see* DISTILLATION.

VACUUM FLASK, a glass vessel with double walls, the space between which is evacuated The only junction of the walls is at the neck of the vessel It is also known as a Dewar vessel after its inventor Sir James Dewar (*q.v.*); Thermos flask is a proprietary name applied to a form protected by metal casing.

It was invented in the first place to preserve liquefied gases (*see* LIQUEFACTION OF GASES) by preventing the transference of heat from the surroundings to the liquid. The approximate vacuum between the glass walls is practically a nonconductor of heat, and radiation is reduced to a minimum by silvering the glass. The chief path by which heat can be communicated to the interior of the inner vessel is at the junction of the walls at the vessel's neck, which is consequently made as small as possible. This thermal isolation applies equally in the opposite direction, a hot liquid remaining at a high temperature for several hours. Where the flask



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VACUUM FLASK, IN WHICH TRANSMISSION OF HEAT TO OR FROM THE CONTAINER IS RETARDED BY THE VACUUM SPACE

is subjected to rough usage. metal has been substituted for glass, but the latter is the more efficient material.

VACUUM PUMP: *see* VACUUM

VACUUM TUBE: *see* ELECTRON TUBE.

VACZ (WAITZEN), a town of Hungary, 20 mi N. of Budapest, on the left bank of an arm of the Danube at the foot of the Cserhát mountains, where the river takes its southward course. On the hills around are large vineyards and the exportation of grapes is an important industry. There are also spirit, soap and shoe factories while the working of wool is carried on. The town is the see of a bishop and has numerous architectural remains and a museum of the Roman and mediaeval antiquities in which the district is so rich. Pop (1930), 20,960.

VADE-MECUM, a Latin phrase meaning literally "come with me" (*vade*, imperative of *vadere*, to go or come; *cum*, with; *me*, abl of *ego*, I), and used in French, Spanish and English for something that a person is in the habit of constantly taking about with him

VAGRANCY. British law against vagrancy was the outcome of more than three centuries of legislation. Sir James Stephen's *History of the Criminal Law*, dealing with vagrancy as a criminal offense, states that "when serfdom was breaking down and when the statutes of labourers provided what might be regarded as a kind of substitute for it, provisions as to vagrancy were practically punishments for desertion. The labourer's wages were fixed, his place of residence was fixed, he must work where he happened to be If he went elsewhere, he must be taken and sent back By degrees the order of ideas which this view of the subject represented died away. The vagrant came to be regarded rather as a probable criminal than as a runaway slave"

The act of 1495 instructed local authorities to search for all "vagaboundes, idell and suspecte persones, lyvyng suspeciously" and put them in the stocks for three days, giving them bread and water only, and then turn them out of the town. In 1530, owing to the increase of vagrancy followed by crime and disorder, whipping was allowed as an alternative to the stocks In 1535 an even severer punishment for the sturdy vagabond was enacted If brought a second time before a justice of the peace he might be marked by having the upper part of his right ear cut off and after this if convicted of wandering, loitering and idleness might be adjudged a felon and suffer death. Other drastic acts followed until 1597 when fortune tellers, tinkers, pedlars, jugglers, etc., were all treated as rogues and vagabonds and even players except such as "belonged to any baron of this realm or any other honourable person of greater degree" This law remained in force with amendments until orders in council in 1603 and 1662 empowered the authorities to transport sturdy beggars and idle and disorderly persons to English plantations beyond the seas. Branding ceased to be legal in 1713. In 1821 a select committee of the house of commons dealing with the system of "passing" vagrants to their place of settlement recommended that the existing system should be abolished and long periods of imprisonment given instead.

As a result of the report, the existing legislation was in 1822 repealed "en bloc" and the new act to remain in force till 1824 reduced the powers of magistrates with regard to vagrants and also reduced the maximum term of detention from seven years' transportation to two years' imprisonment. Finally the Vagrancy act of 1824 repealed all former statutes and "vagrancy offenders were liable to punishment either as "idle and disorderly persons" or as "rogues and vagabonds" or as "incorrigible rogues" Since 1824 legislation and regulations have both been based on reports made by the poor law commission, and under the poor law as reformed in 1834 it became the duty of the guardians to provide relief for destitute persons and to use a test to make sure that relief given from the public funds was not abused. When workhouses were established vagrants applied for admission to them and in 1837 the poor law commissioners expressed the opinion that it was the intention of the act of 1834 that all cases of destitution should be relieved irrespective of the fact that the applicant might belong to a distant parish.

There have been many acts since that time, such for example, as the act of 1842 proscribing a task of work in return for food and lodging and the Poor Law act of 1844 authorizing the formation of districts in London and other large towns for the provision of temporary relief. In 1848 when the poor law board took the place of the poor law commissioners the whole question of vagrancy was reported on by the inspectors to the new board and a minute of the poor law board urged uniformity in action, the refusal of relief to able-bodied men not actually destitute, and the employment of police officers as assistant relieving officers for vagrants Under the act of 1864 every London union was required to provide casual wards.

The "Casual."—Nearly all subsequent legislation deals with the treatment of the casual pauper and the regulations that should be enforced especially when the applicant for admission to a casual ward was an able-bodied man. A general order dated Dec. 18, 1882, prescribed the rules and regulations to be observed and pauper vagrancy decreased for two or three years, but increased again from 1885 to 1895. The number of vagrants in casual wards on Jan 1, 1905, was 9,768. There followed the appointment of the departmental committee on vagrancy in 1906. The recommendations of the committee on vagrancy, of which the Rt Hon J L. Wharton was chairman, were of a varied character, some of which could not be carried into effect without legislation. For example, it was suggested that the control of casual wards and the local relief of vagrants should be transferred to the police authority with a view to securing uniform treatment throughout the country By the 1930s it was often necessary for tramps to apply for tickets at police stations before they could sleep in the casual ward, although the police had no final control. Another recommendation was that of a detention colony and an indeterminate sentence, a detention colony, for example, such as Borstal for boys and the place of detention for an indefinite period instead of prison for a short term. The committee recommended that habitual vagrants should be sent to certified labour colonies for detention for not less than six months or more than three years. The third recommendation, which passed into law, was that of the establishment of labour exchanges the value of which for the unemployed tramp was that information could be obtained at a labour exchange as to where employment was likely to be found. The difficulty however was that if a man was compelled without money to tramp the country he could not stay long enough in one place to enable him to find employment. A considerable advance was made in the direction of forming vagrancy committees for counties or larger areas, the object being to secure uniform treatment of tramps, to find work for those willing to work and to deal with the difficulty of women and children on the road A number of counties also adopted the suggestion of a way-ticket system. By a statutory order of Sept. 23, 1914, the

supply of a midday meal for paupers discharged from the casual ward was legalized The way-ticket system was by no means universally adopted and has not been a success.

The Metropolitan Asylums board by unifying the London tramp wards introduced uniformity in administration and generally speaking the London casual wards are clean and well-kept. As a result of the report of the casual wards committee of the Metropolitan Asylums board many helpable cases were dealt with separately, the idea being to enable those who were really desirous of work to stay in a ward which was treated as a hostel A stay of a week or a fortnight often meant that the man was able to find employment. The implication is that the casual ward with its one or two nights detention did not assist the man to find employment, but that given a longer time a considerable number of men could be assisted to find work

Remedies.—The labour exchange should theoretically enable an unemployed man, likely to become a vagrant, to be transferred to some place where work is more abundant, but the labour exchanges are in many cases overworked and have a mass of local unemployment to deal with, most of it stagnant labour. If the occupants of casual wards could be given a chance there is no doubt that a percentage, small perhaps, but probably not less than 10% would be willing to work if suitable employment could be found. To obtain this fluidity of labour some arrangement is required to enable the man to travel from place to place and this entails the expenditure of money. He also requires when he arrives at a new town some decent accommodation other than the casual ward. Vagrancy reform must be based upon effective individual dealing and proper classification since the vagrant may be either a genuine unemployed man, an ex-serviceman, an old and infirm person, a young boy, a married man with a wife and children, or an habitual vagrant.

Like all social problems vagrancy cannot be isolated from other important questions such as housing, poor-law reform and unemployment. It is a symptom of a deeply rooted social evil which must be remedied by dealing with the other problems which lie at the root of the trouble (*See* also POOR LAW; CASUAL WARD; FARM COLONY; UNEMPLOYMENT.)

BIBLIOGRAPHY.—For a history of vagrancy *see* C J Ribton-Turner, *History of Vagrants and Vagrancy* (1887), *see* also *Reports, Evidence and Appendices of Departmental Committee on Vagrancy* (1906), a most valuable publication, as well as *The Vagrancy Problem* (1910), by W. H. Dawson, who was a witness before the committee, and whose work quoted is full of first-hand information Two Board of Trade *Reports* on "Agencies and Methods for Dealing with the Unemployed" (1893 and 1904) will be found useful, as will also Rev. W. Carlile and V. W. Carlile's *The Continental Outcast* (1906), Mary Higgs, *Down and Out. Studies in the Problems of Vagrancy*; "Royal Commission on the Poor Law," appendix to *Reports on Visit to Labour Colonies*, vol. xxxii. (1919), *Ministry of Reconstruction Report on Transference of Function of Poor Law* (1918). (P. A.; X.)

The United States.—Vagrancy laws in the United States began to appear after the economic depression of 1873 (New Jersey, 1876; Delaware, 1879, New York, 1884) and after the even greater depression of 1893.* Owing to the unique nature of the problem in the United States these laws attempted to differentiate between the vagrant or loafer, about town, and the tramp who roved "about from place to place." Both were "idle persons without visible means of support" only the tramp was more of a romantic adventurer. In other connections he is known as a migratory worker or hobo. He was a conspicuous figure in the building of railroads, prospecting and clearing the land during the strenuous drive against the frontier. With the passing of the frontier he continued in his role as tramp and migratory worker, but he now functions in only the seasonal industries and transient occupations. The migratory worker, because of his facility in using the railroads, is more mobile than any type of vagrant so far developed In the main he is self-sustaining, and when he is not, his problem is as much a matter of unemployment as of vagrancy. His labour market is elusive; harvesting, sheep shearing, lumbering, ice cutting and the like; and his fortunes are no less elusive. However legitimate his function may be in the country's industrial set-up, he still leads a precarious, hand-to-mouth existence, moving from job to job, from state to state at the beck and call of his opportunities, and not infrequently of his moods Most of his life the hobo lives in the open, especially in summer when if he is not at work or travelling to the next job he is basking in the "jungles," his roadside camps. In winter when work is scarce he is frequently forced into some city for food and shelter, and it is then that he gets his rating as a vagrant.

The life of the hobo is divided between train riding, the job, the "jungle" and the "main stem," or the street of the homeless found in most cities In most of his contacts he is relatively isolated from women, so hobo life becomes a man's game A population recruiting its new membership from young men and boys, it has little of the culture traits, jargon and sign language that some observers attribute to vagrants of the old world Since so many boys and young men are attracted into the class and since the promise of adventure generally proves a delusion there is naturally considerable unrest, which may explain the zeal with which hobos often turned to syndicalism Manifestations of unrest, songs of protest, and rapid movement, especially of younger hobos, about the country, all appeared with the passing of the frontier and the swing of the country from a rural to an industrial, city-building civilization The hobo of the old school who lived his life in the open, tramping and working by turns, and carrying his bed wherever he went, began to vanish Whereas the old-type hobo used to avoid the city, the modern species of the undomesticated American is essentially urban, and only when necessity forces him does he venture into the country.

Most attempts in the large cities to cope with the problem of vagrancy were partial and palliative. Small cities at one time opened their jails for winter lodging but that practically ceased after World War I Other cities drove tramps out of town; and others established wood yards to give the work test Numerous cities have municipal lodging houses and in addition private agencies, such as the Salvation Army, maintain industrial shops and transient hotels. In every large city during hard times, and often the year through, bread lines and soup kitchens may be found None of these efforts meets the problem in any comprehensive fashion

Jacob S Coxey who led "Coxey's army" of unemployed to Washington, D C, in 1894 demanded that the government should put them to work building roads. That proposal was often made but only with transient success. One of the earliest instances was in New York city in 1808 during a riot of unemployed sailors.

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(N. A., X.)

VAI, a people of the Mandinga group, on the Guinea coast in Liberia and Sierra Leone, who are remarkable for their use of a syllabic script consisting of more than 150 signs invented in the first half of the 19th century by Momolu Doalu Bukere.

See Migeod, *The Languages of West Africa* (1911)

VAIDA-VOEVOD, ALEXANDRE (1871–1950), Rumanian statesman, was born at Olpret, Transylvania, in 1871. He studied medicine in Vienna and practised for many years at Karlsbad (Karlovy Vary). At the age of 28 he joined the National Rumanian party of Transylvania and from 1906–18 sat in the Hungarian parliament at Budapest, where he waged a permanent fight in defense of the Rumanians in Transylvania. On the collapse of the Central Powers in the autumn of 1918, Vaida-Voevod was instructed by the newly formed "Rumanian National committee," to voice their claims in the Hungarian parliament Invoking the right of self-determination he denied the right of the Hungarian government to speak in the name of the Rumanians of Transylvania and claimed that the latter should have their own representative at the peace conference Soon after, the Rumanian National committee took administrative control of Transylvania and delegated Vaida-Voevod to represent the Rumanians of Transylvania and the Banat at the peace conference in Paris.

In 1919 Vaida-Voevod was appointed prime minister and minister for foreign affairs of Rumania and in the latter capacity went to Paris and London early in the following year to negotiate with the French and British governments the recognition of the union of Bessarabia with Rumania. This he succeeded in doing in March 1920 when the rights of Rumania over Bessarabia were recognized by the Supreme Economic council, and afterward ratified by the Treaty of London (Oct. 28, 1920). Vaida-Voevod resigned in the same year and afterward sat in parliament as one of the leaders of the National Rumanian party, from which he later resigned. He was prime minister again from Aug. to Oct.

1932, and from Jan to Nov. 1933. He died March 19, 1950.

VAIL, THEODORE NEWTON (1845–1920), U S capitalist, was born in Carroll county, O, on July 16, 1845 He became interested in telegraphy, and in 1868 he became station agent and telegraph operator on the Union Pacific Then he was appointed clerk in the railway mail service, and in 1873 was made assistant superintendent of railway mail service, rising in 1875 to general superintendent In 1878 he was made general manager of the American Bell Telephone company. In 1885 he resigned and was elected president of the newly organized American Telephone and Telegraph company, which in 1900 acquired the American Bell Telephone company. In 1887, because of ill-health, Vail retired. In 1896 he installed an electric railway system in Buenos Aires, and later introduced telephone systems in South American cities.

In 1907 he was again induced to accept the presidency of the American Telephone and Telegraph Company. When this company in 1910 bought control of the Western Union Telegraph company Vail was made president of the latter also, and introduced many changes, including "night letters" at reduced rates. When in 1914, as the result of a threatened suit by the government, the Western Union was again segregated Vail remained president of his old company. After the taking over of the wires in Aug. 1918 by the government as a war measure, he was appointed adviser by the postmaster-general. When the wires were returned in 1919 to private ownership he was elected chairman of the board of directors of the American Telephone and Telegraph company. He died in Baltimore, Md, on April 16, 1920.

See A B Paine, *In One Man's Life* (1921).

VAILLANT, EDOUARD MARIE (1840–1915), French politician, was born in Vierzon, Cher, on Jan. 28, 1840 He studied science, residing in Heidelberg, Tubingen and Vienna. On his return to Paris he took part in the republic and socialist battle against the Second Empire, becoming a disciple and friend of Louis Blanqui On March 18, 1871, he took part in the Commune insurrection, and, on the 26th, was elected a member of the Commune. He was a delegate on the executive commission, and his work for public instruction displays his revolutionary audacity and his scientific knowledge.

After the defeat of the Commune he fled to England and became associated with Karl Marx. But, after having been a member of the general committee of the First International, after having participated in 1872 in the congress at The Hague, he induced his friends to abandon this association because it seemed to him to be insufficiently revolutionary. He founded "The Revolutionary Commune" which published the manifesto in which these disciples of Blanqui declared themselves to be atheists, republicans, communists, revolutionaries and partisans of class conflict.

Condemned to death by the war council in 1872, Vaillant only returned to France in 1880 under amnesty. He was a founder of the Socialist Revolutionary party, and in 1884, he became a municipal councillor of Paris, becoming deputy in 1893. Under his direction, the Blanquist party made itself noticeable among the other socialist parties. In Boulangisme (1889), he separated from other blanquists, who, through nationalism, were inclined to accept a plebiscitary dictator.

In 1899, and again in 1905, Vaillant made himself the apostle of socialist unity in France When in 1905, all the socialist parties united, he became a very close friend of Auguste Jaurès, and secured with him the majority in all socialist congresses until 1914. He advocated the eight-hour day, security and hygiene for workers, remedies against stoppage of work, and a struggle against war.

In Aug. 1914 he considered that France was attacked and that it was the duty of the socialists to defend it, as in 1870 and 1871. He resumed the formulas of Blanquist socialism and declared himself unreservedly in favour of national defense.

VAIRAGI: *see* RAMATS.

VAISHNAVITES (Bengal). Chaitanya, the founder of the great Vaishnava sect of Bengal, was the son of a high-caste Brahman of Nadiya, the famous Bengal seat of Sanskrit learning, where he was born in 1485, two years after the birth of Martin Luther, the German reformer. Having married in due time, and a second time after the death of his first wife, he lived as a householder (*grihastha*) till the age of 24, when he renounced his family ties and set out as a religious mendicant (*vairagin*), visiting during the next six years the principal places of pilgrimage in northern India, and preaching with remarkable success his doctrine of Bhakti, or passionate devotion to Krishna, as the supreme deity.

He subsequently made over to his principal disciples the task of consolidating his community, and passed the last 12 years of his life at Puri in Orissa, the great centre of the worship of Vishnu as Jagannatha, or "lord of the world," which he remodelled in accordance with his doctrine, causing the mystic songs of Jayadeva to be recited before the images in the morning and evening as part of the daily service, and seeking to humanize divine adoration by bringing it into accord with the experience of human love. To this end, music, dancing, singing parties (*sankirtan*), theatricals—in short anything calculated to produce the desired impression—would prove welcome to him.

His doctrine of Bhakti distinguishes five grades of devotional feeling in the Bhaktas, or faithful adherents: viz., (*santi*) calm contemplation of the deity; (*dasya*) active servitude; (*sakhya*) friendship or personal regard; (*vatsalya*) tender affection as between parents and children; (*madhurya*) love or passionate attachment, like that which the Gopis felt for Krishna. Chaitanya promoted the celebration on an imposing scale of the great Puri festival of the Rathayatra, or car procession, in the month of Ashadha, when, amidst multitudes of pilgrims, the image of Krishna, together with those of his brother Balarama and his sister Subhadra, is drawn along, in a huge car, by the devotees. This festival was, and is, attended by people from all parts of India, without distinction of caste or sex. All classes, even Mohammedans, were admitted by Chaitanya as members of his sect. The ordinary form of worship is very simple, consisting mainly of the constant repetition of names of Krishna, or Krishna and Radha, which of itself is considered sufficient to ensure future bliss. The partaking of flesh food and spirituous liquor is strictly prohibited. By the followers of this sect, also, an extravagant degree of reverence is habitually paid to their *gurus* or spiritual heads Indeed, Chaitanya himself, as well as his immediate disciples, have come to be regarded as complete or partial incarnations of the deity to whom adoration is due, as to Krishna himself; and their modern successors, the Gosains, share to the fullest extent in the devout attentions of the worshippers. Chaitanya's movement was directed against the vile practices of the Saktas (*see* SAKTISM) then very prevalent in Bengal, but his own doctrine of divine, though all too human, love was by no means free from corruptive tendencies. While in Chaitanya's creed, Krishna, in his relations to Radha, remains at least theoretically the chief partner, an almost inevitable step was taken by some minor sects in attaching the greater importance to the female element, and in this way making Krishna's love for his mistress the guiding sentiment.

VAISON-LA-ROMAINE, a town of southeastern France, in the department of Vaucluse, 26 mi.•N.N.E. of Avignon by road. Pop. (1946) 2,188. Vaison, under the name of *Vasio*, was one of the principal towns of the *Vocontii*; the number of Roman finds, including a fine statue of an athlete (the Diadumenos) in the British Museum, proves its importance in Roman times. The bishopric established in the 3rd century was suppressed in 1791 The temporal power of the bishops passed in the 12th century to the counts of Toulouse. Subsequently Vaison came, together with the rest of Comtat-Venaissin, under the power of the popes. The Ouvèze, a tributary of the Rhône, divides Vaison into two quarters—the Roman and early mediaeval town on the right bank and the mediaeval town on the left bank.

VALAIS, a canton of south Switzerland. The region is the old *Vallis Poenina* (Upper Rhône valley). The former spelling, Vallais, was officially replaced in the early 19th century by Valais.

The modern canton includes the entire basin above St. Maurice, but below this point it consists of the western part only; its lower limits are in the Lake of Geneva. The total area is 2,020.7 sq.mi. (exceeded only by the Grisons and Berne), of which, however, only 55.9% is reckoned as productive; forests cover 282.6 sq mi.

and vineyards 12.2 sq.mi. Its unproductive area includes the most considerable stretch of glaciers in Switzerland (*c* 375 sq mi.), together with about 5 sq mi. of lakes. Poor as the canton is, it would be poorer were it not for its excellent wines—the area under vineyards is second only to Vaud (*q v*) and is increasing—and for its well-organized tourist traffic. Hotels have been built in nearly every tributary glen, and on the majority of the high pastures. The striking beauty of the scenery of its high glens, and the accessibility (*see* below) of the most characteristic features, have made the canton unusually popular, chiefly with summer visitors. The Upper Rhône occupies a northeast to southwest gorgelike trench from Gletsch to Brig, below this the valley widens and runs east to west to Leuk; onward it resumes its original course, ever widening until Martigny is reached, where the remarkably sharp bend carries the feature to the northwest; between St. Maurice and the lake is the only low land in the canton The lowest commune is St. Gingolph (1,266 ft. alt.). The loftiest point is the Dufourspitze summit (15,200 ft) of Monte Rosa, but the highest mountain wholly within the canton is the Dom (14,942 ft.). (*See* SWITZERLAND: *Physical Geography.*)

The chief railway line (about 75 mi.) through the canton is from St. Gingolph, on the Lake of Geneva, to Brig, at the north mouth of the Simplon tunnel (1895–1905—12½ mi. long); from St. Maurice onward it forms part of the main through line from Lausanne toward Milan. There are also several mountain railways; *e g*, from Visp up to Zermatt (thence a branch up to the Gornergrat), from Vernayaz (near Martigny) past Salvan toward Chamonix, and from Leuk to Leukerbad, near the Gemmi pass and noted for its mineral springs A new tunnel (1906–12) beneath the Lötschen pass, connects Kandersteg, in the Bernese Oberland, with Brig, thus opening up a new direct route from Paris to Italy, via Berne. The lofty alpine barriers of Valais are, as a rule, accessible only by footpaths or mule paths, but there are excellent roads over the Great St. Bernard pass (8,094 ft.) and the Simplon pass (6,591 ft.) to Italy, while at the head of the Rhône valley other excellently engineered roads give access to Uri over the Furka pass (7,992 ft.) and to Berne over the Grimsel pass (7,100 ft)

In general, the boundaries of the canton run along the summit ridges of the surrounding mountains, but from an early date it has held a valuable part of the southern slope of the Simplon pass to below Gondo, as well as the rich Alpine pastures on the northern slopes between the Gemmi pass (7,641 ft) and Schwarzenbach.

The total population thus the census of 1910 was 159,178; in 1930 it was 136,394, of whom 88,498 were French-speaking, 44,275 were German-speaking and 3,269 were Italian-speaking. The Italians decreased in number during the 20th century. The linguistic frontier has shown much oscillation; at present the inhabitants above Leuk generally speak a dialect of German, while below Leuk a Savoyard patois (French dialect) is the prevailing tongue In general, the history of Valais (from 1810 to 1814 the French department of the Simplon) is a struggle between French and German elements. It is one of the last three admissions to the confederation. In 1930 there were 130,801 Catholics, 4,662 Protestants and 48 Jews

The canton forms the 4th-century diocese of Sion (created *c.* 580) and has St. Théodule as its patron saint. Since 1513 its bishop has had no superior except the pope Valais contains the three famous religious houses (all now held by Austin canons) of St. Maurice, of the Great St. Bernard, and of the Simplon. The abbey of St. Maurice (4th century and the oldest Christian foundation among the Alps) has, since 1128, belonged to the Augustinians. Since 1840 its abbot has borne the title of bishop of Bethlehem *in partibus.*

Good wines, especially muscat and *vin du glacier,* are produced in the canton, but the chief activity of the main valley below Brig is agriculture, rendered rather precarious in former days by extensive Rhône inundations. In the higher valleys the inhabitants are employed in pastoral occupations. The number of mountain pastures is greater, and they are better stocked in the more congenial Lower Valais than in Upper Valais (the line of division passing near Leuk). The capital is Sion (pop. 10,904). The canton has no large towns. The average density of the population in 1950, 79 per sq.mi , was but little above that of Uri (*q v.*) Of the larger settlements, Monthey (5,608)—near St. Maurice—with an electric railway up the Val d'Illiez to Champéry, and Brig (3,854) are the most important. Naters, near the latter town, has a prosperous colony of Italian workmen.

Valais is divided into 13 administrative districts, which comprise 170 communes. The cantonal constitution was entirely remodelled in 1907. The legislature (*grand conseil*) is composed of 119 members elected by the people in the proportion of one for every 1,100 Swiss residents. The executive (*conseil d'état*) is composed of five members. Both councils hold office for four years The obligatory referendum prevails for all laws and financial resolutions passed by the *grand conseil,* while 4,000 electors (6,000 in the case of a revision of the cantonal constitution) have the right of initiative as to legislative projects; the latter initiative dates back to 1848. The canton provides two members of the federal *Standerat* and six members of the federal *Nationalrat,* elected by a popular vote. The principles of proportional representation are employed in communal elections.

History.—The Vallis Poenina was won by the Romans after a great fight at Octodurus (Martigny) in 57 B C , and was so thoroughly Romanized that the Celtic aboriginal inhabitants and the Teutonic Burgundian invaders (5th century) became Romance-speaking peoples. Valais formed part of the kingdom of Transjurane Burgundy (888), which fell to the empire in 1032, and later of the duchy of Burgundia Minor, which was held from the emperors by the house of Zähringen (extinct 1218). In 999 Rudolph III of Burgundy gave all temporal rights and privileges to the bishop of Sion, who was later styled "praefect and count of the Valais." About the middle of the 13th century independent communities or tithings (*dizains* or *Zehnten*) were growing up, these, though seven in number, taking their name most probably from a very ancient division of the bishop's manors for administrative and judicial purposes. In the same century the upper part of the valley was colonized by Germans from Hasli (Bern), who Teutonized it, though many Romance local names still remain. In 1354 the liberties of several of the seven tithings (Sion, Sierre, Leuk, Raron, Visp, Brieg and Conches) were confirmed by the emperor Charles IV. A little later the influence of Savoy became predominant, and the count secured to his family the bishopric of Sion, of which he was already the suzerain. His progress was resisted by the tithings, which in 1375–76 crushed the power of the house of La Tour-Châtillon, and in 1388 utterly defeated the forces of the bishop, the count and the nobles at Visp, this being a victory of the Teutonic over the Romance element in the land

From 1384 the Morge stream (a little below Sion) was recognized as the boundary between Savoyard or Lower Valais and episcopal or Upper Valais. In 1416–17 the *Zehnten* of the upper valley made an alliance with Lucerne, Uri and Unterwalden, with a view partly to the conquest of the Val d'Ossola, which was finally lost in 1422, and partly to the successful crushing of the power of the lords of Raron (1420) By the election of Walther von Supersax of Conches as bishop in 1457 the Teutonic element finally won the supremacy. On the outbreak of the Burgundian War, the bishop of Sion and the tithings made a treaty with Bern In November of the same year (1475) they seized all Savoyard or Lower Valais up to Martigny, and in 1476 (March), after the victory of Grandson, won St. Maurice, Evian, Thonon and Monthey. The last three districts were given up in 1477, but won again in 1536, though finally by the treaty of Thonon in 1569 Monthey, Val d'Illiez and Bouveret alone were permanently annexed to the Valais, these conquests being maintained with the help of their old allies, Uri, Schwyz and Unterwalden. These districts (or Lower Valais) were ruled as subject lands by the bishop and tithings of Upper Valais In 1790–91 Lower Valais rose in revolt, but it was not finally freed till 1798, when the whole of Valais became one of the cantons of the Helvetic republic. Such prolonged resistance, however, was offered to French rule that in 1802 Bonaparte declared Valais an independent state under the name of the "Rhodanic Republic" In 1810, for strate-

gic reasons, he incorporated it with France as the "department of the Simplon," and it was not freed till the Austrians came in 1813. In 1815 a local assembly was created, in which each of the seven tithings of Upper, and each of the six of Lower Valais elected four members, the bishop being given four votes. This constitution was approved by the federal Swiss diet, and the Valais was received as a full member of the Swiss confederation By the constitution of 1839, the local assembly was to be elected according to population (1 member for every 1,000 inhabitants), and the bishop was given a seat instead of his four votes, while the clergy elected one deputy. By the 1844 constitution the clergy elected a second deputy In 1844 there was civil war, and the Valais became a member of the Sonderbund. It was the last canton to submit in the Sonderbund War (1847). By the constitution of 1848 all ecclesiastical exemptions from taxation were swept away, and the bishop lost his seat in the assembly. New constitutions were framed in 1852, 1875 and 1907. (*See* SWITZERLAND. *History*)

VALDEMAR I, king of Denmark (1131–1182), the son of Canute Lavard and the Russian princess Ingeborg, was born a week after his father's murder, and was brought up in the religious and relatively enlightened household of Asser Rig, whose sons Absalon and Esbjorn Snare, or "the Swift," were his playmates. On the death of King Eric Lam in 1147 Valdemar came forward as one of the three pretenders to the Danish crown, Jutland falling to his portion (compact of Roskilde [1157]). Narrowly escaping assassination at a banquet a few days later, at the hands of his rival, King Sweyn III, he succeeded only with the utmost difficulty in escaping to Jutland, but on Oct. 23 utterly routed Sweyn at the great battle of Grathe Heath, near Viborg, Sweyn perishing in his flight from the field.

Valdemar had no longer a competitor He was the sole male survivor of the ancient royal line; his valour and ability were universally recognized, and in Absalon, elected bishop of Roskilde in 1158, he possessed a minister of equal genius and patriotism. The first efforts of the new monarch were directed against the Wendish pirates who infested the Baltic and made not merely the political but even the commercial development of the Danish state impossible. What the Northmen were to the western powers in the 8th and 9th centuries the Wends were to the Scandinavian lands in the 11th and 12th centuries. At the beginning of the reign of Valdemar the whole of the Danish eastern coast lay wasted and depopulated. Arkona, the chief sanctuary, and Garz, the political capital of the Wends, in the island of Rügen, were captured in 1169 by a great expedition under the command of Valdemar and Absalon; the hideous colossal idol of Rügievit was chopped into firewood for the Danish caldrons, and the Wends were christened at the point of the sword.

This triumph was only obtained, however, after a fierce struggle of ten years, in which the Danes were much hampered by the uncertain and selfish co-operation of their German allies, chief among whom was Henry the Lion, duke of Saxony and Bavaria, who appropriated the lion's share of the spoil. For at the beginning of his reign Valdemar leaned largely upon the Germans and even went the length, against the advice of Absalon, of acknowledging the overlordship of the emperor Frederick Barbarossa at the diet of Dôle, 1162. Very different was Valdemar's second conference with Barbarossa, on the banks of the Eider in 1182, when the two monarchs met as equals in the presence of their respective armies and a double marriage was arranged between two of Valdemar's daughters and two of the emperor's sons.

The only serious domestic trouble during Valdemar's reign was the rebellion of the Scanian provinces, which objected to the establishment of a strong monarchy inimical to local pretensions and disturbances, and especially to the heavy taxes and tithes necessary to support the new reign of law and order. The rising was ultimately suppressed by Absalon at the battle of Dysiaa, 1181 In the following year King Valdemar died.

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VALDEMAR II, king of Denmark (1170–1241), was the second son of Valdemar I and brother of Canute VI, whom he succeeded on Nov. 12, 1202. Already during his brother's lifetime, as duke of Schleswig, Valdemar had successfully defended Denmark against German aggression. In 1201 he assumed the offensive, conquered Holstein, together with Hamburg, and compelled Count Henry of Schwerin to acknowledge the overlordship of the Danish crown. Immediately after his coronation, he hastened to his newly won territories, and was acknowledged lord of Northalbingia (the district lying between the Eider and the Elbe) at Lubeck, Otto IV, then in difficulties, voluntarily relinquishing all German territory north of the Elbe to Valdemar, who in return recognized Otto as German emperor. Thus the three bishoprics of Lübeck, Ratzeburg and Schwerin, which hitherto had been fief of the *Reich*, now passed under Danish suzerainty. In 1208, when the emperor Otto felt more secure upon his unstable throne, he would have attempted the recovery of the lost German territory but for the interposition of Pope Innocent III, who threatened to excommunicate any German prince who should attack Valdemar, the equally pious and astute Danish king having undertaken, at the bidding of the holy see, to lead a crusade against the heathen Estonians. Valdemar's position was further strengthened by the accession of Frederick II, who formally renounced all the German lands north of the Elbe and Elde, as well as the Wendish lands on the Baltic, in favour of Valdemar.

Valdemar henceforth turned to the extension of the Danish empire over the eastern Baltic shores. There, however, he had already been forestalled by German colonists established in Gotland and at Riga In 1206 Valdemar, urged by Archbishop Anders Sunesön, had occupied the Isle of Oesel on the Estonian coast. In 1210 Valdemar led a second expedition eastward, this time directed against heathen Prussia and Samland, the chief result of which was the subjection of Mestwin, duke of Pomerania, the leading chieftain in those parts

In 1218 the German Bishop Albert of Riga was driven to appeal for assistance to King Valdemar. Valdemar cheerfully undertook a new crusade "for the honour of the Blessed Virgin and the remission of my own sins." In 1218 he set sail for Estonia with one of the largest fleets ever seen in northern waters, including a Wendish contingent led by Prince Vitslav. Landing at Lyndantse (the modern Reval) in north Estonia, Valdemar at once received the submission of the inhabitants, but three days later was treacherously attacked in his camp and only saved from utter destruction by his own personal valour and the descent from heaven, at the critical moment, of a red banner with a white cross on it, the Dannebrog (Danes' Cloth), heard of for the first time, and which henceforth was to precede the Danish armies to victory till its capture by the Ditmarshers, three hundred years later. This victory was followed by the foundation of Reval and the occupation of Harrien and Wirland, the northern districts of Estonia, by the Danes

King Valdemar II was then, after the king of England, the most powerful potentate in the north of Europe. The south-western Baltic was a Danish sea, and Danish territory extended from the Elbe to Lake Peipus. But this scattered and heterogeneous empire required a large standing army and a strong central government to hold it together. It is doubtful whether even the genius of Valdemar would have proved equal to such a stupendous task. He never had the opportunity of attempting it. In May 1223 he was seized at midnight in his tent on the isle of Lyö, where he had gone to hunt, by his vassal and guest Count Henry of Schwerin, and conveyed with his son and many other valuable hostages to the inaccessible castle of Dannenberg-on-Elbe. In this dungeon he languished for two and a half years, and despite all the efforts of Pope Honorius III on his behalf, he was ultimately forced to pay a heavy ransom and surrender Northalbingia and all his Wendish conquests except Rugen.

On his release he tried to retrieve his position by force, but was defeated at Bornhöved (July 22, 1227), which deserves a place among the decisive battles of history, for it destroyed at once and for ever the Danish dominion of the Baltic and estab-

lished the independence of Lübeck, to the immense detriment in the future of all the Scandinavian states. On the other hand Valdemar, by prudent diplomacy, contrived to retain the greater portion of Danish Estonia (compact of Stensby, 1238). With rare resignation Valdemar devoted the remainder of his life to the great work of domestic reform. His noblest achievement in this respect is the codification of the Danish laws known as the *Jydske Lov* (Jutland Code), which he lived to see completed a few days before his death at Vordingborg on March 21, 1241. Valdemar was twice married, his first consort being Dragomir (Dagmar) of Bohemia, his second Berengaria of Portugal. All his four sons, Valdemar, Eric, Abel and Christopher, became kings of Denmark

See *Danmarks Riges Historie*, vol. i, pp. 736–849 (Copenhagen, 1897–1905) (R. N. B.; X.)

VALDEMAR IV, king of Denmark (*c.* 1320–1375), was the youngest son of Christopher II of Denmark. Valdemar was brought up at the court of the German emperor Louis of Bavaria during those miserable years when Denmark was partitioned among Holstein counts and German *Ritter*, while Scania, the breadbasket of the monarchy, sought deliverance from anarchy under the protection of Magnus of Sweden. Even the Hansa towns, the hereditary enemies of Denmark, regarded the situation with disquietude. "One would gladly have seen a single king in Denmark if only for peace sake," says the contemporary Lübeck chronicle, "for peace was not to be had either at sea or on land." The assassination at Randers of the detested Holstein tyrant Count Gerhard III (1340), who for nine years had held Jutland and Funen and dominated the rest of Denmark, first opened Valdemar's way to the throne, and on midsummer day 1340 he was elected king at a *Landsting* held at Viborg, after consenting to espouse Helveg, the sister of his most important confederate, Valdemar, duke of Schleswig

Valdemar could not have been more than 20 when he became the nominal king of Denmark, though, as a matter of fact, his territory was limited to the northernmost county of Jutland. His precocious maturity is strikingly evident from the first. An energy which never slackened, a doggedness which no adversity could crush, a fiery ambition coupled with the coolest calculation, and a diplomatic unscrupulousness which looked always to the end and never to the means, these were the salient qualities of the reconstructor of the dismembered Danish state First Valdemar aimed at the recovery of Zealand, which was actually partitioned among a score of Holstein mortgagees who ruled their portions despotically from their strong castles and sucked the people dry. The oppressed clergy and peasantry regarded Valdemar as their natural deliverer; but the work of redemption proved painfully slow

In Nov 1343 Valdemar obtained the town and castle of Copenhagen from King Magnus Smek of Sweden by reconfirming in still more stringent terms the previous surrender of the rich Scanian provinces, and by the end of the following year he had recovered the whole of North Zealand In 1347 the remainder of Zealand was redeemed, and the southern islands, Laaland, Falster and Mon, also fell into the king's hands. By this time, too, the whole of Jutland (except the province of Ribe) had fallen to him, county by county, as their respective holders were paid off In 1349 at the *Landsting* of Ringsted, Valdemar proudly rendered an account of his stewardship to the estates of Zealand, and the bishop of Roskilde congratulated him on having so miraculously delivered his people from foreign thraldom In Aug. 1346, he prudently rid himself of the distant and useless province of Estonia by selling it very advantageously.

In north German politics Valdemar interfered to protect his brother-in-law the Margrave Louis of Brandenburg against the lords of Mecklenburg and the dukes of Pomerania, with such success that the emperor Charles IV, at the conference of Bautzen, was reconciled to the Brandenburger and allowed Valdemar an annual charge of 16,000 silver marks on the city of Lubeck (1349). Some years later Valdemar even contemplated a descent on England in alliance with the French king John, but the chronic state of rebellion in western Denmark, fomented by the discontented Jutish magnates, lasted with short intervals from 1350 to 1360 and compelled Valdemar to renounce this fantastic design. But he proved more than a match for his domestic rebels, especially after his great victory at Brobjaerg in Funen (1357). Finally, the compact of Kalundborg restored peace to the kingdom.

Valdemar now turned his eyes to the "kingdom of Scania" Valdemar had indeed pledged it solemnly and irrevocably to King Magnus of Sweden, who had held it for 20 years; but profiting by the difficulties of Magnus with his Norwegian subjects, after skilfully securing his own position by negotiations with Albert of Mecklenburg and the Hanseatic league, Valdemar suddenly and irresistibly invaded Scania, and by the end of 1361 all the old Danish lands, except North Holland, were recovered.

By the recovery of Scania Valdemar had become the lord of the great herring-fishery market held every autumn from St Bartholomew's day (Aug 24) to St. Denis' day (Oct. 9) on the hammer-shaped peninsula projecting from the southwest corner of Scania containing the towns of Skanor and Falsterbo. This flourishing industry, which fully occupied 40,000 boats and 300,000 fishers assembled from all parts of Europe to catch and salt the favourite Lenten fare of the whole continent, was the property of the Danish crown, and the innumerable tolls and taxes imposed by the king on the frequenters of the market was one of his most certain and lucrative sources of revenue. Foreign chapmen eagerly competed for special privileges of Skanor and Falsterbo, and the Hanseatic merchants in particular aimed at obtaining a monopoly there. But Valdemar was by no means disposed to submit to their dictation, and political conjunctures brought about actual hostilities between Valdemar and the Hansa, or at least that portion of it known as the Wendish towns[1], whose commercial interests lay principally in the Baltic.

From time immemorial the Isle of Gotland had been the staple of the Baltic trade, and its capital, Visby, whose burgesses were more than half German, the commercial intermediary between east and west, was the wealthiest city in northern Europe. In July 1361 Valdemar set sail from Denmark at the head of a great fleet, defeated a peasant army before Visby, and a few days later the burgesses of Visby made a breach in their walls through which the Danish monarch passed in triumph The conquest of Gotland at once led to a war between Valdemar and Sweden allied with the Hanseatic towns; but in the spring of 1362 Valdemar repulsed from the fortress of Helsingborg a large Hanseatic fleet provided with "shooting engines" (cannon) and commanded by Johan Wittenburg, the burgomaster of Lübeck. In Sweden proper he was equally successful, and the general pacification which ensued in April 1365, very greatly in his favour, was cemented by the marriage of his daughter Margaret with Hakon VI of Norway.

Valdemar was now at the height of his power Every political rival had been quelled. With the papal see, since his visit to Avignon in 1364, he had been on the best of terms His ecclesiastic patronage was immense, and throughout the land he had planted strong castles surely held by the royal bailiffs. But in the winter of 1367–68 a hostile league against him of all his neighbours threatened to destroy the fruits of a long and strenuous lifetime. The impulse came from the Hansa At a *Hansetag* held at Cologne on Nov. 11, 1367, three groups of the towns, 70 in number, concerted to attack Denmark, and in Jan. 1368 Valdemar's numerous domestic enemies, especially the Jutlanders and the Holstein counts, acceded to the league, with the object of partitioning the realm among them

And now an astounding and still inexplicable thing happened. At Easter-tide 1368, on the very eve of this general attack, Valdemar departed for three years to Germany, leaving his realm in the capable hands of the earl-marshal Henning Podbusk. Valdemar's skilful diplomacy, reinforced by golden arguments, did indeed induce the dukes of Brunswick, Brandenburg and Pomerania to attack the confederates in the rear; but fortune was persistently unfriendly to the Danish king, and peace was finally concluded with the towns by Podbusk and the Danish council of state at the congress of Stralsund, 1370. The con-

[1] Rostock, Greifswald, Wismar and Stralsund.

ditions of peace were naturally humiliating for Valdemar, though ultimately he contrived to render illusory many of the inordinate privileges he was obliged to concede. He was also able, shortly before his death on Oct 24, 1375, to recover the greater part of Holstein from the rebels.

See *Danmarks Riges Historie*, vol. ii, pp. 275–356 (Copenhagen, 1897–1905). (R. N. B.)

VALDES, JUAN DE (*c.* 1500–1541), Spanish religious writer, younger of twin sons of Fernando de Valdes, hereditary regidor of Cuenca in Castile, was born about 1500 at Cuenca. He has been confused with his twin brother Alphonso (in the suite of Charles V at his coronation in Aix-la-Chapelle, 1520; Latin secretary of state from 1524, died in 1532 at Vienna). Juan, who probably studied at the University of Alcala, first appears as the anonymous author of a politico-religious *Dialogo de Mercurio y Caron*, written and published about 1528. A passage in this work may have suggested Don Quixote's advice to Sancho Panza on appointment to his governorship. The *Dialogo* attacked the corruptions of the Roman Church; hence Valdes, in fear of the Spanish Inquisition, left Spain for Naples in 1530. In 1531 he removed to Rome, where his criticisms of papal policy were condoned, since in his *Dialogo* he had upheld the validity of Henry VIII's marriage with Catherine of Aragon. From the autumn of 1533 he made Naples his permanent residence, his name being Italianized as Valdesso and Val d'Esso.

Valdes' house on the Chiaja was the centre of a literary and religious circle; his conversations and writings (circulated in manuscript) stimulated the desire for a spiritual reformation of the church. His first production at Naples was a philological treatise, *Dialogo de las lenguas* (1533). His works entitle him to a foremost place among Spanish prose writers. His friends urged him to seek distinction as a humanist, but his bent was toward problems of biblical interpretation in their bearing on the devout life. Vermigli (Peter Martyr) and Marcantonio Flaminio were leading spirits in his coterie, which included Vittoria Colonna and her sister-in-law, Giulia Gonzaga. On Bernardino Ochino, for whose sermons he furnished themes, his influence was great. Pietro Carnesecchi, who had known Valdes at Rome as "a modest and well-bred courtier," found him at Naples (1540) "wholly intent upon the study of Holy Scripture," translating portions into Spanish from Hebrew and Greek, with comments and introductions. To him Carnesecchi ascribes his own adoption of the Evangelical doctrine of justification by faith, and at the same time his rejection of the policy of the Lutheran schism. Valdes died at Naples in May 1541.

His death scattered his band of associates. Abandoning the hope of a regenerated Catholicism, Ochino and Vermigli left Italy. Some of Valdes's writings were by degrees published, in Italian translations. They combine a delicate vein of semimystical spirituality with the personal charm attributed to their author in all contemporary notices. Juan Llorente traces in Valdes the influence of Johannes Tauler, any such influence must have been at second hand. The *Avviso* on the interpretation of Scripture, based on Tauler, was probably the work of Alphonso. Valdes was in relations with Fra Benedetto of Mantua, the anonymous author of *Del Beneficio di Gesù Cristo Crocefisso*, revised by Flaminio (reprinted by Babington, Cambridge, 1855). The suggestion that Valdes was unsound on the Trinity was first made in 1567 by the Transylvanian bishop Francis Dávid (*see* article SOCINUS), it has been adopted by Sand (1684), Robert Wallace (1850) and other anti-Trinitarian writers, and is countenanced by Pierre Bayle. But Valdes never treats of the Trinity (even when commenting on Matt. xxviii, 19), reserving it (in his *Latte Spirituale*) as a topic for advanced Christians; yet he explicitly affirms the consubstantiality of the Son, whom he unites in doxologies with the Father and the Holy Spirit (*Opusculos*, p. 145). Practical theology interested him more than speculative, his aim being the promotion of a healthy and personal piety.

The following is a list of his writings:—*Didlogo de Mercurio y Caron* (no date or place, 1528?), *Dialogo de las lenguas* (written, 1533; first printed, Madrid, 1737; reprinted, 1860, 1873), *Qual Maniera si devrebbe tenere a informare . . . gli figliuoli de Christiani delle Cose della Religione* (no date or place; before 1545, as it was used by the Italian translator of Calvin's catechism, 1545), Eng. trans. by J. T. Betts, 1882; *Trataditos* (Bonn, 1881, from a manuscript in the Palatine Library, Vienna, in English, by J. T. Betts, in *XVII Opusculos*, 1882); *Alfabeto Christiano* (written about 1537, in Italian, Venice, 1545, in English, by B. B. Wiffen, 1861); *Ciento i diez concideraciones;* all copies of the original edition suppressed by the Spanish Inquisition; in English by Nicholas Ferrar (at the instance of George Herbert), Oxford, 1638 (another version by J. T. Betts, 1865), *Seven Doctrinal Letters* (original published with the *Trataditos* from Vienna mss. in English, by J. T. Betts, with the *Opusculos*); *Comentario breve . . . sobre la epistola de San Pablo a los Romanos* (Venice, 1556; in English, by J. T. Betts, 1883), *Comentario breve . . . sobre la primera epistola de san Pablo a los Cornitios*, Venice, 1557 (No. 8); *El Evangelio de San Mateo* (1881, from Vienna ms., in English, by J. T. Betts, 1883); *El Salterio* (the Psalms from Hebrew into Spanish published with the *Trataditos* from Vienna manuscript).

Notices of Valdes in Sand (*Biblioth. Antitrinitar.*, 1684), Bayle and Wallace (*Antitrin. Biog.*, 1850) are inadequate. Revival of interest in him is due to McCrie (*Hist Ref. in Italy*, 1827; *Hist Ref in Spain*, 1829). *See* B. Wiffen's *Life* of Valdes prefixed to Betts's translation of the *Considerations* (1865). E. Boehmer, *Spanish Reformers of Two Centuries* (1874), *Lives of J. and A. de Valdes* (1882), and article in *Realencyklopadie fur Prot. Theol. und Kirche* (1885). *See* also M. Young, *Aonio Paleario* (1860); K. Benrath, *Bernardino Ochino* (1875); Menendez Pelayo, *Los Heterodoxos Españoles* (1880), G. Bonet-Maury, *Early Sources of Eng. Unit. Christ* (trans E. P. Hall, 1884). (A. Go.; X.)

VALDEZ, a town of Alaska, farthest north all year open port in North America, situated 61° 07′ N., 146° 16′ W. Pop. (est 1952) 1,600. Selected in 1898 by the U.S war department as a base for exploration, it became the site of a military post, Ft. Liscum, where troops were stationed until 1922. The route of a military telegraph line from Valdez to the settlements of Eagle and Fairbanks became a trail, a wagon road and eventually the principal highway, known as the Richardson highway, open all year between the coast and the interior. Valdez thus became an important port of entry for shipments to Fairbanks, Anchorage and other cities. Gold and copper mining, fish canning and fur farming are important.

VALDIVIA, a province of south Chile. Area 7,723 sq mi., pop. (1950 est.) 214,151. It is roughly mountainous in the east, is heavily forested and is traversed by numerous rivers. There is a chain of lakes across its eastern side near the Andes, the largest of which are Calafquén, Riñihue and Ranco, the boundary between Valdivia and Osorno passing through the centre of the latter. The rivers are the Valdivia or Calle-Calle, with its large tributaries in the central part of the province, and the Bueno which marks the southwestern boundary of the province. The Valdivia (about 100 mi long) has its sources in the Andes and flows west to the Pacific. Its largest tributary on the north is the Río Cruces. The Valdivia is the outlet for Lake Riñihue and is navigable for a long distance. Valdivia is one of the most recently settled provinces and has a large immigrant element, chiefly German. Its most important industry is lumbering. Stock raising is also important, and wheat is grown on the cleared lands. Lumber, cattle, leather, flour and beer are exported. The capital is Valdivia, a flourishing city on the Valdivia river, 12 mi. above its port, Corral, near the mouth of the river. Pop. (1940) 34,496. It is a roughly built pioneer town, in which wood is the principal building material. The mean annual temperature is 52.6° F.; annual rainfall 105 in.

VALDOSTA, a city of southern Georgia, U.S., the seat of Lowndes county. Pop. (1950) 20,046. Valdosta is the seat of the Valdosta State college (opened 1913) and Emory junior college for men. It has large tobacco warehouses.

Its manufactures include cotton, feed, lumber, textiles and metal products. Valdosta was settled in 1859 and was chartered in 1901.

VALENCE, a town of France, on the Rhône. Pop. (1946) 40,020. *Valentia* was the capital of the Segalauni, and the seat of a celebrated school before the Roman conquest, a colony under Augustus, and an important town of *Viennensis Prima* under Valentinian. Its bishopric dates probably from the 4th century. It was ravaged by the Alani and other barbarians, and fell successively under the power of the Burgundians, the Franks, the sovereigns of Arles, the emperors of Germany, the dukes of Valentinois, the counts of Toulouse and its own bishops. To strengthen the hands of the bishops against the dukes of Valen-

tinois, the pope in 1275 united their bishopric with that of Die. The citizens put themselves under the protection of the dauphin, and in 1456 had their rights and privileges confirmed by Louis XI, the bishops consenting to recognize the suzerainty of the dauphin.

Valence became the capital of the Protestants of the province in 1563. The town was fortified by Francis I. It had become the seat of a celebrated university in the 15th century, but the revocation of the Edict of Nantes crippled the prosperity of the town.

The cathedral of St. Apollinaris, with an interesting apse, was rebuilt in the 11th century in the Romanesque style of Auvergne and consecrated in 1095 by Urban II. It was injured in the wars of religion, but restored in the 17th century.

A curious 16th-century house (Maison des Têtes) has a sculptured front with heads of Homer, Hippocrates, Aristotle, Pythagoras, etc.

VALENCE (or VALENCY), in chemistry, is the property of an element which determines the number of other atoms with which an atom of the element can combine. The property is not a simple one; the effort to obtain a clear understanding of the nature of valence has led in recent years to the dissociation of the concept into several new concepts—of ionic valence, covalence, oxidation number, co-ordination number, metallic valence—corresponding to different modes of interaction of atoms. Some chemists have felt that the word valence might well be allowed to drop into disuse, in favour of these more precise terms. In practice, however, valence continues to be used as a general expression of the combining capacities of the elements or as a synonym for one or another of the more precise terms.

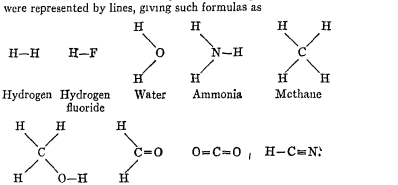
When, toward the middle of the 19th century, the relative weights of atoms and molecules became accurately known, especially through the reintroduction by Stanislao Cannizzaro in 1858 of Amedeo Avogadro's principle (1811) of the relation between the molecular weight and the density of a gas, it became clear that the number of atoms with which a given atom could combine varied with the nature of that atom: that, for example, a fluorine atom could combine with one hydrogen atom, an oxygen atom with two, a nitrogen atom with three and a carbon atom with four, forming the compounds HF, H_2O, H_3N and H_4C. These characteristic combining capacities were shown to extend to more complicated compounds: two of the four hydrogen atoms in methane, CH_4, could be replaced by one oxygen atom, or all four by two, or three by one nitrogen atom, as in H_2CO, CO_2, HCN. Thus, it appeared that every atom could combine with or replace a definite number of other atoms of a specified kind, and hydrogen, since it was the lightest atom and was never found to combine with more than one atom of another element, was selected as the standard. The term valence, or valency, introduced in 1868, is now used to express both the power of combination in general, and its numerical value.

As the examination of the valence of elements was extended there was much dispute as to whether or not it was constant in value for any one element. It soon became evident that the valence of many elements is variable: for a time it was maintained that the variations were always by two units, so that elements could be divided into those of odd and those of even valence; but before long it was recognized that, although this is true of many elements, there are others of which the valence must be admitted to vary by single units at a time.

The discovery of the periodic classification of the elements by Dmitri Mendeleyev and Lothar Meyer (1864–69) brought to light a new regularity in the valences of the elements (*see* PERIODIC LAW, THE). Mendeleyev pointed out that all the elements of a periodic group have the same principal valences, and that these change in value by one unit in passing from one group to the next. In particular, the highest valence of an element, as shown in its oxide, is equal to the ordinal number of the group to which it belongs. On the other hand, the valence in the hydrides seems to rise with that in the oxides from 1 to 4, and then to fall by steps of one unit to unity again.

Earlier Theories.—All discussions of valence in the 19th century were handicapped by the absence of any satisfactory theory of its cause. J. J. Berzelius, in the earlier part of the century, had assumed atoms to be electrically charged, and to be held together in the molecule by the attraction of opposite charges. This view was supported by the phenomenon of electrolysis, as investigated especially by Sir Humphry Davy and Michael Faraday. Its validity as a general theory of valence was, however, destroyed about 1840 by the discovery that under some conditions "electropositive" atoms could be replaced by "electronegative" atoms without any fundamental modification of the properties of the molecule: thus, part of the hydrogen in acetic acid can be replaced by chlorine, and the product resembles the original acid in many ways, and obviously must have a similar structure. The attempts of Berzelius to stretch his theory to explain such phenomena led to its falling into discredit, and it was in part replaced by what ultimately became the theory of structural chemistry.

In this new theory no assumptions were made as to the nature of the forces connecting the atoms in a molecule, and hence no opposition in character between the atoms was required. Every atom was regarded as having a certain number of units of combining power, and every atomic link as involving the utilization of one of these units by each of the atoms concerned. Double and triple links, in which each of two atoms used up two or three of these units in combining with one another, were also recognized. The valence of an atom in the numerical sense was the number of such units which it possessed. On paper, the links were represented by lines, giving such formulas as



This theory had an astounding success in its application to organic chemistry. It was found possible to determine from the reactions of a substance the order in which the constituent atoms are linked in the molecule, and thus to assign to the vast hordes of organic compounds "structural formulas" which account for their existence and to a large extent also for their properties. For a discussion of further extensions of this theory, which made it possible to determine the approximate relative positions in space of the various atoms and groups in a molecule, *see* STEREOCHEMISTRY. The electrical theory again became prominent in and after 1887, with the rise of the Svante Arrhenius theory of salt solutions, which showed that a solution of a salt in water contains oppositely charged ions (a solution of sodium chloride, for example, contains positive sodium and negative chlorine ions) which have to a great extent the properties of free molecules.

(N. V. S.; L. C. P.)

Werner's Co-ordination Theory.—A new concept in chemistry was developed in 1893 by Alfred Werner. It had been recognized that many metallic salts have the power of combining with other salts or with water or ammonia or other molecules. The compounds formed in this way had not been fitted into any theory of valence, however, and their existence had been attributed to the action of weak residual forces, inferior to the forces of true valence. By the study of an immense number of these compounds, Werner showed that their compositions and properties could be systematized on the basis of a new assumption. This assumption, which was later completely verified by X-ray investigations of the structure of complex crystals (R. W.

G. Wyckoff and R. G. Dickinson, 1920), is that a metal atom has the power of combining with a definite number (usually 4 or 6) of other atoms, ions or molecules, and "co-ordinating" them into a definite geometrical arrangement about itself. Werner was able to present sound evidence, consisting mainly of the existence of isomers, to support his proposal that most complexes with "co-ordination number" 6, such as the hexachloroplatinate ion, $[PtCl_6]^{--}$, and the cobaltic hexammine ion, $[Co(NH_3)_6]^{+++}$, have an octahedral configuration, the six attached groups being arranged at the corners of a regular octahedron about the central atom. He also showed that some complexes with co-ordination number 4 have a tetrahedral configuration (such as $[Zn(NH_3)_4]^{++}$) and some have a square, planar configuration ($[PtCl_4]^{--}$ and other complexes of bivalent palladium and platinum). General acceptance of Werner's co-ordination theory came in 1911, after his prediction and the experimental verification of the existence of the optical isomerism of some octahedral co-ordination complexes (*see* Co-ordination Compounds; Stereochemistry)

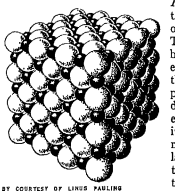
The Development of the Electronic Theory of Valence.—The modern electronic theory provides a detailed and thoroughly sound explanation of valence and chemical combination in terms of the electrostatic forces operating between electrons and atomic nuclei. The first great step in the development of this theory was made by Gilbert Newton Lewis by the identification of the valence bond of the organic chemist with a pair of electrons held jointly by two atoms, and serving to hold them together. Lewis also discussed the relation between the electronic structure of atoms and the valence of elements, including their power to form ions. In the same year (1916) the electronic structure of ions was discussed by W. Kossel; and after the development of the detailed electronic theory of the periodic system of the elements (*see* Periodic Law, The) further progress in the formulation of the electronic theory of valence was rapidly made through the efforts of I. Langmuir, N. V. Sidgwick and many other chemists.

Within two years after the development of quantum mechanics (*q.v.*) by W. Heisenberg, E. Schrodinger and P. A. M. Dirac, the fundamental nature of the shared-electron-pair chemical bond was elucidated by the quantum-mechanical treatment of the hydrogen molecule, carried out by W. Heitler and F. London in 1927. During the next few years many workers contributed to the application of quantum mechanics to the problem of chemical combination and valence, and rapid progress was made in the discovery of the principles determining the formation of shared-electron-pair bonds, the relation of the nature of bonds to the character of bond orbitals, and the significance of quantum-mechanical resonance to molecular structure. As a result of this progress and the great progress which has been made in the determination of the detailed atomic structures of molecules and crystals by methods of spectroscopy and the diffraction of X-rays and electrons, the theory of chemical valence is no longer a discussion of empirical rules, but is in large part a precise discussion of electronic structures and interatomic forces firmly based on the modern knowledge of electrons and atomic nuclei and their interactions.

Ionic Valence.—Molten sodium chloride is a good conductor of electricity. This molten salt consists of monatomic ions, positive sodium ions, Na^+, and negative chloride ions, Cl^-, in a moderately compact aggregate, in which, because of thermal agitation, each ion is free to move slowly around. Under the influence of the applied electrical field the sodium ions move toward the negative electrode and the chloride ions toward the positive electrode, and this motion of the ions carries the electric current through the region between the electrodes.

A sodium ion is a sodium atom which has lost one electron, and has thus acquired an electric charge $+e$ (or $+1$, with use of the magnitude of the electronic charge as unity). Since sodium is one greater in atomic number than neon, the sodium ion contains the same number of electrons as the neon atom. The chloride ion is a chlorine atom which has gained one electron, and has thus assumed a negative charge $-e$ (or -1), and the same number of electrons as argon. It is not accidental that these ions have the same electron numbers as the noble gases neon and argon. The noble gases are shown by their extreme chemical inertness to have especially stable electronic structures. This stability is shown by the fact that the ionization energy (the energy required to remove one electron from the atom: $X \rightarrow X^+ + e^-$) is greater for the noble gases than for any other atoms. Similarly, the electron affinity—the energy liberated in picking up an additional electron, according to the reaction $X + e^- \rightarrow X^-$—is smaller for the noble-gas atoms than for other atoms. An atom with atomic number near that of a noble gas tends to achieve the noble-gas structure by the loss or gain of electrons. One electron of a neutral sodium atom is loosely held and can be removed by a rather small amount of work; the ionization energy of the sodium atom is small. The chlorine atom has the power of adding an electron. When metallic sodium and gaseous chlorine react, an electron is transferred from each sodium atom to a chlorine atom, forming the ions Na^+ and Cl^-. Sodium chloride is an aggregate of these ions. The necessity of electrical neutrality requires that the substance contain equal numbers of singly charged cations and singly charged anions—hence, its formula is Na^+Cl^- (usually written NaCl); only a minute excess of ions of one sign would cause the sample of salt to have a high electrical potential.

The coulomb forces between the ions cause each ion to attract neighbouring ions of opposite sign, and to tend to co-ordinate them about itself. This leads to a stable spatial arrangement, shown by the sodium-chloride crystal (*see* figure), in which each ion has 6 nearest neighbours of the opposite sign, and 12 neighbours of the same sign at a distance $\sqrt{2}$ larger. The total coulomb energy for this arrangement is found by summation over pairs of ions to be $-1.7476\frac{e^2}{R}$ per Na^+Cl^- ion pair, in which R is the distance between the centre of one ion and the centre of one of its six nearest neighbours. The crystal is hence stabilized by this coulomb attraction by an energy quantity 75% greater than the coulomb energy of a positive and a negative charge the distance R apart. This coulomb energy of the crystal is large—it amounts to -205 kg.cal per mole for sodium chloride, and is large enough (with the help of the electron affinity of chlorine) to provide the energy to sublime sodium metal to separate atoms, to ionize these atoms and to dissociate chlorine molecules into chlorine atoms, all with 98 kg.cal per mole to spare, which is evolved as the heat of formation of sodium chloride from the elements.



BY COURTESY OF LINUS PAULING

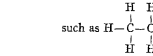
THE ATOMIC ARRANGEMENT IN THE SODIUM-CHLORIDE CRYSTAL: SMALL SPHERES ARE SODIUM IONS, LARGE SPHERES CHLORIDE IONS

The forces of attraction of ions of opposite charge are called "ionic valence forces," and the charge of an ion is called its "ionic valence." Sodium and the other alkali metals, with atomic number one greater than the noble gases, tend to form ionic compounds in which they have ionic valence $+1$ (are "unipositive"). Chlorine and the other halogens form compounds in which they have ionic valence -1 (are "uninegative"). The alkaline-earth metals lose two electrons per atom, to form the bipositive ions Be^{++}, Mg^{++}, Ca^{++}, Sr^{++}, Ba^{++} and Ra^{++}, in compounds such as $Ca^{++}Cl_2^-$, $Ca^{++}O^{--}$, etc. The elements of Group VI of the periodic table may form binegative ions O^{--}, S^{--}, Se^{--} and Te^{--}.

The metals of Groups Ib and IIb (*see* Periodic Law, The) tend to form cations (Cu^+, Ag^+, Zn^{++}, Cd^{++}, Hg^{++}) in which they have ten more electrons than a noble gas. The transition elements also form cations with other electron numbers. Usually these ions are bipositive or terpositive—the electron affinity of electronegative elements and the stabilizing effect of interionic attraction seem to be sufficient to remove two or three electrons from a transition atom, but not more. Examples of stable ions

are Cr^{+++}, Mn^{++}, Fe^{++}, Fe^{+++}, Co^{++}, Ni^{++} and Cu^{++}. The rare-earth metals usually form terpositive ions; a few, such as cerium, also form quadripositive ions, and a few others, such as europium, form bipositive ions.

Covalence.—Another kind of valence of great importance is "covalence," which results from the sharing of two electrons by two atoms. The bond which consists of a pair of shared electrons is called a "covalent bond"; it is essentially the bond of the organic chemist, represented by a dash in structural formulas,



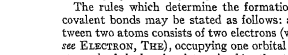
such as H—C—C—O—H for ethyl alcohol.

Whereas in an ionic compound the individual ions retain some independence of one another, and under certain conditions (as in the molten salt or in solution in a solvent of high dielectric constant) can move about rather freely, the atoms which are bonded together by covalent bonds are held tightly to one another and form a rather rigid molecule.

The simplest example of a covalent molecule is the hydrogen molecule, H_2, for which the structure H:H or H—H can be written. This molecule has been found by experiment to be rigid, with the equilibrium internuclear distance 0.740 A, the frequency of nuclear vibration $4{,}318\ cm.^{-1}$ (corresponding to a large restoring force to the equilibrium configuration) and the energy of dissociation of the molecule in its normal state into atoms 102,700 cal. per mole. The quantum-mechanical treatment of this molecule, carried out by Heitler and London and refined by H. M. James and A. S. Coolidge, has given complete agreement with these experimental values, leaving no doubt that the chemical bond in this molecule is the shared-electron-pair bond postulated by G. N. Lewis and formulated mathematically by the theory of quantum mechanics.

The rules which determine the formation and properties of covalent bonds may be stated as follows: a covalent bond between two atoms consists of two electrons (with opposed spins—*see* ELECTRON, THE), occupying one orbital for each atom. The strength of the bond is determined by the stability of the atomic orbitals, and also by their nature, a good bond orbital of an atom being a stable orbital which extends in the direction of the atom with which the bond is formed.

The requirement of stability of bond orbitals (as well as of atomic orbitals occupied by electron pairs not shared with other atoms) causes the covalence of atoms to be related to certain stable electronic configurations, especially those of the noble gases. Since an atomic orbital can be occupied by either an unshared electron pair or a shared electron pair, a noble-gas configuration can be achieved by an atom by the formation of covalent bonds as well as by the transfer of electrons (ionic valence). The normal covalences 4, 3, 2 and 1, respectively, for carbon, nitrogen, oxygen and fluorine, correspond to the achievement of the neon structure by the sharing of electrons:



A double bond between two atoms involves two electron pairs,



and two orbitals for each atom, as in ethylene, C::C, a triple



bond involves three electron pairs, and three orbitals for each atom, as in hydrogen cyanide, H:C:::N:. In each of these molecules the hydrogen atom achieves the helium configuration by forming one shared pair, and the carbon and nitrogen atoms achieve the neon configuration.

An atom may form covalent bonds in number different from the normal number, and complete its stable electronic configuration by the transfer of electrons. An example is nitrogen in the ammonium ion, $\left[\begin{smallmatrix} & H & \\ H & : & H \\ & H & \end{smallmatrix}\right]^+$.

When uncertainty arises as to the most satisfactory electronic structure for a molecule, the question may usually be resolved by assigning to a molecule a hybrid structure, corresponding to resonance among the likely alternative structures (*see* RESONANCE, THEORY OF). Thus, hydrogen chloride may be assigned the structure $\{H^+Cl^-, H-Cl\}$, a hybrid of the structure involving an extreme ionic bond and that involving a normal covalent bond; nitrous oxide may be assigned the structure $\{:\dot{N}=N=\ddot{O}, \cdot N\equiv N-\ddot{O}:\}$, a hybrid of the two most reasonable valence-bond structures. Some progress has been made in the rough quantitative assignment of hybrid structures, with use of experimental values of energy of formation, interatomic distances and other molecular properties.

For some purposes it is convenient to make use of the concept of formal charge. The formal charge of an atom is the electrical charge which the atom would have if it retained all its unshared electrons and one-half the electrons which it shares with atoms to which it is bonded. For example, in the ammonium ion, with the structure shown above, the formal charge of the hydrogen atoms is 0, and that of the nitrogen atom is +1.

Co-ordination Number.—The "co-ordination number" of an atom is the number of atoms, ions or molecules which the atom holds as its nearest neighbours in a complex or a crystal. Thus, the metal atom has co-ordination number 8 in the Werner co-ordination complexes $[Mo(CN)_8]^{4-}$ and $[Sr(H_2O)_8]^{++}$; 7 in the complex $[ZrF_7]^{3-}$; 6 in the complexes $[SnCl_6]^{--}$, $[PtBr_6]^{--}$, $[FeF_6]^{---}$, $[Co(NH_3)_6]^{+++}$ and $[Al(H_2O)_6]^{+++}$; 4 in the complexes $[Zn(CN)_4]^{--}$, $[Cu(CN)_4]^{---}$, $[Ni(CN)_4]^{4-}$, $[Ni(CN)_4]^{---}$, $[Be(H_2O)_4]^{++}$, $[BF_4]^-$ and $[Pt(CN)_4]^{--}$; and 2 in the complexes $[Ag(NH_3)_2]^+$, $[AuCl_2]^-$ and $[HgCl_2]$.

The forces which hold the atoms together in these complexes and which lead to the observed co-ordination numbers are of different kinds. The bonds to the highly electronegative fluorine atoms in the fluoride complexes are essentially ionic, and the increase in co-ordination number, with fluoride ion, from 5 to 6 to 7 for B^{+++}, Fe^{+++} and Zr^{4+}, is the result mainly of the increase in size of the cation, which permits a successively larger number of fluoride ions F^- to be packed about the central ion. The influence of the relative size of the co-ordinated molecule and the central ion is also important in the hydrated cations, in which the co-ordinating bond is mainly the electrostatic attraction of the central cation and the negative end (the oxygen atom) of the water molecule.

In many Werner complexes, including those formed by cyanide ion, the nitrite ion or nitro group, the thiocyanate ion, the halide ions (other than fluoride), the ammonia molecule and the carbon monoxide molecule, the bonds between the attached atom or group and the central atom are essentially covalent, and the co-ordination number is determined by the nature of the bond orbitals of the central atom. Thus, Zn^{++} and Cu^+ have their five 3*d* orbitals occupied by unshared pairs of electrons, leaving as stable orbitals suited to bond formation the one 4*s* and the three 4*p* orbitals. These can hybridize to form four bond orbitals directed toward the corners of a regular tetrahedron; accordingly, these ions form cyanide complexes $[Zn(CN)_4]^{--}$ and $[Cu(CN)_4]^{---}$, with co-ordination number 4 and the tetrahedral configuration.

The neutral nickel atom similarly forms tetrahedral complexes $[Ni(CN)_4]^{4-}$ and $[Ni(CO)_4]$. However, the bipositive nickel ion Ni^{++} behaves differently. It may use one 3*d* orbital for bond formation; this orbital can hybridize with the 4*s* orbital and two 4*p* orbitals to form four bond orbitals directed toward the four corners of a square which is coplanar with the central ion. It was discovered by Werner that bivalent palladium and platinum form these square planar complexes, and this configuration has been verified for the covalent complexes of bivalent nickel also.

The octahedral covalent complexes, such as the ferrocyanide ion, $[Fe(CN)_6]^{4-}$, involve six covalent bond orbitals formed by hybridization of two 3*d* orbitals with the 4*s* and 4*p* orbitals.

Some heavy-metal atoms tend to assume coördination number 2 and to form two oppositely directed covalent bonds. Examples of such linear complexes are: $[:N{\equiv}C-Cu-C{\equiv}N:]^-$, $[:N{\equiv}C-Ag-C{\equiv}N:]^-$, $[Cl-Au-Cl]^-$ and $[Cl-Hg-Cl]^0$.

Oxidation Number.—After the concepts of ionic valence and covalence had been introduced, and detailed electronic structures of molecules began to be written, it was recognized that a simple representation of the oxidation states of elements in a compound is needed, especially as an aid in balancing equations for oxidation-reduction reactions. The "oxidation number" has come into use for this purpose.

The oxidation number of an element in a substance is the electrical charge assigned to the atoms of the element according to certain rules. These rules are simple, but are not completely unambiguous, and their application requires some chemical insight. The rules, as generally accepted, are the following:

1. The oxidation number of a monatomic ion in an ionic substance is equal to its electrical charge.

2. The oxidation number of atoms in an elementary substance is zero.

3. In a covalent compound of known structure, the oxidation number of each atom is the charge remaining on the atom when each shared electron pair is assigned completely to the more electronegative of the two atoms sharing it (*see* PERIODIC LAW, THE) A pair shared by two atoms of the same element is usually split between them.

4. The oxidation number of one element in a compound of uncertain structure may be calculated from a reasonable assignment of oxidation numbers to the other elements in the compound.

For example, in the permanganate ion, MnO_4^-, oxygen is assigned its usual oxidation number -2, manganese, hence, has oxidation number $+7$. In acidic solution this ion can be reduced to manganous ion, Mn^{++}, by a suitable reducing agent. Hydrogen peroxide can serve as the reducing agent for this purpose. The oxidation number of oxygen in hydrogen peroxide, H_2O_2, is -1, that of hydrogen being $+1$, and on oxidation of hydrogen peroxide free oxygen is formed, with increase in oxidation number of oxygen from -1 to 0. Hence, two manganese atoms can oxidize ten oxygen atoms, and the equation for the oxidation of hydrogen peroxide by permanganate ion in acidic solution is easily written:

$$2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{++} + 5O_2 + 8H_2O.$$

The word valence when used in the field of inorganic chemistry ordinarily refers to the state of oxidation of an element as expressed by its oxidation number, whereas in organic chemistry it ordinarily refers to the covalence of the element.

The Hydrogen Bond.—A structural feature which has an important effect on the properties of many substances is the "hydrogen bond." A hydrogen atom bonded to an electronegative atom can attract another electronegative atom, and form with it a weak bond (with bond energy 5 or 10 kg cal. per mole). This bond is not a second covalent bond—hydrogen, with only one stable orbital, can form only one covalent bond—but is the result of the attraction of the residual positive charge of the hydrogen atom bonded to one electronegative atom for an unshared electron pair of the other atom.

The strongest hydrogen bonds are formed by fluorine ($[FHF]^-$, polymers of HF). The hydrogen bonds formed by water molecules are responsible for the surprisingly high melting point of ice and boiling point of water, for the existence of a maximum density of water and for the expansion of water on freezing (*see* ICE). Many special properties of inorganic and organic molecules, such as the dimerization of fatty acids, are caused by hydrogen-bond formation.

Metallic Valence.—The nature of the valence forces operating in metals, and especially in intermetallic compounds, has not as yet (mid-20th century) been completely elucidated. It seems certain, however, that metals and intermetallic compounds can be described as aggregates of metal cations bound together by valence electrons, which have considerable freedom of motion through the specimen, and it is reasonable to call the number of electrons of an atom which help to bind the metallic crystal together the "metallic valence" of the atom.

It is likely that the metallic valence of the alkali metals is 1, and that that of the alkaline-earth metals is 2. Values for the transition metals are uncertain, but their strength and hardness suggest values increasing from 3 for scandium to about 6 for chromium and succeeding elements, and then decreasing for copper and zinc. The magnetic properties of the rare-earth metals provide evidence that the metallic valence is 3 for all the rare-earth metals except europium and ytterbium, and is 2 for these two metals, the paramagnetic susceptibility of these two metals is the same as for their bivalent salts, whereas for the other rare-earth metals it is the same as for their tervalent salts.

Some progress has been made in systematizing the often complex formulas of intermetallic compounds such as γ-brass, Cu_5Zn_8, and the compounds $Cu_{31}Sn_8$, Cu_9Al_4, Fe_2Zn_{21}, etc., which are related to it (*see* ALLOYS) It was pointed out (A Westgren, W. Hume-Rothery) that if the valences 1, 2, 3 and 4 are assigned to Cu, Zn, Ga and Sn, respectively, the formulas Cu_5Zn_8, Cu_9Ga_4, and $Cu_{31}Sn_8$ all correspond to the same ratio, $\frac{21}{13}$, of valence electrons to atoms, and a quantum-mechanical theory of the stability of these alloys in terms of electron waves was developed by H. Jones. An equivalent theory was formulated with the use of another set of metallic valences, originally deduced from the ferromagnetic properties of the transition metals (L. Pauling). These valences, 5.44, 4.44, 3.44 and 2.44 for Cu, Zn, Ga and Sn, respectively, also lead to a constant value, $62\frac{1}{13}$, for the ratio of valence electrons to atoms in the γ-alloys, with the formulas given above Further progress toward a penetrating understanding of the nature of metals was needed before a firm choice between the metallic valences 1 and 5.44 for copper (and similar pairs of values for other transition elements) could be justified.

It is clear that valence does not play as great a part in determining the compositions of intermetallic compounds as it does for salts and organic compounds. Among the other factors of significance for intermetallic compounds the relative sizes of atoms of different kinds is of greatest importance; many intermetallic compounds have compositions corresponding to modes of filling space with atoms of different sizes in such a way as to give each atom the maximum number of neighbours.

From the consideration of interatomic distances V. M. Goldschmidt was led to conclude that the metallic bond is closely related to the covalent bond. Usually the number of neighbours of an atom in a metal or alloy is greater than its metallic valence, and the covalent bonds formed by the atom are considered to resonate among the interatomic positions.

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(L. C. P.)

VALENCIA, the name of a maritime province of eastern Spain, and anciently of a kingdom. Pop. (1950) 1,337,339; area, 4,239 sq mi. When the ancient kingdom of Valencia was incorporated into Aragon in 1238, it included the provinces of Castellón de la Plana (*q.v.*) and Alicante (*q.v.*). It was bounded inland on the north by Catalonia, west by Aragon and New Castile, and south by Murcia. This region had an area of 8,964 sq mi and a population of approximately 2,000,000 in 1939. For its history *see* VALENCIA (city).

The inhabitants are of very mixed race, owing to the successive occupation of the country by Iberians, Greeks, Carthaginians, Romans, Visigoths and Moors. Their dialect resembles Catalan but is softer, and contains a larger percentage of Arabic words

The elaborate irrigation works and the system of intensive agriculture which have rendered the *huertas* or gardens of Valencia celebrated were initiated by the Moors; the fame of the Elche date groves, the Alicante vineyards and the Valencia orange plantations, was also originally due to them.

With the decline of the caliphate of Cordova early in the 11th century, Valencia became an independent kingdom which passed

successively into the power of the Almoravides and Almohades

In 1609, 200,000 Moriscos, or Moors who outwardly professed Christianity, were banished from the country. In 1833 Valencia was divided into the three provinces already named

The coast is skirted by considerable stretches of sand dune, and by a series of these the lagoon called the Albufera de Valencia (*q.v.*) is separated from the Mediterranean. The principal rivers are the Guadalaviar or Turia and the Júcar (*q v.*). Irrigation disputes are settled by the peasants' Tribunal de las Aguas which meets weekly in front of Valencia cathedral.

The *vegas* (cultivated plains) have an exceptionally fine, almost subtropical climate In their low-lying portions rice is the favourite crop; elsewhere wheat, maize and all kinds of fruit; the mulberry is cultivated for silk; and wine and oil are produced. Esparto grass is grown in the less fertile areas The fishing industry is considerable, and there are manufactures of silk, carpets and tapestry, woollen, hemp and linen fabrics, glass, pottery and leather, there are also iron foundries, distilleries, cooperages and oil refineries. The coast railway from Barcelona traverses the province. Valencia, the capital and principal seaport, and the towns of Alcira, Sueca, Játiva, Carcagenta, Cullera, Onteniente, Sagunto and Gandía, are described in separate articles Other towns are Algemesí (15,443), Catarroja (10,078). Oliva (17.557), Liria (10,451), Tabernes de Valldigna (10,885) and Torrente (12,781).

VALENCIA, capital of the Spanish province of Valencia, on the Guadalaviar or Turia, 3 mi. from the Mediterranean sea, and 304 mi. E.S.E of Madrid by rail. Pop (1930) 320,195; (1950) 465,000 (mun., 590,975) Earliest mention of Valencia (*Valentia*) is by Livy (*Epit.*, lv), who states that Junius Brutus settled the soldiers of Viriathus there in 138 B.C., and invested the town with the *jus Latinum*. It sided with Sertorius (*c* 77 B.C.), and was accordingly taken and partially destroyed by Pompey in 75 B.C.; but it must have recovered speedily, as it is mentioned by Pliny (iii, 4) as a colony in the region of the Edetani, and by Mela as an important place. It was taken by the Visigoths in A.D. 413, and by the Moors in 714 An independent Moorish kingdom of Valencia was established in 1021, and extended from Almería to the Ebro estuary The Almoravides occupied the city in 1094, but it was retaken within a few months by the Christians under the Cid (*q v*), from whom it is sometimes called Valencia del Cid The Moors recovered possession in 1101 and the kingdom was re-established in 1146. After 1172 it became tributary to Aragon, and in 1238 James I of Aragon added it to his dominions. The first Spanish printing press is said to have been set up there in 1474. Toward the close of the 15th century Valencia was annexed to Castile. In the 16th and 17th centuries it was the seat of a school of painting. In the War of Succession Valencia sided with the house of Austria. It was captured by the French in 1812 and held till 1813. In Nov. 1936 it was made the loyalist capital for a time. The nationalists captured it in 1939.

Valencia is the seat of an archbishop, a court of appeal, a university, a captain-general and an army corps. All around it stretches Huerta de Valencia, an alluvial plain with groves of oranges, lemons and mulberries. The climate is mild and very dry; rain hardly ever falls. The white houses, often Moorish in architecture, and the multitude of domes and towers give to Valencia an oriental appearance. Until 1871 it was enclosed by a Roman wall rebuilt in 1356 by Pedro IV; two picturesque gateways with machicolated towers still remain. The cathedral (La Seo), begun in 1262, possesses examples of 15th-century sculpture and metalwork, as well as of the Valencian school of painting. The campanile (el Miguelete), an isolated octagonal Gothic tower, is 152 ft. in height.

Valencia university was formed about 1500. It began to decline in 1600 but was reorganized after 1848, and resumed its place as one of the leading universities. There is a provincial museum, with paintings by Velazquez, Ribera, Dürer, Juanes, Bosco, Goya and many modern artists.

The principal manufacture is silk. The town is also celebrated for its coloured tiles or "azulejos," its oranges and onions. Linen, woollen and esparto fabrics, hats, fans, leather, paper, cigars, glass and pottery are also manufactured, and there are foundries and printing works. Corn, rice, silk, saffron, oranges, raisins, almonds, figs and other fruits are exported, and iron, hardware, timber, manure, grain and colonial produce are imported.

The port of Villanueva del Grao is 3 mi. E by N. of Valencia. Spanish and British coasters chiefly call there.

VALENCIA, a city of Venezuela and capital of the state of Carabobo; pop (1950), 84,927 The city is connected by railway to Lake Valencia, which is 1,348 ft. above sea level, 30 mi long, and has an area of 216 sq mi. The city is situated in a large valley between parallel ranges of the Maritime Andes, about 1,625 ft. above sea level, and in the midst of plantations and luxuriant vegetation. There are extensive manufacturing industries.

Valencia was founded in 1555 by Alonzo Diaz Moreno, being 12 years older than Caracas It was occupied for a time in 1561 by Lope de Aguirre and his band of outlaws. At the beginning of the War of Independence it was made the capital of Venezuela, and the patriot congress was in session there on March 26, 1812, when Caracas was destroyed by an earthquake In 1830 Valencia was the scene of the Constituent congress, again in 1856 it was the meeting place of the National convention and served the same purpose in 1870.

VALENCIA or VALENTIA, an island, County Kerry, Ireland, forming the southern horn of Dingle bay It is 7 mi. long and 3 mi. broad. It forms with the mainland a fine natural harbour, land-locked with narrow entrances, and a depth of about 40 ft at low tide. At its north end is the Valencia Harbour station, while across the strait is Knightstown, on the island. The harbour is used by fishing vessels From Valencia the "Great Eastern" laid the cable to Newfoundland in 1866 On the island is a meteorological station. Its name is Spanish; the Irish called it Dairbhre, the oak forest. Pop (1936) 1,778.

VALENCIA DE ALCÁNTARA, a town of western Spain, in the province of Cáceres. Pop. (1940), 6,904 (mun , 15,415) From the 16th century to the 18th Valencia was a celebrated border fortress, it was captured by the Portuguese in 1664 and 1698. Valencia de Alcántara is an important customhouse between Spain and Portugal, and has a flourishing trade in farm produce, and in phosphates from the mines. A Roman aqueduct still brings water to the main street; the courtyards and windows of many houses are Moorish in style.

VALENCIENNES, a town of northern France. Population (1940) 38,684.

Valenciennes is said to owe its name and foundation to one of the three Roman emperors named Valentinian In the middle ages it was the seat of a countship which in the 11th century was united to that of Hainaut. In the 16th century Valenciennes became the stronghold of Protestantism in Hainaut, but was conquered by the Spaniards. In 1656 the Spaniards under the prince of Condé made a successful defense against the French under Vicomte de Turenne; but in 1677 Louis XIV took the town and Vauban constructed the citadel.

Valenciennes, which then became the capital of Hainaut, has since always belonged to France. In 1793, after 43 days' bombardment, the garrison surrendered to the allied forces. In 1815 it defended itself successfully.

The Scheidt there divides into two branches, one of which flows through the town, while the other, canalized and forming a port, skirts it on the west. The Tour de la Dodenne (13th and 15th centuries) and the citadel (17th century) are the chief remains of the old fortifications. The town hall is early 17th century, with a 19th-century façade. The museum contains a good collection of paintings.

Valenciennes is the centre of the rich Anzin coal field. There are important foundries, forges, rolling mills, wireworks and machine shops. There is also an extensive sugar beet cultivation, with attendant sugarworks and distilleries, and glass, starch, chemicals and soap are produced. Hosiery, trimmings and handkerchiefs are manufactured and cotton weaving and printing are carried on, though little of the famous lace is now made.

VALENCY: *see* VALENCE.

VALENS, East Roman emperor from 364 to 378, owed his elevation in the 36th year of his age to his brother, Valentinian, who chose him to be his associate in the empire. Valens had been attached to Julian's bodyguard, but he did not inherit the military ability of his father, Gratian of Pannonia. A revolt headed by Procopius in the second year of his reign was quelled by the ability of his generals In the year 366 Valens at one stroke reduced the taxes of the empire by one-fourth, a very popular measure, though one of questionable policy in the face of the threatening attitude of the Goths on the lower Danube. Before venturing on a campaign against them, Valens received baptism from Eudoxus, the Arian bishop of Constantinople After some small successes over the Goths, won by his generals (367–369), Valens concluded a peace with them, which lasted six years, on a general understanding that the Danube was to be the boundary between Goths and Romans On his return to Constantinople in 369–370 Valens began to persecute his orthodox and Catholic subjects, but he lacked the energy to carry out his edicts.

In the years 371 to 377 Valens was in Asia Minor, most of the time at the Syrian Antioch Though anxious to avoid an Eastern war, because of danger nearer home from the Goths, he was compelled to take the field against Shapur II. Valens crossed the Euphrates in 373, and drove back the king of Persia to the farther bank of the Tigris. But the Roman success was by no means decisive, and no definite understanding as to boundaries was come to with Persia Valens returned to Antioch, where in the winter of 373–374 he instituted a persecution of magicians. Between 374 and 377 we read of grievous complaints of injustice and extortion perpetrated under legal forms Although preparations were made for following up the war with Persia and securing the frontier, a truce was patched up, rather to the disadvantage of the empire, Armenia and the adjacent country being half conquered and annexed by Shapur. The armies of Rome, in fact, were wanted in another quarter The Huns, of whom we now hear for the first time, were beginning in 376 to press the Goths from the north, and the latter asked leave of the emperor to cross the Danube into Roman territory This they were allowed to do, on the condition that they came unarmed, and their children were transported to Asia as hostages. The conditions, however, were not observed by the imperial generals Accordingly, the enraged Goths, under their chief Fritigern, poured across the Balkans into Thrace and the country round Adrianople, plundering, burning and slaughtering as they went They were driven back for a time, but returned in the spring of 378 in greater force, with a contingent of Huns and Alans; and penetrated to the neighbourhood of Adrianople Valens left Constantinople in May 378 with a strong and well-officered army. Without awaiting the arrival of his nephew Gratian, emperor of the West, who had just won a great victory over the Alamanni, Valens attacked the enemy at once. The battle, which was fought on confined ground in a valley, was decided by a cavalry charge of the Alans and Sarmatians, which threw the Roman infantry into confusion and hemmed it in so closely that the men could scarcely draw their swords. The slaughter, which continued till the complete destruction of the Roman army, was one of the greatest recorded in antiquity Valens perished either on the field or, as some said, in a cottage fired by the enemy From the battle of Adrianople the Goths permanently established themselves south of the Danube

See Ammianus Marcellinus, bks. 26–31; E. Gibbon, *The Decline and Fall of the Roman Empire* (ed Bury, London, 1909), chs. 25–26; Hodgkin, *Italy and Her Invaders* (1880; and ed., 1892–99), vol. i ; F. Runkel, *Die Schlacht bei Adrianopel* (Berlin, 1903).

VALENTINE or VALENTINUS, the name of a considerable number of saints. The most celebrated are the two martyrs whose festivals fall on Feb. 14, the one, a Roman priest, the other, bishop of Terni (Interamna). The *Passion* of the former is part of the legend of SS Marius and Martha and their companions; that of the latter has no better historical foundation; so that no argument can be drawn from either account to establish the differentiation of the two saints It would appear from the two accounts that both belonged to the same period, *i.e.*, to the reign of the emperor Claudius (Gothicus); that both died on the same day; and that both were buried on the Via Flaminia, but at different distances from Rome The *Martyrologium Hieronymianum* mentions only one Valentinus. "Interamnae miliario LXIIII. via Flaminia natale Valentini." The St. Valentinus who is spoken of as the apostle of Rhaetia, and venerated in Passau as its first bishop, flourished in the 5th century. For the observances connected with St. Valentine's Eve and Day, *see* John Brand's *Popular Antiquities* (edited by W. C. Hazlitt, vol. ii. pp. 606–11, London, 1905), W. Hone's *Every-Day Book*, and Chamber's *Book of Days*. The association of the lovers' festival with St Valentine seems to arise from the fact that the feast of the saint falls in early spring, and is purely accidental.

See *Acta Sanctorum*, February, ii. 753, 756, and January, i 1094; G. B. de Rossi, *Bullettino di archeologia cristiana* (1877), p 101 and (1878), p. 59.

VALENTINE AND ORSON, a romance attached to the Carolingian cycle It is the story of twin brothers, abandoned in the woods in infancy. Valentine is brought up as a knight at the court of Pippin, while Orson grows up in a bear's den to be a wild man of the woods, until he is overcome and tamed by Valentine, whose servant and comrade he becomes. The two eventually rescue their mother Bellisant from the power of a giant. There are versions of the tale, which appears to rest on a lost French original, in French, English, German, Icelandic, Dutch and Italian. In the older versions Orson is described as the "nameless" one

The French romance was printed at Lyons in 1489. *The Historye of the two Valyaunte Breitheren · Valentyne and Orson . . .* by Henry Watson (*c.* 1550) is the earliest known English version. A ballad on the subject was printed in Percy's *Reliques* For a detailed bibliography of the English, French, German, Dutch and Italian forms of the tale, *see* W. Seelman, "Valentin und Namelos" (Norden and Leipzig, 1884), in vol iv of *Niederdeutsche Denkmaler.*

VALENTINIAN I., Roman emperor of the West from A D 364 to 375, was born at Cibalis, in Pannonia. He had been an officer of the guard under Julian and Jovian, and had risen high in the imperial service He was chosen emperor in his forty-third year by the officers of the army at Nicaea in Bithynia in 364, and shortly afterwards named his brother Valens (*q.v.*) colleague with him in the empire As emperor of the West, Valentinian took Italy, Illyricum, Spain, the Gauls, Britain and Africa, leaving to Valens the eastern half of the Balkan Peninsula, Greece, Egypt, Syria and Asia Minor as far as Persia. During the short reign of Valentinian there were wars in Africa, in Germany and in Britain, and Rome came into collision with the Burgundians, Saxons and Alamanni The emperor's chief work was guarding the frontiers and establishing military positions Milan was at first his headquarters for settling the affairs of northern Italy; next year (365) he was at Paris, and then at Reims, to direct the operations of his generals against the Alamanni who were driven back to the German bank of the Rhine, and checked for a while by a chain of military posts and fortresses At the close of 367, however, they suddenly crossed the Rhine, and sacked Moguntiacum (Mainz). Valentinian attacked them at Solicinium (Sulz in the Neckar valley or Schwetzingen) with a large army, and defeated them with considerable loss on his own part. (Later, in 374, he made peace with their king, Macrianus.) The next three years he spent at Trier, which he chiefly made his headquarters, organizing the defence of the Rhine frontier.

During his reign the coasts of Gaul were harassed by the Saxon pirates, with whom the Picts and Scots of northern Britain joined hands, and ravaged the island from the wall of Antoninus to the shores of Kent. In 368 Theodosius was sent to drive back the invaders; in this he was completely successful, and established a new British province, called Valentia. In Africa the Moorish prince, Firmus, raised the standard of revolt against Count Romanus, the military governor. The services of Theodosius were again requisitioned. He landed in Africa with a small band of veterans, and Firmus, to avoid being taken prisoner, committed suicide. In 374 the Quadi, a German tribe in what is now Moravia and Hungary, resenting the erection of Roman forts to the north of the Danube, and further exasperated by the treacherous murder of their king, Gabinius, crossed the river and laid waste the province of Pannonia. The emperor, in April of the following year,

entered Illyricum with a powerful army, but during an audience to an embassy from the Quadi at Brigetio on the Danube (near Pressburg) died in a fit of apoplexy.

Valentinian's general administration seems to have been thoroughly honest and able, in some respects beneficent. If he was hard and exacting in the matter of taxes, he spent them in the defence and improvement of his dominions Though himself a plain and almost illiterate soldier, he was a founder of schools, and he also provided medical attendance for the poor of Rome, by appointing a physician for each of the fourteen districts of the city. He was an orthodox Catholic, but he permitted absolute religious freedom to all his subjects The great blot on his memory is his cruelty, which at times was frightful.

See Ammianus Marcellinus xxv.–xxx ; Gibbon, *Decline and Fall*, chap. 25; T. Hodgkin, *Italy and her Invaders*, bk i chap. 3, H. Richter, *Das weströmische Reich* (1865), pp. 240–268.

VALENTINIAN II., son of the above, an infant of four in 375 with his half-brother Gratian (*q.v.*) a lad of about seventeen, became the emperors of the West They made Milan their home; and the empire was nominally divided between them, Gratian taking the trans-Alpine provinces, whilst Italy, Illyricum in part, and Africa were to be under the rule of Valentinian, or rather of his mother, Justina In 387 Magnus Maximus (*q v.*), who had in 383 overthrown Gratian and made himself master of the northern provinces, crossed the Alps and threatened Milan The emperor and his mother fled to Theodosius, the emperor of the East. Valentinian was restored in 388 by Theodosius. Four years later he was murdered at Vienne in Gaul, probably at the instigation of his Frankish general Arbogast.

See Gibbon, *Decline and Fall*, chap 27; H. Richter, *Das weströmische Reich unter den Kaisern Gratian, Valentinian II. und Maximus* (1865), pp. 577–650, and O Seek, *Untergang des antiken Welt*, Vol. 5 (1897–1921).

VALENTINIAN III., emperor of the West from 425 to 455, the son of Constantius and Placidia. He was only six years of age when he ascended the throne, and during his minority the conduct of affairs was in the hands of his mother. His reign is marked by the dismemberment of the Western Empire; the conquest of the province of Africa by the Vandals in 439; the loss of great portions of Spain and Gaul, in which the barbarians had established themselves; and the ravaging of Sicily and of the western coasts of the Mediterranean by the fleets of Genseric. As a set-off against these calamities there was the great victory of Aetius over Attila in 451 near Châlons, and his successful campaigns against the Visigoths in southern Gaul (426, 429, 436), and against various invaders on the Rhine and Danube (428–31) Ravenna was Valentinian's usual residence; but he fled to Rome on the approach of Attila, who ravaged North Italy in 452. In 454 Aëtius was treacherously murdered by Valentinian. Next year, however, the emperor himself was assassinated by two of the barbarian followers of Aëtius. He was self-indulgent, incompetent, and vindictive.

Our chief original sources for the reign of Valentinian III. are Jordanes, Prosper's *Chronicles*, written in the 6th century, and the poet Apollinaris Sidonius. *See* also Gibbon, *Decline and Fall*, chaps. 33–35 and pp. 24 and 25 (ed London, 1909); J. B. Bury, *Later Roman Empire*, bk. ii. chaps. 6–8; E. A Freeman, "Tyrants of Britain, Gaul and Spain" (*Eng Hist. Review*, January 1886), and "Aetius and Boniface" (*ibid.*, July 1887).

VALENTINUS, pope for thirty or forty days in 827, in succession to Eugenius II. (824–27). He was a Roman by birth, and, according to the *Liber Pontificalis*, was first made a deacon by Paschal I. (817–24). Nothing further is known of his history, His successor was Gregory IV. (827–44).

VALENTINUS and **THE VALENTINIANS.** Valentinus, the most prominent leader of the Gnostic movement, was born, according to Epiphanius (*Haer.* 31, 2), near the coast in Lower Egypt, and was brought up and educated in Alexandria. Valentinus came to Rome (*c.* 135–160) during the episcopate of Hyginus, flourished under Pius and stayed till the time of Anicetus. According to Irenaeus iii. 3, 4, Polycarp, during his sojourn in Rome under the episcopate of Anicetus, converted a few adherents of the Valentinian sect. Tertullian (*Adv. Valentin.* cap. 4) declares that Valentinus came to Rome as an adherent of the orthodox Church, and was a candidate for the bishopric of Rome, but he abandoned the Church because a confessor was preferred to him for this office. The credibility of this statement may be questioned. Great uncertainty attaches to the residence of Valentinus in Cyprus, recorded by Epiphanius (*loc. cit.*), who places it after his stay in Rome, adding that it was here that he definitely accomplished his secession from the Church. But it seems to be clear that Valentinus did not, like Marcion, break with the Church from the very beginning, but endeavoured to maintain his standing within it

Justin's *Syntagma*, which treats of Valentinus, is unfortunately lost. Irenaeus, *Adversus Haereses*, i 11, 1–3, as in every other article where named, has preserved what is obviously an older document, possibly from Justin, dealing with Valentinus's own teaching and that of two of his disciples. The sketch which he gives is the best guide for the original form of Valentinianism. For Valentinus himself we have also to consider the fragments of his writings preserved by Clement of Alexandria. The best edition of and commentary on them is Hilgenfeld's *Ketzergeschichte des Urchristentums* (pp. 293–307). Irenaeus also gives a detailed account of the two chief schools following Valentinus, the school of Ptolemaeus (i. 1–10), and Marcus and the Marcosians (i 13–21). For his account of the Ptolemaeans, Irenaeus seems to have used various writings and expositions of the school, especially prominent being a collection of Scripture proofs which may have once had a separate literary existence (i. 1, 3; 3, 1–5 [6]; 8, 2–4). To this is appended in a somewhat disconnected fashion a commentary on the prologue to the fourth Gospel (i. 8, 5) Irenaeus himself twice prefaces his remarks by saying he is indebted to other authorities for his exposition (i. 2, 3–4; 7, 2–5). *Excerpta ex Theodoto* which are to be found in the works of Clement and may be looked upon as a collection made by the author with a view to the unfinished eighth book of his *Stromateis*. The lost *Syntagma* of Hippolytus, which can be partially reconstructed from Philaster (*Haereses*) and from pseudo-Tertullian (*Adversus Valentini anos*), seems to furnish us with valuable information as to the earlier doctrines of the sect; and in his second treatise against heretics, the so-called *Philosophumena* (6, 29 *seq.*), Hippolytus gives a homogeneous and continuous exposition of a later Valentinian system, possibly connected with the school of Ptolemaeus. Important, too, are Hippolytus' references to an Italic and an Anatolian branch of the Valentinian sect (6, 35). Tertullian gives at the beginning of his treatise against the Valentinians a few separate notices of the life and disciples of Valentinus, but his further argument is closely dependent upon Irenaeus' exposition of the Ptolemaean system, which he embellishes in his usual fashion with bitterly sarcastic comments. Epiphanius deals with Valentinus and his school in sections 31–36 of his work. He has preserved a valuable letter of Ptolemaeus to Flora, which is of the highest importance for the understanding of Gnosticism.

Valentinus is the only one of the Gnostics who had a whole series of disciples who are known by name—indeed, in the accounts of the Church Fathers his own system and views are almost entirely obscured by the accounts of those of his disciples. The most important disciples are the two dealt with at length by Irenaeus, Ptolemaeus and Marcus, who both seem to have had a numerous following. Also, there was Heraklcon, of whose commentary on the gospel of St. John extensive fragments are preserved by Origen. Ptolemaeus and Heraklcon are counted by Hippolytus (6, 35) among the Italic branch of Valentinianism There was also the Anatolian branch, as representative of which Hippolytus mentions Axionicus, who is also referred to by Tertullian as having actually been taught in Antioch. The *Excerpta ex Theodoto* in Clement are also, according to the superscription, fragments from the Anatolian Gnosticism. It is, however, an error when Hippolytus speaks of Bardesanes as representative of this branch, for he had an entirely distinct position. Valentinianism was based on primitive gnosticism (*q.v.*), with the doctrines of which Valentinus may have become acquainted in Egypt. The mother goddess stands at the centre of the system. The main doctrines are outlined below.

(1) Valentinus has a system of thirty aeons, but the quite shadowy plurality of ten and twelve aeons (the *Dekas* and the *Dodekas*) of the Valentinian system we may at once set aside as mere fantastical accretions. We have left only a group of eight celestial beings, the so-called Ogdoas, and of these eight figures four again are peculiar to this system.

(2) The first pair of aeons, *Bythos* and *Sige*, is an original innovation of the Valentinian school, and clearly betrays a monistic tendency. According to Irenaeus's account of the "Gnostics" (i. 29), their theory was that *Sophia* casts herself into the primal substratum of matter (*Bythos*) to be found outside the celestial world of aeons But in the Valentinian system matter is not originally and irretrievably separated from the higher celestial world, but the latter originally exists for itself alone; the fall or disturbance is accomplished within the celestial world, and the material world first comes into existence through the fall

(3) There remain a double pair of aeons, the Father and Truth, the *Anthropos* and the *Ekklesia*. With the celestial Primal Man—of whom the myth originally relates that he has sunk into matter and then raised himself up from it again—is associated the community of the faithful and the redeemed, who are to share the same fate with him

(4) In the true Valentinian system the so-called *Christos* is the son of the fallen Aeon, who is thus conceived as an individual. *Sophia*, who in a frenzy of love had sought to draw near to the unattainable *Bythos*, brings forth, through her longing for that higher being, an aeon who is higher and purer than herself, and at once rises into the celestial worlds Among the Gnostics of Irenaeus we find a kindred conception, but with a slight difference. Here *Christos* and *Sophia* appear as brother and sister, *Christos* representing the higher and *Sophia* the lower element. In the enigmatic figure of *Christos* we again find hidden the original conception of the Primal Man, who sinks down into matter but rises again. (In the later Valentinian systems this origin of the *Christos* is entirely obscured, and Christ, together with the Holy Spirit, becomes a later offspring of the celestial world of aeons; this may be looked upon as an approximation to the Christian dogma.)

(5) A figure entirely peculiar to Valentinian Gnosticism is that of *Horos* (the Limiter). The name is perhaps an echo of the Egyptian *Horus* The peculiar task of *Horos* is to separate the fallen aeons from the upper world of aeons He becomes a kind of world-creative power, who in this capacity helps to construct an ordered world out of *Sophia* and her passions. He is also called, curiously enough, *Stauros* (cross), and we frequently meet with references to the figure of *Stauros*. But we must not be in too great a hurry to assume that this is a Christian figure. A Platonic conception may have been at work here. The cross can also stand for the wondrous aeon on whom depends the ordering and life of the world, and thus *Horos-Stauros* appears here as the first redeemer of *Sophia* from her passions, and as the orderer of the creation of the world which now begins. The figure of *Horos-Stauros* was often assimilated to that of the Christian Redeemer

(6) The dualism of the two separate worlds of light and darkness was thus overcome. This derivation of the material world from the passions of the fallen *Sophia* is, however, affected by an older theory according to which the son of *Sophia*, whom she forms on the model of the *Christos* who has disappeared in the higher heavens, becomes the *Demiourgos*, who with his angels now appears as the real world-creative power. These two conceptions had now to be combined at all costs. And it is interesting to observe here what efforts were made to give the *Demiourgos* a better position. According to the older conception, he was an imperfect, ignorant, half-evil and malicious offspring of his mother, who has already been deprived of any particle of light (Irenaeus i. 29, 30). In the Valentinian systems he appears as the fruit of *Sophia's* repentance and conversion. He is no longer called *Jaldabaoth*, but has been assigned the better name, drawn from the philosophy of Plato, of *Demiourgos* The *Demiourgos* of the Gnostic corresponded to the God of the Old Testament, which again suggests a compromise with the Christian faith

(7) With the doctrine of the creation of the world is connected the subject of the creation of man. We fortunately know, from a fragment preserved by Clement, that Valentinus here preserved the old Gnostic myth practically unaltered in his system According to it, the world-creating angels—not one, but many—create man, but the seed of the spirit comes into their creature without their knowledge, by the agency of a higher celestial aeon, and they are then terrified by the faculty of speech by which their creature rises above them, and try to destroy him. A definite Valentinian idea is here added in that of the threefold nature of man, who is represented as at once spiritual, psychical and material. In accordance with this there also arise three classes of men, the *pneumatici*, the *psychici* and the *hylici* (ὕλη, matter) All the other Gnostic systems recognize only a dual division, the children of light and the children of darkness. That the Valentinians should have placed the *psychici* between the *pneumatics* and *hylici* signifies a certain recognition of the Christian Church and its adherents who are not treated as outcasts.

(8) At the centre of the whole Valentinian system naturally stands the idea of redemption, and so we find here developed particularly clearly the myth of the heavenly marriage already known from Irenaeus i 30 to be Gnostic. Redemption is essentially accomplished through the union of the heavenly *Soter* with the fallen *Sophia*. This myth of the redeemer is of significance for the practical piety of the Valentinian Gnostics. It is the chief idea of their pious practices mystically to repeat the experience of this celestial union of the *Soter* with *Sophia*. In this respect, consequently, the myth underwent yet wider development Just as the *Soter* is the bridegroom of *Sophia*, so the heavenly angels, who sometimes appear as the sons of the *Soter* and *Sophia*, sometimes as the escort of the *Soter*, are the males betrothed to the souls of the Gnostics, which are looked upon as feminine. Thus every Gnostic had his angel standing in the presence of God, and the object of a pious life was to bring about and experience this inner union with the celestial abstract personage This leads us straight to the sacramental ideas of this branch of Gnosticism.

(9) With this celestial *Soter* of the Valentinians and the redemption of *Sophia* is connected the figure of Jesus of Nazareth and the historical redemption connected with his name The *Soter*, the bridegroom of Sophia, and the earthly Jesus answer to each other as in some way identical. Here again we recognize the artificial compromise between Gnosticism and Christianity

(10) The Valentinians laid down that even the Redeemer has a threefold nature; from his mother, Sophia, he derived his nature as a *pneumaticos*, in the world of the Demiourgos he was united with the Christos, and finally a wonderful bodily nature was formed for him from celestial elements, which was yet not of earthly material As such he was miraculously born of the Virgin. The compromises with the Catholic Church are here obvious. Also, there was the idea that upon this Jesus, so constituted, yet another celestial nature, the Christos or the Soter, has descended at his baptism.

The first survey of these confused speculations, these myths gathered together and preserved from the ancient world, this marshalling together of the most varied traditions, and above all, these artificial attempts at compromise, makes us inclined to doubt whether it was possible for any true piety to coexist with all this. Yet such piety existed; indeed we have here a set of regular mystics. It is not, indeed, a purely spiritual and mystical piety, but a mysticism much distorted and over-grown with sacramental additions and a mysterious cult. But all this is not without an inner value and an attractive atmosphere. In a letter in Clement ii. 20, 114, Valentinus sets forth that the soul of man is like an inn, which is inhabited by many evil spirits "But when the Father, who alone is good, looks down and around him, then the soul is hallowed and lies in full light, and so he who has such a heart as this is to be called happy, for he shall behold God."

But with this mysticism is connected the mystery and cult of the sacrament. The lofty spirituality of the Gnostic degenerates over and over again into a distinctly material and sensual attitude, in which all kinds of efforts are made actually to assimilate to onesself the divine through external means.

The chief sacrament of the Valentinians seems to have been that of the bridal chamber. Just as the apostle Paul represented his Christianity as a living, dying and rising again with Christ, so the first concern of the pious Valentinian was the experience of the divine marriage feast of Sophia As Sophia was united with the Soter, her bridegroom, so the faithful would experience a union with their angel in heaven Through a fortunate chance, a liturgical formula which was used at this sacrament appears to be preserved It runs. "I will confer my favour upon thee, for the father of all sees thine angel ever before his face . we must now become as one; receive now this grace from me and through me; deck thyself as a bride who awaits her bridegroom, that thou mayest become as I am, and I as thou art Let the seed of light descend into thy bridal chamber; receive the bridegroom and give place to him, and open thine arms to embrace him. Behold, grace has descended upon thee."

Besides this the Gnostics already practised baptism, using the same form in all essentials as that of the Christian Church. The name given to baptism was *apolytrosis* (liberation) In one of the formulae occur the words "I would enjoy thy name, Saviour of Truth" The concluding formula of the baptismal ceremony is "Peace over all upon whom the Name rests" (Irenaeus 1 21, 3) This name pronounced at baptism over the faithful has above all the significance that the name will protect the soul in its ascent through the heavens, conduct it safely through all hostile powers to the lower heavens, and procure it access to Horos, who frightens back the lower souls by his magic word

Here and there a reaction took place against the absurdity of this sacramental superstition Thus Irenaeus (i 21, 4) tells us of certain Gnostics who would admit no external holy practices as efficacious A pure piety breathes in the words of the Gnostics preserved in *excerpta ex Theodoto*, 78, 2: "But not baptism alone sets us free, but knowledge (*gnosis*): who we were, what we have become, where we were, whither we have sunk, whither we hasten, whence we are redeemed, what is birth and what rebirth"

We have seen that Valentinian Gnosticism affected the nearest approach of all the Gnostic sects to the Catholic Church Valentinus's own life indicates that he for a long time sought to remain within the official Church, and had at first no idea of founding a community of his own

And yet this reconciliation of Gnosticism was a fruitless and henceforward a purposeless undertaking Oriental dualism and wildly intemperate Oriental mythology had grown into so radical and essential a part of Gnosticism that they could not be separated from it to make way for a purer and more spiritual view of religion And at a time when the prevailing tendency of Christianity was a struggle out of the darkness of Oriental mythology and eschatology into clearness, and an effort towards union with the lucid simplicity of the Hellenic spirit, these Gnostics, for all their efforts, and even the most noble of them, had come too late They are not the men of a forward movement, but they are, and remain, in spite of all clearer insight, the rear-guard of piety.

See Bibliography to article GNOSTICISM Also E F. Scott, art. "Valentinianism" in Hastings *Encyclopaedia of Religion and Ethics*, vol xii.; R A. Lipsius, art. "Valentinus" in Smith's *Dictionary of Christian Biography*; Pauly-Wissowa, *Realencyklopädie des klassischen Altertums*, s.v. *Gnosticismus, Gnostiker*; G Heinrici, *Die Valentinianische Gnosis und die heiligen Schriften* (1871); and A. Harnack, "Brief des Ptolomaeus und die Flora," *Sitzungsber. der Berl. Akademie* (1909)

VALENZUELA, FERNANDO DE (1630–1692), Spanish royal favourite and minister, was born at Naples on Jan. 19, 1630 He obtained a footing in the palace by his marriage with Maria de Uceda, lady-in-waiting to Mariana, Philip IV.'s second wife. When he was appointed introducer of ambassadors (Oct. 12, 1671), it became notorious that whoever had a petition to present must apply to him. He became popularly known as the *duende*, the fairy or brownie of the palace, and was believed to be the lover of the queen Dismissed (1675) from court by intrigue, he was made marquis of Villa Sierra by the queen and ambassador to Venice He exchanged the embassy for the governorship of Granada, organized a counter-intrigue and returned to court. The queen-regent appointed him prime-minister and made him a grandee, to the profound indignation of the other grandees At the palace revolution of Jan. 1678, Valenzuela fled to the Escorial, was captured, degraded from the grandeeship, exiled to the Philippines and his property confiscated. He died in Mexico on Feb 7, 1692

See *Documentos inéditos para la Historia de España*, vol. lxvii. (1842, etc).

VALERA Y ALCALÁ GALIANO, JUAN (1824–1905), Spanish novelist, entered diplomacy in 1847 and became unpaid attaché to the Spanish embassy at Naples under the famous duke de Rivas He held various other diplomatic posts until 1858 when he returned to Spain and entered the House of Deputies, taking his place with the Liberal opposition On the flight of Isabella II. in 1868 he was elected deputy for Montilla in the province of Cordova, became under-secretary of state for foreign affairs, and was one of the deputation who offered the crown to Amadeus of Savoy in the Pitti Palace at Florence. Though he always called himself a Moderate Liberal, Valera invariably voted for what are considered Radical measures in Spain, and a speech delivered by him in Feb 1863 against the temporal power of the pope created a profound sensation. However, though a member of the revolutionary party, he steadily opposed organic constitutional changes, and therefore he retired from public life during the period of republican government After the Bourbon restoration he acted as minister at Lisbon (1881–83), at Washington (1885), at Brussels (1886) and as ambassador at Vienna (1893–95), retiring from the diplomatic service on March 5, 1896 During his last ten years he took no active part in politics.

Valera's *Poesías* (1858) are imitative exercises rather than original poetry His criticism in the *Estudios críticos sobre literatura* (1864), in the *Disertaciones y juicios literarios* (1878) and in the *Nuevos estudios críticos* (1888) show penetration and taste, but also an excessive amiability. He said a hundred incisive, wise, witty, subtle and suggestive things concerning the mysticism of St Theresa, the art of novel-writing, *Faust*, the Inquisition, *Don Quixote*, Shakespeare, the psychology of love in literature; but, to do himself justice, it was an almost indispensable condition that he should deal with the past. In the presence of a living author Valera was disarmed

When in his 50th year, he published *Pepita Jiménez* (1874) a recital of the fall of Luis de Vargas, a seminarist who conceived himself to be a mystic and a potential saint, and whose aspirations dissolve at the first contact with reality It is easy to point out blemishes the story is not well constructed, and it has pauses during which the writer's fantasy plays at pleasure over a hundred subjects not very germane to the matter; but its characters are as real as any in fiction, the love story is told with the most refined subtlety and malicious truth, while page upon page is written in such Spanish as would do credit to the best writers of the 16th and 17th centuries. A second novel, *Las ilusiones del Doctor Faustino* (1875), was received with marked disfavour, and has the faults of over-refinement and of cruelty, yet in keen analysis and in humour it surpasses *Pepita Jiménez* The *Comendador Mendoza* (1877) is more pathetic and of a profounder significance, and in *Doña Luz* (1879) repeats the situation and the general ides already used in *Pepita Jiménez* it strikes a deeper and more tragic note, which came as a surprise to those familiar only with the lighter side of Valera's genius. Besides these elaborate psychological studies, Valera issued a volume of *Cuentos* (1887), some of these short tales and dialogues being marvels of art and of insight.

At the close of the 19th century Valera was recognized as the most eminent man of letters in Spain. He had not Pereda's force nor his energetic realism; he had not the copious invention nor the reforming purpose of Pérez Galdós; yet he was as realistic as the former and as innovating as the latter. And, for all his cosmopolitan spirit, he fortunately remained intensely and incorrigibly Spanish. His aristocratic scepticism, his strange elusiveness, his incomparable charm are his own; his humour, his flashing irony, his urbanity are eminently the gifts of his land and race. He is by no means an impersonal artist; in almost every story there is at least one character who talks and thinks

and subtilizes and refines as Valera himself, wrote in his most brilliant essays This may be a fault in art, but, if so, it is a fault which many great artists have committed (J.F.-K.)

VALERIA, VIA, an ancient highroad of Italy, the continuation north-eastwards of the Via Tiburtina (*q.v.*). It probably owed its origin to M. Valerius Messalla, censor in 154 B.C. It ran first up the Anio valley past Varia (*q.v.*), and then, abandoning it at the 36th mile, where the Via Sublacensis diverged, ascended to Carsioli (*q.v.*), and then again to the lofty pass of Monte Bove (4,003 ft.), whence it descended again to the valley occupied by the Lago di Fucino (*q.v.*). The difficult route from Cerfennia, the easternmost point of Marsian territory, to the valley of the Aternus (mod. Pescara)—a drop of nearly 1,000 ft., involving too the crossing of the main ridge of the Apennines (3,675 ft.) by the Mons Imeus (mod. Forca Caruso)—was not made into a highroad until the reign of Claudius, who also constructed a road, the Via Claudia Nova, connecting the Via Salaria, which it left at Foruli (mod. Civitatomassa, near Amiternum) with the Via Valeria near the modern Popoli. This road was continued south to Aesernia From Popoli the road followed the valley of the Aternus to its mouth, and there joined the coast-road at Pescara The modern railway from Rome to Castellammare Adriatico follows closely the line of the Via Valeria.

See R. Gardner in *Papers of the British School at Rome*, ix., 75–106.

VALERIAN, a genus of herbaceous perennial plants of the natural order Valerianaceae. Two species—*Valeriana officinalis* and *V. dioica*—are indigenous in Britain, while a third, *V. pyrenaica*, is naturalized in some parts. The valerians have opposite leaves and small flowers, usually white or reddish, and arranged in terminal cymes. The limb of the calyx is remarkable for being at first inrolled and afterwards expanding in the form of a feathery pappus which aids in the dissemination of the fruit. The genus comprises about 150 species, which are widely distributed in the temperate parts of the world. In medicine the root of *V officinalis* is intended when valerian is mentioned

Valerian is cultivated in England, but to a much greater extent in Saxony, in Holland and in the United States The dried root or rhizome consists of a short central erect portion, about the thickness of the little finger, surrounded by numerous rootlets about $\frac{1}{16}$ of an inch in diameter, the whole being of a dull brown colour. When first taken from the ground it has no distinctive smell; but on drying it acquires a powerful odour of valerianic acid. This odour, now regarded as intolerable, was in the 16th century considered to be fragrant, the root being placed among clothes as a perfume (Turner, *Herbal*, 1568, part iii. p. 76), just as *V. celtica* and other species are still used in the East.



VALERIAN (VALERIANA OFFICINALIS), ONE-THIRD NATURAL SIZE
A, flower; B, flower after removal of corolla; C, fruit crowned by the feathery pappus (A, B, & C enlarged)

The red valerian of gardens is *Centranthus ruber*, also belonging to the Valerianaceae; but Greek valerian is *Polemonium coeruleum*, belonging to the family Polemoniaceae Cats are nearly as fond of the smell of this plant as of the true valerian, and will frequently roll on the plant and injure it.

The chief constituent of valerian is a volatile oil, which is present in the dried root to the extent of 1–2%, plants growing on dry or stony soil being said to yield the largest quantity. The oil is of complex composition, containing valerianic (valeric), formic and acetic acids combined with a terpene, $C_{10}H_{16}$; the alcohol known as borneol; and pinene Valerian acts medicinally entirely in virtue of its volatile oil, which exerts the actions typical of its class. The special use of this drug, like that of others which contain an offensive volatile oil—such as asafoetida—is in hysteria from A.D. 253 to 260. He was of noble family, and in 238 was *princeps senatus*. In 251, when Decius revived the censorship with practically supreme civil authority, Valerian filled the post. Gallus, the successor of Decius, summoned him from the upper Rhine in 253 when threatened by the rebellion of Aemilianus The soldiers, however, proclaimed Valerian emperor, and marching slowly towards Rome he found both his rivals dead, slain by their own soldiers Trouble on the frontiers east and west was complicated by something near national bankruptcy. Valerian left his son, Gallienus, in charge of the wars in Europe; and took the offensive against the Goths, recaptured Antioch and marched to relieve Edessa. He was defeated and taken prisoner, and disappears from history (258)

See Trebellius Pollio, *Life of Valerian* (frags.); Aurelius Victor, *Caesares*, 32, Eutropius ix 6; Ammianus Marcellinus xxiii. 5; Zosimus i 27; Gibbon, *Decline and Fall*, chap. 10; H. Schiller, *Geschichte der römischen Kaiserzeit* (1883–86) i pt. 2.

VALERIC ACID or **VALERIANIC ACID,** an organic acid belonging to the fatty acid series ($C_nH_{2n+1}CO_2H$). It exists in four different forms, all having the same formula, $C_4H_9.CO_2H$ (*See* ISOMERISM.) One of these contains an asymmetric carbon atom and consequently occurs in two optically active modifications and one optically inactive modification. Ordinary valeric acid (baldrianic acid) is a mixture of *iso*valeric acid or *iso*propylacetic acid $(CH_3)_2CH.CH_2.CO_2H$, and optically active methylethylacetic acid $(CH_3)(C_2H_5)CH.CO_2H$, both of which occur free or as esters in the vegetable and animal kingdoms, chiefly in the roots of *Angelica archangelica* and *Valeriana officinalis*. It may be extracted by boiling with water or soda. A similar product is obtained by oxidizing fermentation amyl alcohol with chromic acid. Isovaleric acid is an oily liquid having the odour of stale cheese and boiling at 174° C; its salts are usually greasy to the touch Potassium permanganate oxidizes it to *β* hydroxisovaleric acid $(CH_3)_2C(OH).CH_2.CO_2H$, whilst nitric acid gives, among other products, dinitropropane, $(CH_3)_2C(NO_2)_2$. The acid has been synthesized, as has also the inactive form of methylethylacetic acid; this modification is split into its optical antipodes by crystallization of its brucine salt Normal valeric acid or propylacetic acid, $CH_3.CH_2.CH_2.CO_2H$, is a liquid boiling at 186°. The remaining isomeride, pivalic or trimethylacetic acid, $(CH_3)_3C.CO_2H$, melts at 35° and boils at 163°; it is prepared by oxidizing pinacolin. (*See* KETONES.)

VALERIUS FLACCUS, GAIUS, Roman poet, flourished under Vespasian and Titus. He has been identified on insufficient grounds with a poet friend of Martial (i. 61. 76), a native of Padua. His work, the *Argonautica*, dedicated to Vespasian on his setting out for Britain, was written during the siege, or shortly after the capture of Jerusalem by Titus (70) It is an epic in eight books on the Quest of the Golden Fleece and is not wholly extant. Part is borrowed from Apollonius of Rhodes.

The *Argonautica* was unknown till the first four and a half books were discovered by Poggio at St Gall in 1417. The *editio princeps* was published at Bologna (1474) Recent editions by G. Thilo (1863), with critical notes, C. Schenkl (1871), with bibliography; E. Baehrens (1875), with critical introduction, P. Langen (1896), with Latin notes, and short introductions on the style and language, Caesar Giarratano (1904); *see* also J. Peters, *De V. F. Vita et Carmine* (1890); W. C. Summers, *Study of the Argonautica* (1894).

VALERIUS MAXIMUS, Latin writer, flourished in the reign of Tiberius. His family was poor, and he owed everything to Sextus Pompeius (consul A.D. 14), proconsul of Asia and a kind of minor Maecenas, whom he accompanied to the East in 27. He intimates that his work is intended as a commonplace book of historical anecdotes for use in the schools of rhetoric. The stories are loosely and irregularly arranged, and are from Roman history, but each section includes extracts from the annals of other peoples, principally the Greeks. The work reproduces the general feeling of the empire, that the Romans of the day are degenerate compared with their ancestors, but still vastly superior to the rest of the world

The author's chief sources are Cicero, Livy, Sallust and Pom-

peius Trogus In spite of his confusions, contradictions and anachronisms, the excerpts are apt illustrations Valerius often used sources now lost, and affords us some glimpses of the much debated and very imperfectly recorded reign of Tiberius Modern criticism will hardly regard as flattery his description of Tiberius, once so misunderstood, as *salutaris princeps*. He reveals the transition from classical to silver Latin It is an instructive lesson to compare minutely a passage of Valerius with its counterpart in Cicero or Livy The tenth book of the ms., the *Liber de Praenominibus*, is much later. The collection was used as a schoolbook, and was very popular in the middle ages.

One complete epitome, probably of the 4th or 5th century, bearing the name of Julius Paris, has come down to us, also a portion of another by Januarius Nepotianus. Editions by C. Halm (1865) and C Kempf (1888), contain the epitomes of Paris and Nepotianus.

VALÉRY, PAUL (1871–1945), French poet, was born at Cette on Oct 30, 1871 He first became known as the author of several apocalyptic poems of remarkable beauty and form, which appeared in such reviews as *L'Ermitage*, *Le Centaure*, etc., and were issued later in a collection entitled *Album de Vers anciens* (1920). From 1900 to 1917 Valéry lived in strict retirement and published nothing. During this period, however, his ideas matured, and he accumulated material later given to the public in *Cahier B, Rhumbs* and *Analecta*. It was not until 1917 that he published his first great poem *La Jeune Parque*, dedicated to André Gide. Then came *Aurore* (1917), *Le Cimitière marin* (1920), *La Platane*, *L'Ebauche d'un Serpent*, etc., which appeared in a collection entitled *Les Charmes* (1922). Valéry also wrote critical essays (on Stendhal, Poe, etc.) and philosophical treatises (*Introduction à la méthode de Léonard de Vinci*, *Soirée avec M. Teste*) of which some were collected under the title *Variétés* (1924), *Eupalinos* and *Ame et la Danse* (1923), two Platonic dialogues.

Valéry initiated a new movement in French poetry Influenced by Mallarmé, especially in his sense of verbal music, he believed with the symbolists that pure poetry must have value in itself apart from any reference to the accidents of being. Interested in philosophy and mathematics, he was a poet-mathematician trying to set his subtle analysis to music Valéry was a member of the Académie française from 1926. He died July 20, 1945, at Paris.

See H A L Fisher, *Paul Valéry* (1927); R. Fernandat, *P. Valéry* (1927); F. Souday, *P. Valéry* (1927); *Hommage des écrivains étrangers à Paul Valéry* (Maestricht, 1928), containing appreciations by R. M Rilke, R. Kayser, T. Shuge Moon, P Zaffer, È Cecchi, and others.

VALHALLA, according to the heathen Scandinavians the abode where the souls of those who had fallen in battle (Old Norse *Valhöll*, *i.e.*, "hall of the slain") are received by the god Odin, and fight and feast in his service. (*See* TEUTONIC PEOPLES.)

VALJEVO, a town in western Serbia, Yugoslavia, lying in a pine clad valley 627 ft. above sea level. Pop. (1931) 11,055. Besides being the centre of the plum growing and distillery industries, Valjevo has a considerable trade in cattle, the pastures watered by the Kolubra being famous. The best nut trees in Serbia flourish here. It was at Valjevo that the standard of revolt against the Turks was raised in 1804, and during the second rising in 1815 Prince Milosh captured the town.

During the Balkan campaign of World War II, Valjevo was occupied by German troops advancing westward from Rumania and Bulgaria, shortly after the fall of Belgrade in April 1941.

VALKYRIES, generally represented in Northern mythology as divine maidens who, sent by Odin, ride through the air to determine the course of battles and to select brave warriors for Valhalla (*q.v.*). Beings with the same name (*waelcyrgean*) were in England associated with witches.

VALLA, LORENZO or **LAURENTIUS** (*c.* 1407–1457), Italian humanist, was born at Rome about 1406, his father, Luca delle Vallea, being an advocate He was educated at Rome, became a priest in 1431, and wandered from one university to another lecturing. About 1437 he became private secretary to Alphonso V of Aragon, who ever afterwards protected him, and later helped him to open a school at Naples Valla by now had achieved a great reputation by the *De Voluptate* and the *De Elegantus Linguae Latinae* The first is a remarkable dialogue presenting in turn the Stoic, Epicurean and Christian ethical systems Christianity is allowed to prevail, but Epicurus is very favourably treated The *De Elegantus* is a scientific analysis of the rules of Latin grammar and style In 1444 he appeared his famous exposure of the Donation of Constantine (*q.v.*), followed by other attacks on spurious documents He was compelled to appear before an inquisitory tribunal composed of his enemies, and he escaped only by the special intervention of Alphonso He was not, however, silenced; he ridiculed the Latin of the Vulgate and accused St Augustine of heresy In 1446 he visited Rome, but in this city also his enemies were numerous and powerful, and he saved his life only by flying in disguise to Barcelona, whence he returned to Naples. After the death of Eugenius IV in 1447 he went again to Rome, where he was welcomed by the new pope, Nicholas V, who made him an apostolic secretary, and this entrance of Valla into the Roman Curia has been justly called "the triumph of humanism over orthodoxy and tradition." Valla also enjoyed the favour of Pope Calixtus III. His most famous dispute was with Poggio (*q.v.*). He died in Rome on Aug 1, 1457.

Over Valla's private life, the most obscene language was employed. He appears as a vain, jealous and quarrelsome man, but an elegant humanist, an acute critic and a venomous writer, who had committed himself to a violent polemic against the temporal power of Rome. In him posterity honours the man who initiated a bold criticism, which he applied to language, to historical documents and to ethical opinions. Luther had a high opinion of him, and Cardinal Bellarmine calls him *praecursor Luthers*, while Sir Richard Jebb says that his *De Elegantus* "marked the highest level that had yet been reached in the critical study of Latin."

Collected, but not quite complete, editions of Valla's works were published at Basle in 1540 and at Venice in 1592 *seq.*, and *De Elegantis* was reprinted nearly 60 times between 1471 and 1536. For detailed accounts of Valla's life and work *see* G. Voigt, *Die Wiederbelebung des classischen Alterthums* (1880–81); J. A. Symonds, *Renaissance in Italy* (1897–99), G Mancini, *Vita di Lorenzo Valla* (Florence, 1891); M von Wolff, *Lorenzo Valla* (Leipzig, 1893); J Burckhardt, *Kultur der Renaissance* (1860); J Vahlen, *Laurentius Valla* (1870); L Pastor, *Geschichte der Papste*, Band ii. Eng. trans by F. I Antrobus (1892); the article in Herzog-Hauck's *Realencyklopadie*, Band xx. (Leipzig, 1908); J. E Sandys, *Hist of Class Schol.* ii. (1908), pp. 66–70; and V. Rossi, *Il Quatrocento*, and ed. (Milan, 1933)

VALLABHACHARS, a numerous sect in western and central India in which the emotional and erotic elements are allowed free scope, aided by vernacular dialects in prayers and hymns of praise.

Vallabha, the son of a Telinga Brahman, lived at Gokula near Mathura, and set up a shrine with an image of Krishna Gopala. Vallabha went subsequently to reside at Benares, where he died. In the doctrine of this Vaishnava prophet, if the human soul is identical with God, the practice of austerities must be discarded as directed against God, and it is rather by a free indulgence of the natural appetites and the pleasures of life that man's love for God will best be shown. The followers of this creed direct their worship chiefly to Gopal Lal, the boyish Krishna of Vrindavana, whose image is sedulously attended like a revered living person eight times a day—from its early rising from its couch to its retiring to repose at night. The sectarial mark of the adherents consists of two red perpendicular lines, meeting in a semicircle at the root of the nose, and having a round red spot painted between them. Their principal doctrinal authority is the Bhagavata-purana, as commented upon by Vallabha himself, the author of several other Sanskrit works highly esteemed by his followers Children are solemnly admitted to full membership at the early age of four, and even two years, when a rosary, or necklace, of 108 beads of basil (tulsi) wood is passed round their necks, and they are taught the use of the octo-syllabic formula *Sri-Krishnah saranam mama*, "Holy Krishna is my refuge." Their spiritual heads, the Gosains, also called Maharajas, adorn themselves in splendid garments, and allow themselves to be habitually regaled by their adherents with choice kinds of food; and as the living representatives of the "lord of the Gopis" himself, claim and receive in their own persons all acts of attachment

and worship due to the deity, even, it is alleged, to the extent of complete self-surrender. In the final judgment of the famous libel case of the Bombay Maharajas, before the Supreme Court of Bombay, in January 1862, these improprieties were severely commented upon.

A modern offshoot of Vallabha's creed, formed with the avowed object of purging it of its objectionable features, was started, in the early years of the 19th century, by Sahajananda, a Brahman of the Oudh country, who subsequently assumed the name of Svami Narayana Having entered on his missionary labours at Ahmadabad, and afterwards removed to Jetalpur, where he had a meeting with Bishop Heber, he subsequently settled at the village of Wartal, to the north-west of Baroda, and erected a temple to Lakshmi-Narayana, which, with another at Ahmadabad, form the two chief centres of the sect, each being presided over by a Maharaja.

VALLADOLID, a town of Mexico in N E Yucatán Pop. (est 1950) 7,000 Founded 1544 on an ancient Maya site (Zaci), Valladolid lies in a fertile, healthful section and is famous as an ancient ecclesiastical centre and health resort. Numerous native uprisings, notably the War of the Castes (1847–53), destroyed many of its colonial edifices. It is the commercial hub of its area. (HD C.)

VALLADOLID, an inland province of Spain, one of the eight into which Old Castile was divided in 1833. Population (1950 census) 340,915, area, 3,155 sq mi

The province belongs to the basin of the river Duero (Douro) It is for the most part flat and exceedingly fertile, the only part that can be called hilly being in the northwest, where the low Montes de Torozos occur Valladolid shares with the Tierra de Campos in Palencia the title of granary of the Peninsula

Besides wheat, maize, barley and oats, the province produces hemp, flax, various fruits, red and white wine, oil and madder. Honey, wax and silk are also produced. The woollen fabrics of Valladolid were once highly esteemed, but this industry later greatly declined, although in the larger towns there are still linen and cloth factories, besides iron foundries, tanneries, saw-mills and flour-mills Trade is facilitated by the Canal de Castilla, connecting Valladolid, on the Pisuerga, with Alar del Rey, in Palencia. Valladolid is traversed from north to south by the railway from Madrid to France. Apart from the capital Valladolid (*q v.*), Medina del Campo (13,242) is the only large town The province was captured by nationalist troops in 1936, during the early stages of the civil war of 1936–39

VALLADOLID, the capital of the Spanish province of Valladolid, 2,228 ft above sea-level, at the confluence of the river Pisuerga with the Esgueva Pop (1940) 120,000 (mun, 124,212). It is sometimes identified with the ancient Pintia of Ptolemy. Its Roman origin is uncertain. The present name is undoubtedly Moorish Valladolid was recovered from the Moors in the 10th century, but is first named by Sancho II of León in 1072 The cortes of Castile frequently met here in the following centuries, and in the beginning of the 15th century John II made it his principal residence After the removal of the capital to Madrid by Philip II in 1560 it began rapidly to decay Columbus died (1506) and Philip II was born (1527) at Valladolid.

Valladolid is an archbishopric, and the seat of an army corps, a court of appeal and a university. It is connected by numerous railways with every province of Spain. The granite cathedral was begun in 1585 by Juan de Herrera in the Renaissance style. The interior contains pictures by Luca Giordano (1632–1705) and the celebrated silver monstrance wrought by Juan de Arphe. Other buildings are the church of Santa Maria la Antigua (1200); the church of San Pablo (1286); San Gregorio (15th century); and San Benito (end of the 14th century). The Plateresque college of Santa Cruz, built by Enrique de Egas in 1479–92, contains three pictures by Rubens, and some remarkable wooden statues by Alonso Berruguete (d. 1581), Gregorio Hernandez (1566–1636) and others. The university, originally founded at Palencia early in the 13th century, was transferred to Valladolid before 1250. The house in which Cervantes lived (1603–6) has been preserved by the Hispanic Society of America. The principal industries are the manufacture of linen, silk and woollen fabrics, pottery, gold and silver work, flour, wine, beer, chocolate, leather, ironware

VALLANDIGHAM, CLEMENT LAIRD (1820–1871), American politician, was born in New Lisbon, Ohio, on July 29, 1820 He was duly admitted to the bar in 1842. Elected to the Ohio house of representatives in 1845, he became one of the extremists of the state rights Democrats of his section From 1858 to 1863 he was in the lower house of Congress, where he was noted for his strong opposition to the principles and policies of the growing Republican party, his belief that the South had been grievously wronged by the North, his leadership of the peace democrats or "copperheads," who were opposed to the prosecution of the war, and his bitter attacks upon the Lincoln administration, which, he said, was destroying the Constitution and would end by destroying civil liberty in the North In 1863 he made violent speeches in Ohio against the administration, and for these he was arrested by the military authorities, tried by military commission, and sentenced to imprisonment President Lincoln commuted this sentence to banishment, and Vallandigham was sent into the Confederate lines, whence he made his way to Canada. While in exile he was elected supreme commander of the Knights of the Golden Circle in Ohio and received the Democratic nomination for governor of Ohio, but was defeated In 1864 he returned to Ohio, took active part in the campaign of that year, wrote part of the national Democratic platform at Chicago, and assisted to nominate McClellan for the presidency After the war he denounced the reconstruction policy of the Republicans as unconstitutional and tyrannical, but in 1870, seeing the uselessness of further opposition, he advised his party to accept the situation and adopt new issues. Vallandigham was an able lawyer and a popular politician. He died in Lebanon, Ohio, on June 17, 1871.

See J L Vallandigham, *Life of Clement L. Vallandigham* (Baltimore, 1872), J. F Rhodes, *History of the United States from the Compromise of 1850* (1839–1906); H van Fossan, "Clement L. Vallandigham," in *Ohio Archaeological and Historical Quarterly*, vol. xxiii., p. 256–267 (1914).

VALLE, PIETRO DELLA (1586–1652), Italian traveller in the East, came of a noble Roman family, and was born on April 11, 1586, in the family palace built by Cardinal Andrea. He served against the Moors of Barbary, but also became a member of the Roman academy of the Umoristi, and acquired some reputation as a versifier and rhetorician The idea of travelling in the East was suggested by a disappointment in love, as an alternative to suicide, and was ripened to a fixed purpose by a visit to the learned Mario Schipano, professor of medicine in Naples, to whom the record of Pietro's travels was addressed in the form of very elaborate letters, based on a full diary. Before leaving Naples he took a vow of pilgrimage to the Holy Land, and, sailing from Venice in 1614, reached Constantinople, where he remained for more than a year, and acquired a good knowledge of Turkish and a little Arabic. In September 1615 he sailed for Alexandria with a suite of nine persons. From Alexandria he went on to Cairo, and, after an excursion to Mount Sinai, left Cairo for the Holy Land in March 1616, in time to assist at the Easter celebrations at Jerusalem. Having visited the holy sites, he journeyed by Damascus to Aleppo, and thence to Baghdad, where he married a Syrian Christian named Maani, a native of Mardin, who died in 1621 He now desired to visit Persia; but, as that country was then at war with Turkey, he had to leave Baghdad by stealth in Jan 1617. Accompanied by his wife he proceeded by Hamadan to Isfahan, and joined Shah Abbas in a campaign in northern Persia, in the summer of 1618. Here he was well received at court. On his return to Isfahan he began to think of returning by India rather than Turkey; but the state of his health and the war between Persia [illegible]

[illegible]

reached Rome on March 28, 1626, and was received with much

honour by Pope Urban VIII, who appointed him a gentleman of his bedchamber. He died at Rome on April 21, 1652.

VALLE-INCLÁN, RAMON DEL (1869–1936), Spanish novelist and poet, was born at Puebla de Caramiñal (Pontevedra) A subtle artificer in his verse—*Aromas de leyenda* (1907), *Cuento de Abril* (1910), *Cara de plata* (1923)—he writes a refined and delicate prose in the *Memorias del marqués de Bradomín* (*Sonatas de primavera, de estío, de otoño* and *de invierno* [1902–1907]), while his *Guerra Carlista* is an impressive historical work.

VALLEJO, a city of Solano county, California, U.S.A., on San Pablo bay at the mouth of the Napa river, 25 mi. N.E. of San Francisco. It is served by the Southern Pacific railroad, passenger bus lines and by steamships for coastal as well as foreign trade.

The population of Vallejo was 26,038 in 1950 and was 20,072 in 1940 by the federal census.

Across Mare Island straits are the Mare Island naval shipyard and other naval establishments, making this the largest naval installation on the west coast. Vallejo was settled about 1849. It was named after Gen. Mariano Guadalupe Vallejo, a prominent Mexican leader. Through his efforts it became the state capital for a brief period, and the legislature met there in 1851, 1852 and 1853. In the struggle for the terminus of the Central Pacific railway (1869–72) it was a formidable, though unsuccessful, rival of Oakland.

VALLÈS, JULES (1832–1885), French journalist and author, was born at Puys, France, on June 10, 1832. Coming to Paris, he joined the staff of the *Figaro* and became a constant contributor to the other leading journals. He was in Paris during the siege of 1870 and after the capitulation was a member of the Commune and founded *Le Cri du Peuple*. He took a conspicuous part in the fighting in the Paris streets but finally made his escape to London, whence he contributed anonymously to the French press.

In 1878 he began in the *Siècle* the serial publication of his principal work, *Jacques Vingtras*, a long autobiographical romance. He died in Paris on Feb. 14, 1885.

VALLETTA or **VALETTA**, the capital of Malta (since 1570). Pop. (1946) 18,666. The nucleus of the city is built on a ridge of rock (Mount Sceberras) which runs like a tongue into the middle of a bay, which it thus divides into two harbours, the Grand harbour to the east and the Marsamuschetto to the west, which are subdivided again by three other peninsulas into creeks. On two of these peninsulas on the east side of the Grand harbour, and at their base, are built the aggregate of towns called the Three Cities—Vittoriosa, Conspicua and Senglea. (*See* MALTA.) On the main promontory, with Valletta, stands the suburb Floriana; Fort St. Elmo, with a lighthouse, stands on the extremity of the promontory; the suburb Sliema lies on the point which encloses the Marsamuschetto harbour; Fort Ricasoli is on the opposite point, enclosing the east, Grand, or Great harbour. The streets of Valletta, paved with stone, run along and across the ridge and end on each side toward the water in steep flights of steps. At the start of World War II the city contained several fine public buildings, as the Grand Master's palace (official residence of the governor), the Royal Opera house, the Royal Malta library (having 200,000 vol. and 1,185 MSS.), the Museum of Maltese antiquities and the *auberges* or lodges of the Knights of Malta (especially the Auberge de Castile et Leon), these last used for military offices, clubrooms and other purposes. Roman Catholic churches in Valletta were very numerous; the cathedral of S. Giovanni, dating from 1576, was famous for its rich inlaid marbles, its Brussels tapestries, its roof painted by Matteo Preti (1661–99), a picture by Michelangelo da Caravaggio of the beheading of John the Baptist and numerous memorials of the knights and other relics. All these magnificent memorials of the past suffered irreparable damage during World War II, the majority of them being completely destroyed. Valletta was the principal objective of unparalleled bombing raids on Malta by both Italian and German aircraft, which commenced on June 11, 1940, and continued for nearly three years on a scale unequalled elsewhere in the world.

After the British occupation Valletta became a naval and military station of the first importance. The naval dockyard and victualling stores occupied the shores of the two main creeks within the great harbour. The large transit trade and the local trade of the island also centred in the city.

See Ian Hay, *The Unconquered Isle* (1943).

VALLEY CITY, a city of North Dakota, U.S.A., on federal highway 10. Pop (1950) 6,851. It is the seat of a state teachers' college (established 1890). It was incorporated in 1881.

VALLEYFIELD (Salaberry-de-), city and port of entry, Beauharnois county, Quebec, Canada, 25 mi. S.W. of Montreal, at the foot of Lake St. Francis—an expansion of the river St. Lawrence—and at the head of the old and the new Beauharnois canals. Pop. (1951) 22,414. It is the see of a Roman Catholic bishop, and contains a college and normal school. Industries include cotton and silk mills, flour mills and chemical works.

VALLEY FORGE, an area about 20 mi. northwest of Philadelphia, Pa, U.S.A, where the American Revolutionary army of about 11,000 men under George Washington spent the winter of 1777–78. Their sufferings there from cold, starvation and sickness hallowed the historic site for Americans. The troops wintered in log huts and received little food or clothing. On Dec. 23, 1777, Washington wrote: "We have this day no less than 2,873 men in camp unfit for duty because they are barefooted and otherwise naked. . . . Numbers are still obliged to sit all night by fires" There were many desertions and occasional symptoms of mutiny, but for the most part the soldiers bore their sufferings with heroic fortitude. In Feb. 1778 the winter encampment became the first training camp of any United States armed forces. Under the drillmaster, Baron Frederick von Steuben, the army was reorganized, and left Valley Forge June 19, 1778, an efficient fighting unit. Of the original encampment 2,033 ac. is owned, maintained and preserved by the commonwealth of Pennsylvania and known nationally as Valley Forge park. Washington headquarters, Varnum quarters, Commissary quarters and much of the military works used by the Continental army are restored. The ruins of the valley forge, an iron plant which gave name to the area, and which the British burned in Sept. 1777, have been excavated. Statues of Anthony Wayne and Von Steuben and the National Memorial Arch, erected as a tribute to all the men, are outstanding monuments. The locations of troop units from each of the 13 original Colonies are indicated by granite markers. One memorial to Washington is the magnificent Washington Memorial chapel with its national carillon of 49 bells, one for each state and one for the union.

(G. S. J.)

VALLEY OF TEN THOUSAND SMOKES, a volcanic region in Alaska, which came into being at the time of the eruption of Mt. Katmai on the Alaskan peninsula on June 6, 1912. An ancient trail led through the valley, so that it was well-known to have been rich in plant and animal life, a favourite hunting ground of the natives. One of the first events in the Katmai eruption was the bursting forth of a new volcano, Nova Rupta, in the floor of one arm of the valley. Probably from this vent, and other smaller ones, issued the great flow of incandescent sand which filled the floor of the valley, 17 mi. in length and 4 mi. in width, utterly consuming everything in its path until it reached the lower end of the valley, where the trees were merely turned to charcoal. At the time of its discovery not ten thousand but millions of jets of steam were issuing from the floor of the valley from vents ranging in size from a tiny crack to pits or craters 150 ft. in diameter. In temperature they ranged up to 1,200° F., hot enough to melt zinc and to set ablaze a stick held in the steam. Immediately following the hot sand flow Mt. Katmai exploded. Its three-peaked snow-covered crown was blown to atoms, leaving a crater 3 mi. wide, containing a lake 3,700 ft. below the crater rim. Five cu m. of ash were thrown out, covering Kodiak Island, 100 mi. away, with a blanket a foot deep. Acid rains fell in Cordova, 360 mi. distant, while the fumes tarnished brass in Victoria, B.C., 1,500 mi. away. The haze was noted in Virginia and at the bureau of standards in Washington, D.C. The dust from Katmai thrown into the higher layers of atmosphere robbed the north temperate zone of 10% of the sun's heat in the summer of 1912. Because Katmai



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VARIED SCENERY IN VALLEY OF TEN THOUSAND SMOKES

1. Ash covered snowdrift near intense heat of fumaroles (crevice in volcanic cone) making an ideal temporary refrigerator
2. Looking across a corner of the Valley of Ten Thousand Smokes from the rim of Novarupta
3. Lines of fumaroles across the valley, illustrating that the smokes spring largely from fissures traversing the floor
4. Apparatus for measuring temperature of a fumarole. This one was found to be 572°F.
5. Frying bacon over a fumarole. Clear steam rushes forth with sufficient pressure to lift frying pan into the air

is located in a region almost uninhabited, not a human being lost his life, though this eruption was one of the largest ever known.

The Valley of Ten Thousand Smokes and its neighbouring wonders were discovered by Robert F Griggs, director of the National Geographic Society's expeditions of 1915–16–17–18–19 This region proved to be so stupendous a volcanic laboratory as well as so rich in scenic value that in Sept. 1918 President Wilson set aside the whole district, comprising 2,697,590 ac. as the Katmai National monument. (L T G.)

VALLOMBROSA, a summer resort of Tuscany, Italy, in the province of Florence, reached by road (9 m.) from the station of S Ellero (which is 16 m SE of Florence) and 328 ft above sea-level, on the north-west slope of the Prato Magno chain. The former monastery was suppressed in 1866 A number of hotels have been built. Similar summer resorts are situated among the woods above the Casentino or upper valley of the Arno to the east, such as Camaldoli, Badia di Prataglia, etc. Camaldoli was the original headquarters of the Camaldulensian order, now partly occupied by an hotel Five hours' journey to the south of the last on foot and 7½ m. to the east of Bibbiena by road is the monastery of La Verna, 3,660 ft above sea-level, founded by St. Francis in 1215 on an isolated limestone peak Here he received the stigmata in 1224. The small Church of the Angels, erected by him, and the Chiesa Maggiore (begun in 1348) contain some fine terra-cotta reliefs by the della Robbia family

VALLOMBROSIANS, an order of monks under the Benedictine rule, founded by St John Gualbert, who, about 1030, withdrew to Vallombrosa, a shady dale on the side of a mountain in the Apennines, 10 m from Florence, and for some years led a completely solitary life Disciples, however, gathered around him, and he formed them into an order in which the cenobitical and the eremitical lives should be combined The Benedictine rule was the basis of the life; but every element of Benedictine life was eliminated that could interrupt the attention of the mind to God—even manual labour. The Vallombrosians spread in Italy and France, but they never had more than sixty houses

See the *Catholic Encyclopaedia*, art "Vallombrosians"; and Max Heimbucher, *Orden u Kongregationen* (1907), I. § 44.

VALMY, a small village on the main road between Verdun and Paris, just west of Ste Menehould, famous for the French victory of Sept. 20, 1792. Eastward of Valmy lies, roughly north and south, the long barrier of the forest of Argonne. Dumouriez, with the belated assistance of Kellermann, was attempting to hold this in September against the advance of the duke of Brunswick's German troops Heavy and continuous rains had made the chalky and clayey soil a greater obstacle even than the thick undergrowth and wild country, but the French revolutionary troops were unable to hold the forest In their previous conflicts with Austrian or Prussian troops they had met continuous, immediate and shameful defeat; and their morale was going from bad to worse The duke's forces broke through easily, not by the main road it is true, but to the north by a pass known as the Cross in the Woods In great haste, on the 19th, Dumouriez was able to withdraw under the cover of darkness the forces guarding the northern portions of the Argonne, which would otherwise have been cut off. and to complete his junction with Kellermann. By the morning of Sept 20 his army was on the flank of Brunswick's advance and was facing towards Paris, with its back to the Argonne It consisted chiefly of troops of the *ancien régime*, disorganized by the defection of their officers, and young and wholly untrained volunteers.

Dysentery, the long detour necessitated by his holding a northern pass, and the general badness of the Prussian communications forced Brunswick to attempt immediately to clear Dumouriez's force off his flank and make safe his sources of supplies. As soon as the heavy mist lifted on the morning of Sept 20, therefore, he commenced an attack on the French by heavy artillery preparation The French line was drawn up on a slight elevation, of which the most prominent feature was the famous mill of Valmy. Between them and the Prussians was a shallow depression of about a half to three-quarters of a mile in breadth; the Prussians were drawn up on the opposite undulation The French artillery, which was less heavy in metal than the German, was the sole important arm which had not been disorganized, and was able to reply effectively to the Prussian cannonade Early in the afternoon, however, the Prussian guns did tremendous damage by a lucky shot which struck the French ammunition reserves by the mill, blowing them up with a tremendous report and great damage. A German mercenary brigade in the French service broke, and the effect on the whole sorely-tried French line was such that Brunswick decided that the right moment had come for a general attack, and gave the signal.

The Prussians advanced *en échelon* under a severe fire, but steadily, some two-thirds of the intervening distance The shaky ranks of the French were rallied by Kellermann, and were more or less prepared to meet the attack, when the Prussians hesitated. and, still apparently without disorder, retreated to their original position Some mystery surrounds this, the central event of the battle it seems probable that the Prussian advance was impeded by unsuspected thick mud at the foot of the hill, as well as by the accurate French gunnery—the support of their own guns necessarily ceasing as they approached the French lines The cannonade continued till nightfall. Brunswick, having failed to defeat his enemy, realized that his position was strategically untenable and, after a few days, retreated (*See* FRENCH REVOLUTIONARY WARS)

VALOIS, COUNTS AND DUKES OF. The French countship of Valois (*pagus Vadensis*) takes its name from Vez (Latin *Vadum*), its early capital, a town in the department of the Oise From the 10th to the 12th century it was owned by the counts of Vermandois and of Vexin; but on the death of Eleanor, sister and heiress of Count Raoul V. (d 1167), it was united to the crown by King Philip Augustus Soon detached from the royal domain, Valois was the property of Blanche of Castile, widow of Louis VIII., from 1240 to 1252, and of Jean Tristan, a younger son of Louis IX., from 1268 to 1270. In 1285 Philip III gave the county to his son Charles (d. 1325), whose son and successor, Philip, count of Valois, became king of France as Philip VI in 1328 Sixteen years later Valois was granted to Philip's son, Philip, duke of Orleans, then passing with the duchy of Orleans in 1392 to Louis (d 1407), a son of Charles V, it was erected into a duchy in 1406, and remained the property of the dukes of Orleans until Duke Louis became king of France as Louis XII. in 1498, when it was united with the royal domain After this the duchy of Valois was held by Jeanne, countess of Taillebourg (d 1520), from 1516 to 1517, and by Marie, countess of Vendôme, from 1532 until her death in 1546; it was given to Catherine de' Medici, the widow of Henry II., in 1562, and in 1582 to her daughter, Margaret of Valois, the wife of Henry of Navarre In 1630 Louis XIII. granted Valois to his brother Gaston, duke of Orleans, and the duchy formed part of the lands and titles of the dukes of Orleans until the Revolution

The house of Valois, a branch of the great Capetian family, is thus descended from Charles, a son of Philip III, and has been divided into several lines, three of which have reigned in France These are· (1) the direct line (reigned 1328–1498) beginning with Philip VI; (2) the Orleans branch (reigned 1498–1515), descended from Louis, duke of Orleans, a son of Charles V.; (3) the Angoulême branch (reigned 1515–1589) descendants of John, another son of the same duke.

VALOIS, CHARLES DE (1671–1747), son of Adrien de Valois, was a distinguished numismatist, and formed a fine collection of medals, chiefly Roman. He became a pupil (1705), and associate (1714), and finally a *pensionnaire* (1722) of the Académie des Inscriptions et Belles Lettres. He published *Histoire des Amphictyons*, and collected a number of critical observations, anecdotes, and Latin poems of his father in *Velesiana* (1694) His *Éloge* by Fréret is in the *Mémoires de l'Académie des Inscriptions*, vol xxi p 234 (1747).

VALOIS, anciently a district of Picardy, part of the government of the Ile-de-France, bounded on the north by Soissonnais, on the east by Champagne, on the south by the Ile-de-France proper, and on the west by Beauvaisis. It included the towns of Crépy (capital), Morienval, Pierrefonds, Compiègne, Verberie, Pont-Sainte-Maxence, Senlis, Chantilly, Villers-Cotterets. Under

the Roman domination it belonged to the Suessiones but it is now a small area in the departments of the Oise and the Aisne.

At first governed by its own independent counts, Valois in 1214 was joined to the kingdom of France by Philip Augustus It has given its name to three lines of the second branch of the Capetian kings (*See* VALOIS, COUNTS AND DUKES OF)

For history *see* A. Poilleux, *Le Duché de Valois, pendant les XIVe et XVIe siècles* (1843).

VALONA (Albanian, *Vlonë*), a seaport of Albania Pop. (1930) about 9,100, of whom 65% were Muslims, 30% Orthodox and 5% Roman Catholics Valona occupies an eminence near the gulf of Valona and is almost surrounded by mountains. The port is the best on the Albanian coast, with good anchorage and shelter, being protected by the island of Saseno (the ancient *Saso*) It is a port of call, and the cable and telegraph line to Otranto, Italy, has an important station there. About 1½ mi. from the sea, Valona has a pleasant appearance with its minarets and its palace, surrounded by gardens and olive groves Valonia, a material largely used by tanners, is the pericarp of an acorn obtained in the neighbouring oak woods and derives its name from Valona. The surrounding district is mainly agricultural and pastoral, producing oats, maize, cotton, a little rice, olives, cattle, sheep, hides, skins and butter, all of which are exported, together with bitumen from the mine at Selenitsa At Smoktina there are steam sawmills, while in the town itself there are motor repair works and an oil refinery Valona played an important part in the wars between the Normans and the Byzantines during the 11th and 12th centuries In 1464 it was taken by the Turks, captured by the Venetians in 1690 but restored to Turkey in 1691. In 1851 it suffered severely from an earthquake During the Balkan Wars (1912–13) Valona was bombarded by the Greek fleet in 1912, and in the same year Ismail Bey proclaimed the independence of Albania In the following year the International Commission of Control sat at Valona and appointed Prince William of Wied king of Albania After his flight, a few months later, Valona was seized by the insurgents At the outbreak of World War I in 1914 the Italians seized Saseno, which had been ceded to Albania, and occupied the town itself, which they held until 1920. They occupied Valona again in 1939 The city was bombed heavily during the Greek-Italian war in 1940–41.

VALPARAÍSO, a province in the coast ranges of central Chile, smallest and most densely inhabited province in the country. Area 1,860 sq mi.; pop (1950) 528,326, most of which is in Valparaíso, capital of the province, and the suburban towns along the coast. The climate is mild and semiarid.

VALPARAÍSO, city and seaport of Chile, capital of province of the same name, on a broad open bay of the Pacific in lat 33° 0′ 2″ S, long. 71° 41′ 15″ W., 115 mi. by rail N W. of Santiago Pop. (1944) 209,945 The almost semicircular Bay of Valparaíso is slightly over 3 mi. across from Punta Angeles to Punta Gruesa, and the city stands on the south side, on the slopes of a spur of barren hills projecting into the Pacific and forming a rocky peninsula terminating in Punta Angeles. This point affords good shelter from southerly and westerly storms, but the bay is open to those from the north The extreme points of the bay are strongly fortified. The city occupies a narrow strip of beach around the head of the bay and extends up the steep slopes and valleys of the enclosing hills, which have an altitude of 1,000 to 1,400 ft The city's civic improvements are striking and beautiful. The Chilean naval academy buildings and fine residences are located on heights overlooking the bay. Improved roads connect the upper and lower city. There are numerous inclined passenger elevators. The suburban resort Viña del Mar is noted for its buildings, amusements and society.

Valparaíso is pre-eminently commercial and industrial, there are large foundries and factories producing chemicals, textiles, paints and clothing. The city's trade, normally the largest and most important on the Pacific coast of South America, makes it a terminal and port of call for several major steamship lines. In 1949, the foreign trade amounted to 687,200 tons imported and 89,300 tons exported compared with 732,000 imported and 98,000 exported in 1950. Trade with other Chilean ports included 170,996 tons in exports and 609,572 in imports in 1949 compared with 210 058 and 686,156 tons in 1950

An electrified line of the state railways connects the city with Santiago, and steam lines of the same system link Valparaíso with virtually all important cities and ports of Chile from Pisagua in the north to Puerto Montt in the south It is the western terminus of the Transandne railway, giving the city direct overland connection with Buenos Aires Air lines connect the city with other parts of Chile and with foreign countries Good highways extend northward from Valparaíso along the coast and to the national capital.

Harbour improvements, completed in 1930, represented an outlay of several million dollars Although the great depth of the water retarded progress, a breakwater more than 3,000 ft long was built to the western part of the inner bay, sheltering an area of approximately 123 ac. The depth in this part of the harbour is sufficiently great to accommodate the largest vessels afloat There are scores of piers, a mile of stone sea wall, warehouses and modern cargo-handling machinery

Valparaíso was founded in 1536 by Juan de Saavedra, who named it after his birthplace near Cuenca, Spain The port and town were of little note during the colonial period, for free commercial intercourse with the colony was forbidden. In 1819, near the end of the war with Spain, its population barely reached 5,000 In 1578 it was captured by Sir Francis Drake, and in 1596 by Sir John Hawkins.

In 1600 it was sacked by the Dutch under Oliver van Noort On March 31, 1866, it was bombarded by a Spanish fleet under Adm. Casto Méndez Nuñez, when a large part of the town was laid in ruins, and on Aug 28, 1891, after the victory of the congressional troops over José Manuel Balmaceda's forces in the vicinity, it was partially sacked by the Chileans themselves It suffered much from the earthquakes of 1731, 1822, 1839, 1873 and 1908 That of 1908 caused the destruction of a large part of the city. Its modernization may be said to date from the earthquakes of 1906–07 From ashes and debris streets were widened and paved, better business structures arose and modern sewerage was provided

VALPARAISO, a city of Indiana, U S, 40 mi. S.E. of Chicago; county seat of Porter county. It is served by the Grand Trunk, the Nickel Plate and the Pennsylvania railways and is on federal highway 30. Pop. (1950) 12,028 It is the seat of Valparaiso university, established 1871 as a revival of a Methodist college (1859–69), and from 1925 under Lutheran auspices; also of the Valparaiso Technical institute. Valparaiso was settled about 1836 and chartered as a city in 1865.

VALS (Vals-les-Bains), Ardèche, a town of southeastern France. Pop. (1946) 2,669. Vals is situated on the Volane among volcanic mountains. It is celebrated for its numerous cold mineral springs, impregnated in most cases with sodium bicarbonate They are used chiefly for drinking but also as baths and are efficacious in maladies of the digestion, liver and kidneys and for gravel and gout. Great quantities of bottles are exported

VALTELLINA (Ger. *Veltlin;* the name comes from the former capital, Teglio), properly the name of the upper valley of Adda, in north Italy. Historically, it also comprises the Italian Lire or San Giacomo valley, now the province of Sondrio

Pop (1936) 142,919. Today the whole valley belongs to the kingdom of Italy, except the side valley of Poschiavo (Puschlav), which belongs to the Swiss canton of the Grisons (Graubünden) The chief town is Sondrio (1936–7,639), other important places being Tirano (3,867), Chiavenna (3,823) and Morbegno (4,277) Near Bormio there are some frequented mineral springs (sulphur and lime), known in Pliny's time, and efficacious in diseases of the skin There are several other baths in the side valleys, such as Santa Caterina (chalybeate), Masino and Le Prese (sulphur).

The highest points in the ranges enclosing the valley are the Piz Zupo (13,117 ft) in the Bernina group and the Gran Zebrù (Königsspitze) (12,661 ft.) in the Ortler district; the Monte della Disgrazia (12,067 ft.) is the highest peak comprised entirely within the water-basin of the valley. Four well-marked Alpine passes are traversed by good roads—the Stelvio pass (9,048 ft., the highest carriage-road in Europe) from Bormio to Spondigna

in the Adige valley; the Bernina pass (7,645 ft.) from Tirano to Samaden in the Upper Engadine; and the Aprica pass (3,875 ft.) from Tirano to the Val Camonica and the Lake of Iseo, while from near the top of the Stelvio a fourth road leads over the Umbrail pass (8,242 ft, the highest in Switzerland) to the Swiss valley of Münster, which is reached at the village of Santa Maria. The main valley is traversed from end to end by a magnificent carriage-road constructed by the Austrian Government in 1820–25. A railway runs from Colico, on the Lake of Como, past Sondrio to Tirano, a distance of 42 m, while there is another from Colico to Chiavenna (16½ m.).

The population is wholly Italian-speaking and Roman Catholic, the valley being in the diocese of Como. The shrine of the Madonna of Tirano (founded 1520) attracts large numbers of pilgrims. The valley, particularly in its lower portion, is extremely fertile, and of late years vigorous measures have been taken to prevent the damage caused by the frequent inundations of the Adda. Chestnuts, vines, mulberry trees and fig trees abound; and there are many picturesquely situated churches, castles and villages The chief articles exported are wine and honey. Large quantities of honey are annually sent abroad The Valtellina has now become important for its hydroelectric plants.

History.—After the defeat of the Lombards (774) the Valtellina was given (775) by Charlemagne to the abbey of St Denis near Paris, which never seems to have exercised its rights. In 824 Lothair I., confirming an earlier donation (803) made by Charlemagne, gave the churches of Poschiavo and Bormio to the bishop of Como. Bormio was in 1205 won by the men of Como, who in 1006 had received one-half of Valtellina from the emperor, and by 1214 they were masters of the entire valley They retained Bormio till 1300, when it freed itself, but in 1336 it belonged to the bishop of Chur In 1335 the Visconti of Milan became lords of Como, and therefore of Valtellina. As early as 1360 the men of Rhaetia made incursions into Valtellina on the pretext that it had formed part of ancient Rhaetia. This idea was confirmed in 1404, when, in return for kind treatment received during his exile, Mastino Visconti (son of Barnabò) gave to the bishop of Chur his share of the Milanese, including Poschiavo, Bormio and Valtellina. Relying on this donation, the men of the three Leagues of Rhaetia (best known by the name of Graubünden) invaded the valley in 1486–87. Poschiavo becoming in 1486 permanently a member (not a subject land) of the *Gotteshausbund* In 1512 Chiavenna, Bormio and Valtellina were also seized and harshly ruled. Mastino Visconti's donation was solemnly confirmed in 1516 by the emperor Maximilian I In 1530 the bishop of Chur was forced to sell to the Three Leagues his title to these two districts. At the time of the Reformation Poschiavo became Protestant. The other two districts clung to the old faith and came under the influence of Carlo Borromeo. Valtellina was extremely important to the Habsburgs as affording the direct route between their possessions of the Milanese and Tirol. Hence a great struggle took place between Austria and Spain on one side and France and Venice on the other The religious conflicts in Graubünden led to reprisals in the "subject land" of Valtellina In 1620 (July 19–Aug. 4) the Spanish and Catholic faction (headed by the Planta family) massacred from 350 to 600 Protestants in the valley, according to different accounts (*Veltliner Mord* or *Sacro Macello*). For the next 20 years the valley was the scene of great strife, being held by the Spaniards (1621–23, 1629–31, 1637–39), by the French (1624–27, 1635–37) and by the pope (1623, 1627). At length George Jenatsch, a former pastor, who had been the active and unscrupulous leader of the Protestant party, became a Catholic (1635) in order to free the land from the French by aid of the Spaniards (1637), who finally (1639) gave it back to its old masters on condition that the Protestants were excluded from the valley In this way the local struggles of Valtellina came to be mixed up with the Thirty Years' War In 1797 Bormio and Valtellina were annexed to the Cisalpine republic, in 1805 to the Napoleonic kingdom of Italy and in 1815 (despite the remonstrances of the Rhetian leagues) to the kingdom of Lombardo-Venetia, held by the emperor of Austria. In 1859 they became, like the rest of Lombardy, part of the kingdom of united Italy. Poschiavo followed the fortunes of the "Gotteshausbund." It became (after 1798) part of the canton Rhetia of the Helvetic republic, and in 1803 of the canton of the Graubünden or Grisons, which was then first received a full member of the Swiss Confederation (*See* SWITZERLAND)

VALUATION AND VALUERS. A valuation or appraisement, under English law, need not be stamped where it is made (1) for, and for the information of, one party only, and is not obligatory as between parties; (2) in pursuance of the order of a court of admiralty or on appeal therefrom; (3) of property of a deceased person for the information of an executor, or other person required to deliver an affidavit of the estate of such deceased person; or (4) of any property for the purpose of ascertaining the legacy or succession or account duty payable in respect thereof. Any other valuation or appraisement must be stamped. Who makes an appraisement or valuation chargeable with stamp duty must, within 14 days after, write it out in words and figures showing the full amount upon duly stamped material. If he omits to do so, or in any other manner discloses the amount, he becomes liable to a fine Any person who receives from an appraiser, or who pays for the making of, any such appraisement or valuation not so written out and stamped, becomes liable to a fine

Where a contract has been made for the sale of property at a valuation, a valuation made in accordance with its terms will be conclusive as between the parties, in the absence of fraud, collusion or mistake Where there has been an agreement to sell goods on the terms that the price is to be fixed by the valuation of a third party and such third party cannot or does not make such valuation, the agreement is avoided; but if the goods or any part thereof have been delivered to and appropriated by the buyer he must pay a reasonable price therefor Where the third party is prevented from making the valuation by the fault of the seller or buyer, the party not in fault may maintain an action for damages against the party in fault. Where the fixing of a value by valuers is not of the essence of an agreement, but is wholly subsidiary to it, the courts will, if justice require it, ascertain the value in order to carry the agreement into effect Where an agreement had been entered into for the sale of a house at a fixed price and of the furniture at a valuation by a person named by both parties, and he undertook the valuation but was refused permission by the vendor to enter the premises for that purpose, the vendor was ordered to allow the entry so that the valuation might proceed

A person who exercises the calling of an appraiser or who, for or in expectation of any fee or reward, makes any valuation or appraisement chargeable with stamp duty, must (unless he is licensed as an auctioneer or house agent) have an appraiser's licence, upon which a duty is charged and which continues in force from the day of its date until the following 5th of July. By default in this respect a liability to a penalty is incurred. Moreover, an unlicensed appraiser cannot recover remuneration A valuer is liable to the person who has employed him for the consequences of negligence or want of due care and skill on his part If his services are thereby rendered worthless he will not be able to recover anything by way of remuneration (*See* AUCTIONS AND AUCTIONEERS; ESTATE AND HOUSE AGENTS.) (X.)

United States.—The American law conforms substantially to the English as stated above, save that there are no American stamp duties in reference to valuation There are, however, at least three additional fields in which valuation has assumed considerable importance in the United States One is a matter of private law, the other two, of constitutional law The first is the common legislative attempt to control stock-watering by providing that corporate stock shall be issued only in return for full par value in money or property, and giving creditors various civil remedies against directors or against those who receive stock without making adequate return. This raises immediately the question of valuation of property exchanged for stock. In substantial effect these statutes have proved inadequate to their purposes They leave no legitimate machinery for promoters to procure the profits which the courts themselves view as proper and necessary; hence there is persistent pressure to devise means of evasion. And

the courts show a distinct tendency to support valuations of the property arrived at "in good faith," which in practice regularly means some substantial addition to provable tangible assets, by way of the anticipated profits from their use And transfer of the stock to a bona fide purchaser is held to wipe out the creditors' claims against the stock. Furthermore, the introduction of no-par stock makes possible in many States to-day the complete disregard of the older regulations The second field is valuation for purposes of taxation Here the common practice is for the assessors to undervalue realty, so that tax valuation of realty is not admissible as evidence of value in a suit for any other purpose And such undervaluation becomes a constitutional right of the tax-payer, in so far as he is entitled not to have his holdings valued at their true worth, if other holdings of like character are undervalued by the assessors A more difficult problem is met in the apportionment of the intangible going value of an interstate enterprise, for taxation by the several States in which the enterprise is operated In the field of communication and transportation agencies, which have been chiefly concerned, the courts have in general worked out the permissible divisions by taking the total tax base of the enterprise (*e.g.*, gross income or value of outstanding securities, etc) and permitting any one State to reach its due proportion as calculated by the ratio of tangible assets (*e g* , miles of track) or traffic (ton-miles, car-miles, etc) inside the State to total tangible assets or total traffic The more recent cases show a definite trend toward nicer approximation to measurement of business actually done in the taxing State In the case of interstate business enterprises, the combined effects of the interstate commerce clause and of interlocking corporate structure produce a technical chaos incapable of brief exposition The third field is valuation for purposes of determining the rates chargeable by public utilities. On the one hand, such utilities as gas, railroad, water and telephone companies are subject to rate regulation by the government to prevent excessive charges On the other, they are private property, in the sense that rates may not be put so low as to be confiscatory "A fair return on fair value" is the legal formula applied It is clear, however, that value itself, in the market, depends wholly on the return from the assets, so that reference to market value to determine the "fair value" on which a fair return is to be allowed involves reasoning in a circle. This the courts have never expressly recognized, but in their actual decisions they have introduced other more stable factors by requiring any rate-regulating commission to "consider" certain phases of cost in determining the fair value. The emphasis has been strong on the reproduction cost of plant and equipment. Originally, this seems to have been influenced by a desire to avoid the padded original costs of early corporate exploitation; more recently, it is a reflection of rising costs of reproduction The valuers, in the first instance, are of course the railroad or public utility commissions of the States. It is clear that market value is by no means always the measure of value which is sought in legal valuation. (K. N. L.)

VALUE. In economics, use is made of three closely related conceptions of value: *exchange value, subjective value* and *imputed price.*

Exchange Value, or value in exchange. This denotes the relative importance which the community, as a whole, manifesting its preferences through the process of the market, attaches to a particular good (commodity or service) in comparison with other goods. It is often defined in the older treatises on political economy as "power in exchange." The exchange value of a particular "good" is measured or expressed by the quantity of other goods for which a unit of that good can be exchanged, or, preferably, as a ratio of exchange Any one good, of course, really has many different specific exchange values, corresponding to the various ratios at which it can be exchanged for different commodities and services The notion of the general exchange value of a good rests upon an inclusive view of all of its different specific exchange values The money price of a good is conceived of as one of its specific exchange values or, in other connections, as its general exchange value expressed in terms of money, which thus serves as a "common denominator of values." Because the direct barter of goods for goods is uncommon, the exchange values of different goods have to be inferred from their money prices. Indeed, the conception of exchange value is derived from the conception of price by making abstraction of the use of money as an instrument of purchase and sale This abstraction has been found useful in economics because, first, some aspects of important economic problems are seen more clearly when values are looked upon as though they were determined by the direct comparison of goods with goods without the intervention of money, and second, because it is often desirable to eliminate the effects which changes in the value of money have upon the money prices of different goods With the development of statistical technique, however, it has been found possible to take separate account of general changes of prices and of relative changes in the prices which are paid for particular goods For this and other reasons the conception of exchange value has lost some of the importance which it once had in economics Economic analysis now commonly deals, more directly and realistically, with money prices

Subjective Value.—This denotes the relative importance which an individual consumer attaches to a particular good, in comparison with other goods It relates always to specific quantities or specific increments or decrements of goods. Even an individsible good, an automobile for example, is a compound of various qualities, such as size, power, comfort and appearance, and buyers have a certain range of choice within which these qualities may be had in larger or smaller measure and combined in different proportions So far as a consumer chooses rationally rather than impulsively he apportions his outlays so that he would gain nothing by buying more of one thing and less of another Thus he brings his monthly or annual outlays for different purposes to or towards a common boundary or margin (his "margin of consumption") where the importance which he attaches to what he gets for the final or marginal pound or dollar which he spends, say for food, is equal to the importance of what he gets for the marginal pound or dollar spent for clothing or other object

Imputed Price.—This is an estimate of the amount of money for which a given article or a given quantum of goods could be sold or bought. When we say that the value of a work of art, a house, or a stock of goods is so many pounds or dollars, we are using the word value in the sense of imputed price. The "valuation" or appraisal of goods for purposes of taxation or of formal transfer is an imputation of price. A nation's wealth can be expressed in terms of its money value only by imputing prices to the various items of which it is composed. Value, in this sense, is not the price would could be got at a forced sale or the price which would have to be paid by buyers in order to induce holders to part with their goods *en bloc.* It is, instead, an estimate of the price which could be obtained in due course, with no sudden accelerating of either supply or demand. Statements to the effect that the price of a commodity is above or below its value generally mean only that because of a temporary excess of supply or demand or because buyers or sellers lack knowledge of facts which, if known, would affect their offers, the present price is out of line with the probable future price.

Theories of Value.—That the exchange value of a good is determined by the amount of labour required to produce it was at one time a fairly common belief. Adopted and restated by Adam Smith and his successors, this doctrine was later taken over by Karl Marx and other socialists and put into a form in which labour is held to be the sole source or cause of value. In its best form, as set forth by Ricardo, the labour theory of value was to the effect that, allowing for temporary fluctuations of supply and demand, the exchange values of different commodities tend to be *proportional* to the respective quantities of labour required to produce them. The rent of land was held to be without influence on the value of its produce, for the reason that the value had to be high enough to cover the labour costs incurred under the most unfavourable conditions of cultivation, where no rent is or can be paid. Capital was regarded as stored up labour, and interest or necessary profit on capital was disregarded on the arbitrary assumption that its amount would be roughly proportionate to the total amount of labour employed in producing a commodity

Apart from the circumstance that other costs than labour are not adequately brought into the reckoning, the labour theory of value encounters two difficulties First, different kinds of work call for different kinds and degrees of ability and training, and differ in respect of attractiveness Different kinds of labour can be fused into a "quantity" of labour only by grading them or weighting them in accordance with the different values which their respective products command in the market, and this procedure leads to circular reasoning Second, so far as there is, in fact, any systematic relation between quantities of labour and the values of products, it is a result of the circumstance that labour is apportioned to different tasks only in such proportion and degree as its different products are valuable Similar difficulties are encountered in any attempts to find a simple relation between values and "real costs"

Dissatisfied with explanations of values in terms of costs, some economists, taking note of the circumstance that values must necessarily be related to the choices and preferences of consumers, sought to find the determinant of value in marginal utility (*i e*, the utility or importance to the buyer of the least important or "marginal" part of his current consumption of any commodity). Subjective values are proportionate to marginal utilities and exchange values must be proportionate to subjective values. If they were not, the consumer would alter his budget by buying more of one thing and less of another. Each consumer thus adjusts his purchases so as to bring his own valuations into line with the values which obtain in the market, but the values which obtain in the market are the resultants of the aggregate demand of consumers for different products This aggregate demand determines what and how much shall be produced and what the values of different uses of labour and of other productive agents shall be. Such, in brief outline, is the marginal utility theory of value It illuminates some aspects of the problem, but it is quite as one-sided and incomplete as a cost-of-production theory of value is. That consumers' preferences determine what shall be produced and what costs of production shall be incurred is no more true than that the relative costs of producing different things determine how far consumers can follow their preferences.

Displacement Costs.—The costs which are most directly and systematically related to values are displacement costs. Labour displaces other uses of time, saving displaces present consumption, any one use of labour or capital or natural resources displaces other uses, and in general, the production of one good displaces the production of other goods The production of some goods can be increased with a progressively smaller sacrifice of other possible products. Other goods can be had in larger quantities only by sacrificing progressively larger amounts of alternative products As the amounts of a given good which have to be sacrificed in order that other goods may be acquired change, consumers will alter their budgets, but how far they will go will depend upon the relative importance to them of the uses of the increments of goods which they acquire and of the increments which they sacrifice Out of the play of forces such as these, and especially out of the relation between the preferences of consumers on the one hand and the technical conditions which determine the displacement costs of production on the other hand, there emerges a tendency—never fully effective because of continuous changes in the structure of demand and in the conditions of supply—towards the establishing of a system of exchange values which would bring production and consumption fully into equilibrium.

See also ECONOMICS and PRICE. (A. Yo)

VALUE, THEORY OF. Until recently there has been no general theory of value Value has long been a fundamental notion of political economy and various theories of its nature have been developed, but it is only in the last decades that it has been universally recognized as one of the great philosophical topics. Its discovery has been held by some to be "the greatest philosophical achievement of the 19th century," and its development as a special field of psychological and philosophical study has gone so far that a special name has been created for it, namely *Axiology*.

The development of such a theory requires the consideration of the following problems: (1) What is the nature of values? (definition), (2) What are the fundamental values and how are they to be classified? (3) How may we determine the relative values of things and what is the ultimate standard of value? (4) Are values merely subjective, satisfying merely subjective desires, or are they objective, in some sense other than objects of desire, and giving some law or norm to desire? (5) What is the relation of values to things or of value to existence and reality?

The History of the Value Notion.—A brief sketch of the history of the idea of value in philosophy will help to make clear the meaning of these problems The Greeks did not have the term value as now understood, but in the light of subsequent developments we may see that they had the notion, and were aware of these problems Plato conceived the good or value as the culmination of the world of ideas and the constructive principle of the world which organizes all its forms or laws. Aristotle, in proposing to view all things teleologically, and to make the relation of a thing to its end or value essential to its very being, affirmed, not only the objective reality of value qualities, but also their supremacy over all the other attributes of things. Neither Plato nor Aristotle developed this line of reflection fully, nor did succeeding philosophers investigate the subtle and perplexing problems involved in it. Plato himself called this the most difficult question of all science. Nevertheless, the general principle enunciated by Greek philosophy continued to be the rule throughout the middle ages, and the objectivity of value the key to all their thinking.

The modern developments of the subject proceed directly from Kant who here, as elsewhere, represents a crisis in philosophic thought. The classical conception of the objectivity of the good or value had been abandoned by modern empirical thought If the so-called "secondary" qualities, such as colour, taste, sound, etc are made dependent upon the percipient subject, all the more must the "tertiary" qualities, such as beauty, goodness, etc. be made dependent upon human desire and feeling This extrusion of all values from the objective world seemed to Kant to be the necessary consequence of the assumptions of "science." But he could not accept it as the whole story of values By a well-known line of reasoning which cannot be repeated here, he restored their objectivity in a new form. Though not "existent" in the same sense as physical things, their reality must be postulated and acknowledged, if life and action are to be possible They have, in his terms, "validity" and "practical reality." With this an entirely new line of thought was set in motion, raising new problems of fact and value, value and validity, value and existence A large part of modern axiology or general theory of value has developed under the inspiration of Neo-Kantianism. But it is to R. H Lotze (1817–81) more than any other man perhaps except Nietzsche, that the popularity of the term value is due, and certainly he more than any other is responsible for the prevalence of the idea of value as an ultimate notion in philosophy. Albrecht Ritschl (1822–89), Lotze's theological colleague at Göttingen, made the value notion central in the discussions of religion and theology and furnished modernist tendencies in theology with a large part of their inspiration and much of their terminology He agrees with Kant that the objects of religion are objects of faith as distinct from knowledge in the scientific sense, but he develops much further the notion that they are matters of value judgment as distinct from theoretical judgment, although equally capable of certainty and validity. It is mainly to Ritschl that is due the current distinction between judgments of value and judgments of fact, and the subordination of judgments of fact to judgments of value. From Ritschl's position it was easy to pass to that of W Windelband (1848–1915) who, together with H Rickert and Hugo Munsterberg (1863–1916) developed the Neo-Kantian axiology to which reference has been made

The chief stimulus to the development of the general theory of value as a distinct field of psychological and philosophical study, came, however, from the work of A. Meinong (1853–1920) and C von Ehrenfels (1859–1932). A fresh analysis of value in the economic sense had been undertaken by the Austrian economists, Boehm Bauwerk and Von Wieser, which resulted, among other things, in raising many problems of psychological and even philosophical importance. Under their influence, Meinong and Von

Ehrenfels investigated values other than economic, and first undertook a systematic study of the entire field of value. The more philosophical developments of the subject are largely due to Meinong Starting with the psychological concept of the economists he gradually came to the view of values as objective and independent of their being experienced At this point the problems of the two modern movements described tended to coalesce No history of value theory would, however, be complete that did not note the influence of Nietzsche, with his "transvaluation of all values," and the Pragmatic movement in philosophy, for which knowledge is subordinated to practice and truth becomes a form of value

The Nature of Value.—The fundamental problem of a general theory of value is the question of the nature of all determinations of value, in other words of so defining it as to include all the forms of value. The immediate and natural answer to this question is to say that value is a determination or quality of an object which involves *any sort of appreciation or interest*. Such appreciation, however, involves feeling and ultimately desires or tendencies underlying the feeling Therefore value *is* the feeling Value and feeling of value are the same thing This is the psychological notion of value and the theory of value developed on this basis the *psychological theory of value* For many this seems to tell the whole story. The economic theory of value made its first scientific steps by abandoning the notion of value, whether in use or exchange, as an objective quality inherent in the thing, and conceiving it as the function of the relation of the object to satisfaction of desire Following this lead, the general theory of value was in the first place a psychological theory of value. Even in economic theory, however, it is realized that this is only part of the story. Back of desire and feeling lie certain biological tendencies or instincts presupposed by the desire and its satisfaction. So that value becomes, in the words of Orestano, "a biological phenomenon appearing in psychological form." A theory of value that shall be not merely a theory of *price* must relate the *instrumental* values of economics to life. Unless we consider these tendencies merely in their aspect of determinants of price, we must have a quite different notion of value to include them If this is true of the limited field of economic goods or values, it is all the more true of the *intrinsic* values which a more general theory of value recognizes. Psychological theories of value thus tend to become biological theories in the broader sense of the term. Value is defined in terms of survival and enhancement of life, and the biological tendencies are graded according to some standard of value-for-life. It is at this point, however, that the specifically philosophical theories of value arise We wish to explain and ultimately validate these values by carrying them back to life. But in this it is already assumed that life and its continuance have value. If values get their significance from their teleological relation to life and its enhancement, then surely life must get its significance from "absolute" values which it embodies, otherwise life and its relative values lose all genuine meaning. From a more ultimate point of view a knowledge of value is presupposed in any concept of a valuable life. As the result of reflections of this type, two main positions have emerged in the general philosophical theory of value. Either value is conceived of as a "logically primitive" concept, and therefore as ultimately indefinable, as are certain other ultimate concepts in philosophy, or else it is conceived of as function of the coherent organization of life or experience as a whole.

It may be said without hesitation that value theory is to-day predominantly philosophical rather than psychological This does not mean, however, that the psychological study of the processes of valuation is not an important part of the general theory. The psychological question is what goes on in consciousness when we value, and while an answer to this question will neither tell us what value ultimately is, nor afford us a standard of value which will enable us to form a system or scale of values, it nevertheless throws light on many questions. The most important contributions here are, perhaps, the studies of the mutations or transvaluations of values. The popular interest aroused by Nietzsche in his *Genealogy of Morals* has found a scientific echo in the study of the phenomena, causes and laws of the mutations of values.

A notable feature of modern value theory is the interpretation of history as a value science, or part of a philosophy of values.

Classes and Standards of Value.—It is generally admitted that distinct species of value exist, although there is no complete agreement as to what they are or how they are to be classified. It is clear, however, that there are sciences which deal with values and special sciences have been developed to deal with special classes of value. Thus economic value has long been recognized as a fundamental notion of political economy, which ever since Adam Smith divided it into value in use and value in exchange has been defined thus. the former as the utility of objects for human purposes and the latter the power to induce or compel people to pay other valuables for the use of them. That ethics also deals with values is generally agreed, although there is dispute as to just what these values are and how they are related. It is now generally recognized that ethical value is not identical with pleasure or happiness, although pleasure is one of the values Aesthetic values are also generally, although not universally, admitted, many pragmatists holding that, since valuation is always judgmental, and the aesthetic "has no logical function, it must be denied the name of value" From the philosophical standpoint, the most important group of values distinguished is perhaps the logical or theoretical values. Several schools of thought hold that logic is the science of cognitive values and that truth is a positive and error a negative value. Indeed this view is quite generally implied although it is not always explicitly avowed. "Religious values" are quite commonly talked about, although whether they constitute a special group or represent rather a fusion of, or a reaction to, the other values is a matter of dispute It may be argued that they do not constitute a distinct class, because there is no specific biological tendency or instinct to which they correspond, or that they represent merely the reaction on the fate of the other values in the universe. But the tendency to recognize the value of the "holy" as a distinct type, as developed by the Neo-Kantians, is very strong, and has recently found expression in a much read book, *The Holy*, by Rudolf Otto. Some writers speak of distinct classes of social and political values, but the general tendency, perhaps, is to view these as sub-forms of the ethical.

Despite such differences of opinion, incidental to any developing theory, there is substantial agreement as to the existence of these four outstanding classes of values. There is, unfortunately, not the same consensus of opinion regarding their relations, *i.e.*, the ordering of these values in a system or in a scale of relative value and importance There are in general three accepted ways of classifying them. There is the psychological which, assuming values to be the functions of interests or desire, divides them according to modes of this interest and tends to become ultimately biological and genetic, the outstanding classes being connected with some fundamental "instinct" or tendency. A more historical mode of classification accepts as units those values, or groups of values, which have acquired an institutional form, such as economic, moral, cognitive, political, aesthetic, religious. A third, which has been called the axiological, accepts in the main the trinity or tetrad of the good, the beautiful and the true, to which it adds the higher unity of God Such classifications or systems of value all have their uses, but it is generally felt that the first two are not sufficient. A large body of opinion, accepting the "axiological" classification, holds that while the economic values are clearly instrumental and relative to the others, the other groups are intrinsic and absolute, and as such ultimately co-ordinate. Others hold that they may be put in relations of subordination in a comprehensive scale of values. There are, however, some things that may be said with a certain degree of assurance. The ethical, aesthetic and logical values are self-sufficient and co-ordinate in the sense that they are irreducible the one to the other. All attempts at such reduction, whether, for instance, of the aesthetic to the ethical, of the ethical to the logical or the logical to the ethical, have proved unsatisfactory On the other hand, it seems clear that they are all intimately related No intrinsic value can stand alone. This is equally true whether we consider the question from the standpoint of the realization of values in the individual life or from the more objective point of view of their logical relations.

It is impossible to define any one type of value alone or apart from the others The ancient view that values are subsumable under the heads of goodness, beauty and truth, "a threefold cord, not lightly broken," is in general strengthened rather than weakened by modern value theory.

The idea that these ultimate values are co-ordinate in the sense described does not, however, as might at first appear, exclude the notion of an ultimate standard of value in the light of which some hierarchical principle or scale of value might be developed, and the classes of values be subordinated to each other. On the general question of the commensurability of value as such, there is a large measure of agreement. For the opinion, held by a few, that they are incommensurable, there is indeed something to be said. It may be objected that an economic satisfaction and an aesthetic experience are of such different inner qualitative content that it is absurd to compare them with each other The fact remains that we do actually compare them constantly. We compare values not only within the same class, as when we choose one economic good rather than another; we also choose between types and classes. The standpoint of the incommensurability of values can be admitted only in the sense that the different values cannot be expressed in quantitative units and measured in this sense. But there are few that hold this idea at the present day. For the merely psychological or biological theories, the standard of value is found in such conceptions as intensity of feeling, the strength of the desire, or ultimately in the importance for life of the biological tendencies presupposed. For the more philosophical theories, on the other hand, that recognize the limitations of these notions of value, a different conception of the ultimate standard is also necessary In general such a standard is found in the notion of *inclusiveness*, in some functional conception such as the totality of life or experience, that value being highest which contributes most to the coherent functioning and organization of experience as a whole Such a standard may be formulated in terms that seem to avoid metaphysical implications, but in general it may be said that the highness or lowness of an experience of value is held to be determined by its metaphysical content From this point of view a very common table or scale of values is that which puts the economic values as the lowest and the religious (in the broadest sense) as the highest, the ethical, the logical and the aesthetic being arranged in various ways in between The standard here employed is, in the last analysis, some form of the principle of inclusiveness, the different values being arranged either in accord with the degree of integration of our interests or tendencies, or in accord with the range of the metaphysical content to which they correspond

Logical or Theoretical Values—Validity.—The inclusion of logical or theoretical values in the general theory of value is undoubtedly the main reason for the outstanding place which axiology has in present day thought. Such an inclusion obviously involves a radical revision of our entire notion of values and of the relation of value to fact and truth. It is pointed out by the value philosophers that for an ultimate analysis, logic is also a science of values. The Pragmatists insist that theoretical values "presuppose purposes, selections, choices," and that "judgments are acts which do not differ in kind from those which are openly practical." The Neo-Kantian axiologists point out that the desire for truth and rationality, the demand for logical consistency or validity, is itself a craving for what *ought to be* and that here too we are moved by an ideal and directed by a norm, as surely as in the realms of ethical and aesthetic values. In either case validity becomes a form of value and logical rules instruments of the will to truth. The development of this notion involves difficult problems which cannot be gone into here. Whether the "value" of truth is relative or absolute, whether truth is the ultimate value upon which all the others in some way depend, or merely subordinate and instrumental to the other values; or, finally, in some way co-ordinate with them—all these are debated questions which, as we have seen, in turn affect the problems both of classification and order of values. In any case, the notion of validity as a form of value has brought about in many quarters a radical revision of our notion of the relation of value to fact and truth Against purely intellectualistic or "scientific" views it is contended, not only that every fact is ultimately an evaluation, but also that the logical impulse ought not to have the primacy over the other demands of our nature, and that no philosophical system can be adequate which fails to do justice to all our values. Philosophic system tends to become, from this point of view, a system of values, or at least to presuppose such a system.

Value and Reality.—Whatever differences of opinion there may be among the various theories of value, there is substantial agreement that values are not subjective in the sense that they are merely matters of opinion and exist only for the persons who appreciate or feel them Even for the psychological-biological theory, while they are dependent upon interest (desire and feeling), they are independent of judgment and opinion The "objectivity" thus universally accorded values is indeed given different meanings, but in any case it is now generally agreed that values cannot be denied existence or reality in any world that can exist for man. They must, it would seem, exist in several senses

Values "exist" (1) in the sense that they are operative and effective in and on human minds and in human action, and find embodiment in the objective institutions of society. They are "real" in the sense that they are valid, that is they claim to be true ideals as opposed to false ideals or fictions. They must, however, be real in a still more ultimate sense (metaphysical), in that they are part of the nature of things, and not something merely added to existences. For values to be real in either of the first two senses they must be real in the third. For both must be so related to real existence that they constitute the key to the nature of the real Otherwise they become false ideals and futile fictions. The question of just how values may be said to exist (to be part of the nature of things) is a difficult and debated question that cannot be gone into here. It is possible, however, to state a general proposition to which almost all theories of value would subscribe. Values are not mere subjective incidents, more or less gratuitously superadded to fact, but are inherent in the structure of reality Reality in its fullness contains and exhibits values, and they can be extruded from it only by a process of abstraction that is relative to restricted purposes (of special sciences) and which is never quite successful This reinstatement of the objective reality of [illegible] philosophy [illegible] philosophy [illegible] the present [illegible] *Value* (1926). Refs. to the more extensive liter. will be found in an art. by W. M. Urban, written in prep. for the Sixth Inter. Congress of Philosophy, entitled *Value Theory and Aesthetics*, and pub. in the *Monist* for Oct., 1926. Important works in general philosophy in which the value notion is central are Hugo Munsterberg *Eternal Values* (1909); B. Bosanquet *The Principle of Individuality and Value* (1912), and the *Value and Destiny of the Individual* (1913) (rep. the idealistic point of view); S. Alexander *Space, Time and Deity* (rep. the realistic and naturalistic point of view); and W. R. Sorley *Moral Values and the Idea of God* (1919). The Ger. and Fr. lit. is even more extensive Only a few of hist. import and of recent pub. can be noted. Among these are Ch. V. Ehrenfels *System der Wertheorie* (1897); A. Memong *Zur Grundlegung der Allgemenen Wertheorie* (1923); G. Simmel *Philosophie des Geldes* (1900); H Rickert, *System der Philosophie*, 1921; W. Stern *Wertphilosophie* (1924); C. Bergner *La Notion de Valeur* (1908); C Bougle *L'Evolution des Valeurs* (1922). (W. M. U.)

VALVES (MECHANICAL) are devices for controlling the flow of air, gases, or liquids. They vary from the small air-valve in the automobile tyre to huge valves for controling the flow of large volumes of water in such engineering developments as the locks of the Panama Canal.

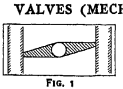


FIG. 1

One of the simplest types is the valve shown in fig 1. This is made in all sizes up to about 10 ft. in diameter in water-pipes and is known as the butterfly-valve. This valve is similar to the

damper used in stove-pipes. Another simple type is the flap-valve which is used as a check-valve in hand-pump pistons, to allow water to pass through the plunger on the down stroke and to prevent its return on the lift stroke. A similar valve (fig. 2) is also used between steam boilers and the pump or other method of supplying the boiler with water. When the water pressure is withdrawn, the steam pressure in the boiler forces the valve to its seat and retains the water in the boiler. In another form of check valve the stem guides the valve to its seat.

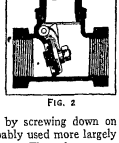


FIG. 2

It is but a step from this to the globe-valve in fig. 3 where the valve is closed by screwing down on the valve stem. This type of valve is probably used more largely than any other in controlling water and steam. The valve seat in fig. 3 is usually separate from the valve stem. In most cases the seat can be easily removed when worn and replaced. In some designs of simple globe-valves, the seat can also be replaced when worn.



FIG. 3

In a later design of globe-valve, which has replaced the valve in fig. 3 to a considerable extent, the valve acts as a gate in the line of flow, and does not compel the liquid or gas to take such a circuitous route as in the globe-valve. Gate-valves are made with both straight and angular seats. When the angular seat is used, the gate acts as a taper wedge between the seats. When the seats are parallel, the wedging action is secured by a tapered piece on the valve stem being forced between the two discs. The valve openings in both types are usually round, as when placed in a pipe line and forming part of it. In exceptional cases, however, the valves are rectangular, as in some of the gates of the intakes of the Panama Canal locks.

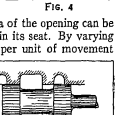


FIG. 4

A valve used largely in high pressure work and for securing fine adjustments of the opening, as in spraying or atomizing, is known as the needle-valve (fig. 4). The area of the opening can be varied very slightly as the needle is moved in its seat. By varying the angle of the needle point, the opening per unit of movement can be varied between wide limits. This type of valve is used in spraying fuel into Diesel engine cylinders.

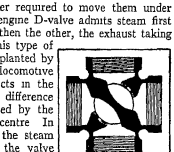


FIG. 5

Valves for admitting steam or gas to engines are either sliding, rotary or poppet. The slide-valve is among the oldest types used for this purpose, but has largely disappeared, owing to the power required to move them under high pressure. The old steam engine D-valve admits steam first to one end of the cylinder and then the other, the exhaust taking place in the central cavity. This type of valve has now been largely supplanted by the piston-valve, particularly in locomotive use. A piston-valve (fig. 5) acts in the same way as the D-valve, the difference being that the valve is balanced by the steam at each end or in the centre. In some cases, the admission of the steam takes place at the centre of the valve and the exhaust from each end.

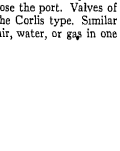


FIG. 6

Rocking- or rotary-valves are also used for similar purposes. Such valves admit steam in one position and block its flow when turned so as to close the port. Valves of this kind were used on steam engines of the Corliss type. Similar valves are also used to direct the flow of air, water, or gas in one or more directions at will. They are frequently known as three-way or four-way valves. A four-way valve is shown in fig. 6. When moved from one position to another, the flow is directed into any of the pipes shown. The simplest form of rotary-valve is the plug cock in fig. 7. (For gasolene engines of the poppet and sleeve types *see* MOTOR CAR, *Valves.*)

Safety-valves, for relieving the pressure of boilers, pressure tanks, or pipe lines, may be said to be check-valves held to their seats by weights or springs set so as to open when the desired blowing-off pressure has been reached. Safety-valves are made in a variety of forms, the older type having a lever with a weight placed at the proper point to give the desired pressure. Loaded valves have springs over the valve seat instead of the lever. (F. H. C.)

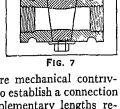


FIG. 7

VALVES or **PISTONS,** in music, are mechanical contrivances applied to wind instruments in order to establish a connection between the main tubing and certain supplementary lengths required for the purpose of lowering the pitch. Various devices have been tried from the days of ancient Greece and Rome to produce this effect, the earliest being the additional tubes inserted into the lateral holes of the aulos and tibia (*qq v.*) in order to prolong the bore and deepen the pitch of each individual hole, these tubes were stopped by the fingers in the same manner as the holes. This device enabled the performer to change the mode or key in which he was playing, just as did the crooks—or coils of tubing inserted between the mouthpiece and the main tube in the trumpet and horn, and between the slide and the bell joint in the trombone—many centuries later.

But the resourcefulness of the ancients did not stop there. The tibiae found at Pompeii had sliding bands of silver, one covering each lateral hole in the pipe; in the band were holes (sometimes one large and one small, probably for semitone and tone) corresponding with those on the pipe. By turning the band the holes could be closed, as by keys, when not required. By fixing the δδοί in the holes of the bands, the bore was lengthened instantly at will, and just as easily shortened again by withdrawing them; this method was more effective than the use of the crooks, and foreshadowed the valves of eighteen centuries later. The crooks, or coils of tubing inserted between the mouthpiece and the main tube in the trumpet and horn, and between the slide and the bell joint in the trombone, formed an important step in this direction.

Although the same principle underlies all these methods, *i.e.*, the lengthening of the main column of air by the addition of other lengths of tubing, the valve itself constitutes a radical difference, for the adjustment of crooks demands time and the use of both hands. The action of the valve being as instantaneous as that of the key, the instrument to which it was applied was at once placed on a different basis, becoming a chromatic instrument capable of the most delicate modulations from key to key.

The slide had already accomplished this desirable result, but as its application was limited to instruments of which the greater part of the bore was cylindrical, *i.e.*, the trumpet and trombone, its influence on concerted musical composition could not be far-reaching. In fact it is doubtful whether the chromatic possibilities of the slide were fully realized until the end of the 18th century, when, key mechanism having made some advance, it was being applied successfully to the transverse flute, and to the clarinet and oboe families.

In 1760 Kölbel, a Bohemian horn-player engaged in the St Petersburg Imperial Orchestra, turned his attention to this method of extending the compass of brass instruments. His experiments, followed up by Anton Weidinger of Vienna at the beginning of the 19th century, produced a trumpet with five keys and a complete chromatic compass. Halliday followed with the keyed bugle in 1810. Halary applied the principle of the keyed bugle to the bass horn in 1817, and produced the ophicleide—an ideal chromatic bass as far as technical possibilities are concerned. The horn had become a chromatic instrument through Hampel's discovery of

bouché sounds, but the defects in intonation and timbre still remained Such were the conditions when the successful application of the valve to brass wind instruments by Heinrich Stolzel of Silesia brought about an entire revolution in the design and construction of these instruments Further efforts to perfect the key system as applied to the brass wind were abandoned in favour of valves, and the short space of two decades witnessed the rise of the Flugel-horns, the tubas, the saxhorns and the cornet-à-pistons, the trombone, French horn and trumpet having led the van

Although the valves of brass wind instruments vary in form and detail according to the makers, the general principles governing their action are the same for all types. The piston, placed on some branch of the main tube, must be so constructed that on being depressed it closes the natural windways through the main bore and opens others into the additional piston length The piston, seated on a spring, instantly regains its normal position when the finger is removed. The length of tubing attached to each valve is calculated on the basis of the length of the main column, to give for the first piston a tone, for the second a semitone, for the third a tone and a half, and for the fourth two tones.

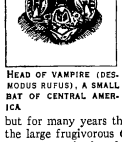
There was, however, a difficulty at first In the early valved instruments it was found that the intonation of the notes yielded by the combined pistons was seriously inaccurate, an increase in the length of the additional tubing being required to give the right results, and it took many years before the instrument-makers succeeded in satisfactorily overcoming this defect and producing the perfected instruments of the present day

Although the accredited inventor and patentee of valves applied to musical instruments was Heinrich Stölzel, of Pless in Silesia, the actual inventor was really one Blumel, also a Silesian, who sold his rights to Stölzel in 1815.

VAMBERY, ARMIN (1832–1913), Hungarian Orientalist and traveller, was born of humble parentage at Duna-Szerdahely, a village on the island of Shütt, in the Danube, on March 19, 1832 He was educated at the village school until the age of 12, and owing to congenital lameness had to walk with crutches. At an early age he showed remarkable aptitude for acquiring languages, but straitened circumstances compelled him to earn his own living After being for a short time apprentice to a ladies' tailor, he became tutor to an innkeeper's son. He next entered the untergymnasium of St Georgen, and proceeded thence to Pressburg Meanwhile he supported himself by teaching on a very small scale, but his progress was such that at 16 he had a good knowledge of Hungarian, Latin, French and German, and was rapidly acquiring English and the Scandinavian languages, and also Russian, Serbian and other Slavonic tongues At the age of 20 he set up as teacher of European languages in Constantinople, and shortly afterwards became a tutor in the house of Pasha Hussein Daim. Under the influence of his friend and instructor, the Mollah Ahmed Effendi, he became, nominally at least, a full Osmanli, and entering the Turkish service, was afterwards secretary to Fuad Pasha After spending six years in Constantinople, where he published a *Turkish-German Dictionary* (1858) and various linguistic works, and where he acquired some 20 Oriental languages and dialects, he visited Tehran; and then, disguised as a dervish, joined a band of pilgrims from Mecca, and spent several months with them in rough and squalid travel through the deserts of Asia. He succeeded in maintaining his disguise, and on arriving at Khiva went safely through two audiences of the khan. Passing Bokhara, they reached Samarkand, where the emir, whose suspicions were aroused, kept him in audience for a full half-hour; but he stood the test so well that the emir was not only pleased with "Resid Effendi" (Vámbéry's assumed name), but gave him handsome presents. He then reluctantly turned back by way of Herat, where he took leave of the dervishes, and returned with a caravan to Tehran, and subsequently, in March 1864, through Trebizond and Erzerúm to Constantinople By the advice of Prokesch-Osten and Eötvös, he paid a visit in the following June to London; there his daring adventures and linguistic triumphs made him the lion of the day In the same year he published his *Travels and Adventures in Central Asia* In connection with this work it must be remembered that Vámbéry could write down but a few furtive notes while with the dervishes, and dared not take a single sketch, but the weird scenes, with their misery and suffering, were so strongly impressed on his memory that his book is convincing by its simplicity, directness and evidence of heroic endurance Vámbéry also called the attention of politicians to the movements of Russia in Central Asia. From London he went to Paris; then returning to Hungary, he was appointed professor of Oriental languages in the University of Budapest. there he settled down, contributing largely to periodicals, and publishing a number of books He died at Budapest on Sept 15, 1913

His travels have been translated into many languages, and his autobiography, *Arminius Vámbéry, his Life and Adventures* (1883; 9th ed., 1914), was written in English. Amongst the best known of his works, besides those alluded to, are *Wanderungs and Adventures in Persia* (1867); *Sketches of Central Asia* (1868), *History of Bokhara* (1873); *Manners in Oriental Countries* (1876); *Primitive Civilization of the Turko-Tatar People* (1879), *Origin of the Magyars* (1882), *The Turkish People* (1885), *Hungary* (1887), with Heilprin, and *Western Culture in Eastern Lands* (1906).

VAMPIRE, a term originally applied to bloodsucking ghosts, now transferred to blood-eating bats inhabiting South America. In its original meaning a vampire is supposed to be the soul of a dead man which quits the dead body at night to suck the blood of living persons. Hence, when the grave is opened, the corpse is found to be fresh. To put a stop to his ravages the commonest method is to drive a stake through the body. The belief in vampires is still prevalent among Slavonic peoples. (*See* also DEMONOLOGY.)



HEAD OF VAMPIRE (DES. MODUS RUFUS), A SMALL BAT OF CENTRAL AMERICA

The blood-eating bats comprise three genera (*Desmodus*, *Diphylla* and *Diaemus*) from the forest of tropical America. Their attacks upon men and warm-blooded animals were noticed by early writers, but for many years the bats themselves were not identified and the large frugivorous *Glossophaga soricana* and *Vampyrus spectrum* were mistaken for the true sanguivorous species. *D. rufus* is the more abundant species; it is a small bat, about 3 in. in length with reddish-brown fur, and peculiar teeth (*see* fig.) adapted to its mode of feeding. They are said to be able to pierce the skin and lap up blood without awakening their victim. The oesophagus is very narrow, as is the pyloric division of the stomach, while the cardiac part is produced into a large diverticulum. *D. ecaudata* is less abundant, confined to Brazil, and differs in the details of the teeth.

VAN. (1) The chief town of a vilayet of the same name in Asiatic Turkey; altitude, 5,400 ft. Pop. (1940) 11,785. It is situated about a mile from the eastern shore of Lake Van, and built along the south side of the citadel rock, an isolated rocky ridge 1,300 yd. long, rising 360 ft. out of a plain which extends up to the sharply defined rocky mass of the Varak range, 8 m distant. On the gently sloping ground east of the citadel are the Gardens, covering an area of 5 m. by 3, and containing several suburbs and detached houses, along central avenues fringed with trees, and having channels of running water by the sides for irrigation.

The town itself is a poor place with flat-roofed mud houses, narrow winding streets, and surrounded by a ruinous mud wall, but it still contains the business quarter, the government offices and the principal bazaars. Water comes from *karez* or underground channels and streams from Varak, fed from the Sikhe Lake, an ancient reservoir which preserves the snow waters on the summit of the mountain For the southern quarter there is the Shemiram Canal, also of very ancient construction, which derives its supply from a large spring 19 m distant, near Meshningird The climate is generally healthy, extremely cold in winter, with 2 to 3 ft. of snow from December to March, while the summer heat is not excessive. The Persian trade of Van has declined, European goods, with which the bazaars are fairly well supplied, come from Trebizond through Erzerum. There is a fair local trade in wheat and agricultural produce, also sheep and cattle, wool, hides and furs for export.

The cuneiform inscriptions of Van are very numerous, the town

having been the capital of the Vannic kingdom of the Assyrian period, for which *see* URARTU

In the sixth century B C. Van passed into the hands of the Persians, and shortly before it fell to Alexander the Great it was rebuilt, according to Armenian historians, by a native prince called Van. In 149 B C Valarsaces or Vagharshag, the first Armenian king of the Arsacidae, rebuilt the town, and a colony of Jews was settled in it by Tigranes (94–56 B C.) In the middle of the 4th century A D it was taken by Sapor (Shapur) II, and became the capital of an autonomous province of the Sassanian Empire, until it fell into the hands of the Arabs (*c* 640), under whom it regained its autonomy About 908 the governor of Van or Vaspuragan was crowned king by the caliph Moktadir, and in 1021 his descendant Senekherim was persuaded by Basil II to exchange his kingdom for the viceroyalty of the Sebasteian theme. After having formed part of the possessions of the Seljuks, Mongols, Tatars and Persians, Van passed in 1514, after the defeat of Shah Ismail by Selim I at the battle of Kalderan, to the Osmanlis, who only occupied the town in 1543 In 1636 it was taken by the Persians, but soon recovered In 1845 the town was held for a time by the Kurd chief Khan Mahmud

(2) The vilayet of Van lies along the Persian frontier between the vilayets of Bayazid and Hekkiari. Pop. (1940) 112,975. The mineral wealth of the vilayet is believed to be great.

(3) LAKE VAN, called Arsissa Palus and also Thospitis from its Armenian names, is roughly rectangular 55 mi long and 40 broad, with a long northeastern arm which increases the greatest length to 80 mi. It stands about 5,260 ft. above sea-level. It is without an outlet, and its greatest depth is along the southern shore. It has constant steady fluctuations, rising and falling some 8 ft in a periodic movement of five years In the middle of the 19th century a sudden rise submerged several places on the banks, including Arjish Kale, and the waters did not subside. The northeastern arm is much shallower than the rest. The water is bitter and undrinkable, being largely impregnated with carbonate and sulphate of soda with some borax The salts are evaporated in pans, and called *perek*, being sold for washing purposes. There is, however, good water along the coast from springs and streams The lake has been navigated from the earliest times, and sailing boats, carrying about 20 tons burden, now ply on it, chiefly with wheat and firewood. Severe storms make navigation dangerous in winter. The southern shore is fringed by a steep range of mountains, with several thriving villages along the coast. The hills have been almost denuded of trees. At the southeastern corner is the island of Akhtamar with its ancient church, erected (*c.* 928) by Gagig, first king of the Ardzrunian dynasty. The Catholicos of Akhtamar was one of the highest offices in the Armenian Church, and dated from 1113 Large numbers of *darekh*, a kind of herring, exist in the lake, and are caught in nets from boats or when they enter the shallow lagoons in the spring and summer. Fresh or salted they form an important article of diet of the poor.

VANADINITE, a mineral consisting of lead chloro-vanadate, $(PbCl)\,Pb_4\,(VO_4)_3$, crystallizing in the hexagonal system and isomorphous with pyromorphite and mimetite (*q.v.*). The crystals are usually six-sided prisms terminated by the basal planes, but are sometimes modified by numerous pyramidal planes which exhibit parallel hemihedrism. Rounded crystals and groups also occur. The colour is usually light brown or yellow, but crystals from Arizona are brilliant scarlet. Owing to isomorphous replacement of the vanadium by phosphorus and arsenic, the specific gravity varies from 6.6 to 7 2; a variety containing much arsenic is called *endlichite*. The mineral is one of secondary formation in veins of lead ore. In New Mexico and Arizona it has been mined as a source of vanadium for the manufacture of vanadium-steel. Several occurrences are known in South Africa.

VANADIUM, a metallic chemical element belonging to a family which also includes columbium (*q v*) and tantalum (*q.v.*). Although one of the rarer elements, vanadium (symbol V, atomic number 23, atomic weight 51), is fairly widely distributed, and since its application in the production of special steels (*see* STEELS, ALLOY), several of its minerals have been extensively exploited.

Occurrence.—Patronite, native vanadium sulphide, which is an important source of the metal, occurs in Peru associated with iron pyrites in coal deposits. Carnotite, potassium uranyl vanadate, $K_2O_2UO_3V_2O_5.3H_2O$, is found in Colorado and Utah and is extensively worked for vanadium, radium and uranium Vanadinite $[Pb_3Pb_3(VO_4)_3]Cl_2$, isomorphous with pyromorphite and mimetite, occurs as deep red crystals in Arizona, New Mexico, South East Africa and Northern Rhodesia Other vanadium minerals are descloizite, a lead zinc vanadate found in New Mexico and Arizona, and roscoelite, a micaceous mineral in which aluminium is partially replaced by vanadium; the latter occurs in Colorado and is an important source of the metal Mottramite, a basic vanadate of lead and copper, is found in Cheshire In addition to these minerals in which it is a major constituent, vanadium occurs in numerous rocks and deposits Many iron ores such as the minette of Lorraine and the German and Swedish iron ores contain as much as 0 3 to 0 7% of vanadium pentoxide

A new metal was first observed in vanadinite by M. Del Rio (1801). Subsequently N G. Sefstrom (1830) isolated its compounds from the slag of Taberg iron and having noticed the beautiful colours which they displayed in solution, he called the new metal vanadium, in allusion to Vanadis, a name sometimes given to Freya, the Scandinavian goddess of beauty. F. Wöhler (1830) showed that vanadium was identical with Del Rio's erythronium and a more extended study of the metal and its compounds was made by J J Berzelius (1831). In 1868 H E Roscoe proved that the supposed vanadium obtained by the earlier investigators was chiefly the nitride or oxide of the element and by a brilliant application of the principle of isomorphism, he showed that vanadium was a member, together with phosphorus and arsenic, of Group V of the periodic classification.

Extraction of Vanadium Oxide from its Minerals.—Patronite is roasted and fused with sodium carbonate, the sodium vanadate thus formed is extracted with water, and the addition of ammonium chloride then precipitates ammonium vanadate On ignition this salt leaves vanadium pentoxide. The vanadium when dissolved as vanadate may also be precipitated as calcium or ferrous vanadate The native vanadates, carnotite, mottramite, etc, are extracted with concentrated hydrochloric acid; the acid extract and washings are evaporated with ammonium chloride, when ammonium metavanadate separates. (For further details of separation consult special treatises indicated in the bibliography.)

Metallic Vanadium.—The metal was first obtained by Roscoe on passing hydrogen over the heated dichloride. It is also prepared by reducing the pentoxide with "mischmetall," a mixture of the rare-earth metals. It has been prepared by the aluminium reduction method from vanadium trioxide and by the electrolysis of sodium vanadate in hydrochloric acid

Vanadium is a silvery white metal with specific gravity 5·5 to 5·89; its melting point is 1,710° C. The fusibility is diminished by the presence of vanadium carbide or oxide. Vanadium is stable in air and is unacted on by bromine water, aqueous alkalis, hydrochloric acid or cold sulphuric acid It is dissolved by hydrofluoric acid or hot sulphur acid to green solutions. Molten potash or potassium nitrate attacks the metal forming potassium vanadate. Its alloy with aluminium containing up to 10% of vanadium is malleable. Cuprovanadium is an alloy employed in copper castings and bronzes

Ferrovanadium.—The greater part—about 90%—of the vanadium extracted is used in form of ferrovanadium alloys containing 25 to 30% of vanadium. Such alloys are produced by the "thermite" process on iron vanadate, by the reduction of this compound with carbon in the electric furnace, or by electrolysis of vanadium pentoxide dissolved either in fused ferrosilicon or in a molten mixture of iron fluoride and calcium carbide. When vanadium is added to steel it effects the removal of oxygen and nitrogen carrying these into the slag, and the portion which remains in the metal increases the tensile strength, toughness and elastic limit of the steel These improvements are effected by comparatively small amounts ranging from 0·05 to 0·5%.

Compounds of Vanadium.—Vanadium salts are used as catalysts in a variety of chemical operations. A trace of vanadic acid accelerates the oxidation of cane sugar by nitric acid (*See* MESOXALIC ACID and OXALIC ACID.) A very small amount of vanadyl sulphate promotes the development of aniline black. Vanadium pentoxide has been utilised as a catalyst in bringing about the combination of sulphur dioxide and oxygen to sulphur trioxide, and in the aerial oxidation of naphthalene to phthalic anhydride, benzene to maleic anhydride and benzoquinone, toluene to benzaldehyde, and anthracene to anthraquinone. Vanadium resinate and linoleate have been employed as driers for linseed oil and other drying oils, the action being more rapid than that induced by lead or manganese salts. Ammonium vanadate has been used in leather dyeing and other vanadium salts have been employed in photography and chemotherapy, where vanadium arsenate and salicylate have produced beneficial effects, the latter as a substitute for salvarsan

Vanadium exhibits five stages of valency, each stage giving rise to characteristic colours. An acid solution of vanadium pentoxide, V_2O_5, is yellow to orange; mild reducing agents convert to the V_2O_4 stage which is characterised by a deep blue colour. Further reduction of $VOCl_2$ leads to a green solution, now containing hydrated trichloride, VCl_3, corresponding with the V_2O_3 stage Drastic reduction gives rise to a lavender solution of VCl_2 corresponding with the VO stage A lower oxide, V_2O, is described but is unimportant.

Vanadium pentoxide, V_2O_5, made by igniting ammonium metavanadate, NH_4VO_3, crystallises in yellowish-red prisms sparingly soluble in water but dissolving in aqueous alkalis to vanadates and in acids to vanadic salts such as $(VO)_2(SO_4)_3$ Metavanadic acid, HVO_3, is obtained as a brown powder by boiling copper vanadate with nitric acid, and when produced from this vanadate by digestion with ammonium chloride it separates in gold spangles known as "vanadium bronze" and employed as a pigment Vanadic acid and its oxide V_2O_5 enter into many complex combinations:—polyvanadates, phosphovanadates, arsenovanadates, molybdovanadates and tungstovanadates Vanadyl chloride, $VOCl_3$, a yellow liquid boiling at 127° C, is prepared by passing chlorine over heated vanadic oxide, but when carbon or sulphur is present vanadium tetrachloride, VCl_4, is also obtained as a reddish-brown liquid boiling at 154° C. Vanadium tetroxide, V_2O_4, is a blue infusible substance obtained by mild reduction of the pentoxide; it dissolves in acids to yield blue vanadyl salts such as $VOSO_4$ and $VOCl_2$ and in aqueous caustic alkalis to brown solutions of the alkali vanadates (also termed hypovanadates); the potassium salt is $K_2V_4O_9{,}7H_2O$.

Vanadium trioxide, V_2O_3, a black infusible powder produced by reducing the heated pentoxide in hydrogen, dissolves slowly in hydrochloric acid to yield vanadium trichloride, the green solution of which is more readily prepared by reducing vanadic oxide with magnesium and hydrochloric acid. Anhydrous vanadium trichloride, VCl_3, prepared by heating vanadium pentoxide in chlorine and sulphur chloride, forms bluish-red crystals resembling anhydrous chromic chloride.

Vanadium trisulphate, $V_2(SO_4)_3$, a crystalline yellow powder, combines with sulphates of ammonium, potassium, rubidium and caesium to form vanadium alums. (*See* ALUM.) Vanadous oxide, VO, a grey powder having metallic lustre and metallic conductivity, is obtained by reducing the higher oxides with potassium. It was erroneously regarded as a metal by Berzelius and shown to be an oxide by Roscoe. The corresponding vanadous chloride, VCl_2, produced by reducing the tetrachloride with hydrogen, forms light green crystals dissolving readily to a lavender solution.

Vanadium acetylacetone, $V\{CH(CO\,CH_3)_2\}_3$, obtained by the interaction of vanadium trichloride, acetylacetone and aqueous sodium carbonate, crystallises from chloroform in dark brown tabular prisms melting at 185–190° C, and on exposure to moist air undergoes oxidation to bluish-green vanadyl acetylacetone, $VO\{CH(CO\,CH_3)_2\}_2$, also prepared by dissolving vanadyl hydroxide, $VO(OH)_2$, in alcoholic acetylacetone (G. T. Morgan and H W. Moss, 1913).

Vanadium forms three sulphides, V_2S_3, V_2S_5 and VS, the most stable of which is the trisulphide. The nitride, VN, produced by direct combination of its constituents, forms a metallic powder formerly confused with the metal itself The carbide, VC, an electric furnace product, forms hard silvery white crystals melting at 2750° C.

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VANADIUM STEEL. The desirability of adding vanadium to certain steels has been known since 1896, but it was too rare to be used until 1905 when a rich deposit was discovered in Peru. Since then many minor localities have been worked, so that while ferrovanadium is still expensive, owing to the difficulty with which it is reduced and refined, there is ample raw material for present use Vanadium has a great chemical affinity for oxygen and nitrogen dissolved in steel; to avoid waste it is only added to deadmelted steel after all other quieting additions have been made Even so, some of it slags off, the residual analysis in engineering alloy steels being usually 0·15 to 0·25% Vanadium forms very stable carbides in steel, reluctant to go into solution when heated above the critical temperature for quenching, and reluctant to accumulate into discrete particles on tempering. The first-mentioned property contributes to the maintenance of fine grain (toughness) over a considerable range of quenching temperatures; the second contributes to strength and toughness at high operating temperatures These actions supplement the characteristic effects of other alloys present

Chromium-vanadium steels are now widely used for axle forgings, chain gears and springs, where strength, hardness, impact and fatigue resistance are a requisite The Society of Automotive Engineers' standards include several alloys with carbon from 0·15 to 0·55%, manganese from 0·50 to 0·80% (even higher with higher carbon), chromium from 0·80 to 1·10% and vanadium from 0·15 to 0·25%. These low alloys will give about the same properties after heat treatment as the nickel-chromium steels (*q v.*). Case-hardened articles made of the lower carbon contents have intense surface hardness and wear resistance; to intensify the skin hardness such steels are frequently quenched from a cyanide bath, and the vanadium is said to prevent the usual embrittlement caused by nitrogen

Carbon-vanadium steels are mostly used in the annealed state for locomotive castings or forgings and are preferred over other alloys which must be heat treated, because subsequent heating at shops unequipped for precise work will not seriously reduce their strength. Locomotive frames of cast steel containing 0·20% vanadium have an elastic limit 25% above that of a similarly annealed plain carbon casting, without any loss in ductility. Locomotive side rods, driving axles and large shafting for electrical machinery or reciprocating engines are frequently forged of carbon-vanadium steels, made in the acid open-hearth furnace Before machining they are usually air cooled from just above the critical range to refine the grain, and then annealed at just below the critical range to relieve all internal strains. (*See* IRON AND STEEL.) (E. E. T.)

VAN BEERS, JAN (1821–1888), Belgian poet, usually called "the elder" to distinguish him from his son, Jan van Beers, the painter, was born at Antwerp on Feb 22, 1821 Van Beers started life as a teacher of Dutch language and literature, first at Malines, then at Lierre, and in 1860 was appointed a professor of both at the Athenaeum (high school) in Antwerp, where he had also been a sub-librarian in the communal library. Van Beers's historical poems, the principal of which is, perhaps, *Jakob Van Maerlant* (Amsterdam, 1860), helped the Flemish revival in Belgium He is best known, however, as the writer of ballads and songs Among the best are *De Blinde* ("Blind"), *De Zieke Jongeling* ("Young and Doomed"), *Bij 't Kerkportaal* ("At the Church Porch"). Van Beers's poetry, full of glow and pathos, simple yet forcible, is somewhat akin to that of Longfellow. In 1884 his poems were collected in a volume, Van Beers died at Antwerp on Nov 14, 1888

VANBRUGH, SIR JOHN (1664–1726), British dramatist and architect, was born in the parish of St Nicolas Acons in the City of London, and christened on Jan 24, 1664 His father was a sugar baker, and his grandfather, Gillis van Brugg, came to England from Ghent in James I's reign The Vanbrughs left London during the Plague and went to Chester. After a few years at the King's School, Chester, John at nineteen was sent to France to study the arts, after two years' absence he returned to take up a commission in the regiment soon to be known as the 13th Foot. In the early autumn of 1690 Vanbrugh was arrested at Calais on a charge of espionage, on the information of a lady He was imprisoned at Vincennes, but on Feb 1, 1692, by a *lettre de cachet*, he was removed to the Bastille. His enforced leisure was responsible for the first draft of the *Provok'd Wife*. For a time after his return he resumed his commission

The production of Cibber's *Love's Last Shift* at the Theatre Royal in January 1696 kindled afresh his attachment to the comic muse. He thought it would be interesting to develop the situation upon which Cibber had rung down the curtain, and the result was *The Relapse*, "got, conceived and born in six weeks' space." It was given on Boxing Day 1696, with Cibber as Foppington, one of the three parts borrowed from the preceding comedy The Sir Novelty Fashion of Cibber was developed in this play into Lord Foppington, who has been pronounced "the best fop ever brought upon the stage." Foppington, Tunbelly Clumsy and Miss Hoyden are as fine a trio of comic characters as any play can show *Aesop* at Drury Lane followed This ran for a week only, but the success of *The Relapse* was so triumphant that Montague, afterwards Lord Halifax, asked at once for the *Provok'd Wife* for the theatre in Lincoln's Inn Fields, and it was produced at that theatre in May 1697. Sir John Brute, the husband, is Vanbrugh's masterpiece, and as usual the servants' characters are well drawn. The play was a complete triumph, and Brute was one of Garrick's great parts Vanbrugh was fiercely attacked by Jeremy Collier for immorality in 1698, and wrote nothing more for the stage until 1700, when an adaptation of the *Pilgrim* of Beaumont and Fletcher was produced at Drury Lane. In this play, in the part of Alinda, Anne Oldfield scored her first success Two years later appeared *The False Friend*, a version of Le Sage's *Traître puni*. Other adaptations from the French were *A Country House*, from Dancourt's *Maison de campagne*; *Confederacy* (1705), from the same author's *Bourgeoises à la mode*; *Squire Trelooby* (1704), a version of Molière's *Monsieur de Pourceaugnac*; and *The Mistake* (1705), from Molière's *Dépit amoureux* As a dramatist Vanbrugh is less polished than Congreve, and less remorseless than Wycherley He was not primarily a man of letters, and, as Cibber said, his dialogue is "common conversation committed to paper." No one would trouble to defend his dramatic morality, but his worst efforts are less repulsive than Wycherley, because there is less ruthless realism and more fun in his attitude. His plays are farce, very often, rather than strict comedy, and warmed with humour

Collier's attack and the resulting movement must have been responsible in part for "Van" turning his attention to architecture. The demand for splendid country seats in the new Palladian style was steadily increasing, and his reputation as a modern wit was an introduction in itself. In 1702 he was entered as comptroller of the Royal Works (now the Board of Works, where several of his designs may still be seen) In 1703 he wrote to ask his friend Jacob Tonson to procure him a "Palladio," and in the same year he was a commissioner at Greenwich In the meantime, Vanbrugh had been appointed architect to the earl of Carlisle, and the result, completed in 1714, was the Corinthian mansion of Castle Howard. The work is an extension of the Palladian plan introduced by Inigo Jones, with the addition of immense corridors in segmental colonnades leading from the main entrance to the wing blocks From a scenic artist's point of view, it is a magnificent (and certainly his best) piece of work. The earl procured for Vanbrugh a high place in the College of Arms. In March 1704 he was actually promoted Clarenceux, though he not only knew nothing of heraldry but had openly ridiculed that grave science in *Aesop*. His next work was to prepare designs for Kneller Hall near Hounslow. But the success of Castle Howard now caused him to entertain the rash project of building a theatre in the Haymarket, from his own design, for the acting of his own plays. Congreve joined in the venture. The magnitude of Vanbrugh's architectural ideas grew as the work went on, and with the ideas the structure grew till a theatre meant for the delicate *bijouterie* work of polite comedy seemed growing to the proportions of the Roman Colosseum. When at length the time came to test the acoustics of the pile, it was found to be sadly defective What changes were made to rectify the errors of structure does not appear The theatre was opened to the public with an Italian opera, which was followed by three of Molière's comedies, and these by the *Confederacy*, Vanbrugh's masterpiece

Vanbrugh at last withdrew from the disastrous speculation; Congreve had already withdrawn But a man to whom Fortune had been so kind as she had been to Vanbrugh could hardly be depressed by any of her passing frowns Queen Anne at once sent him abroad on an important state errand, and afterwards he was commissioned to build Blenheim Upon the merits and demerits of this famous "hollowed quarry" there has been much conflict of opinion Blenheim Palace is probably the largest domestic building in England, and consists of three blocks, the centre containing the private living rooms, one wing the stables, and the other the kitchens and storehouses It is planned on a colossal scale Vanbrugh considered a building and the parts of a building as simply so much material for effect, without regard to their reasonable use and the necessary limitations of design. Personal comfort was sacrificed to perspective. Windows were to adorn the elevation, not to light the interior; and, as Voltaire said, if the rooms had only been as wide as the walls were thick, the château would have been convenient enough. After Blenheim and Castle Howard, his next largest palace was probably Fleurs, near Kelso Blenheim, however, was a source of great sorrow to the kindly dramatist Though parliament had voted for the building of it, no provision had been made for the supplies The queen while she lived paid them, and then Vanbrugh was left to the mercies of the duke of Marlborough, and after this to the insolence of the "wicked woman," who did her best to embitter his life. Besides Castle Howard and Blenheim, he built many other country mansions, such as Grimsthorpe and Duncombe Hall in Yorkshire, Eastbury in Dorsetshire.

In January 1719 Vanbrugh married Henrietta Maria, daughter of Colonel Yarborough of Heslington, and four years afterwards, at the accession of George I, he was knighted. He afterwards wrote again for the stage, and the unfinished fragment of the *Journey to London* (completed by Cibber as *The Provok'd Husband* in 1728) shows that his powers remained to the last as fine as ever. His married life was mostly spent at Blackheath, very probably in "Bastile House" on Maze Hill, repaired in 1904 and now known as Vanbrugh Castle. His wife died there at a great age in 1776, but "Van" himself died on March 26, 1726 in his modest town house in Whitehall. The site is occupied to-day by the War Office The famous epitaph, "Lie heavy on him, earth," is attributed to Abel Evans.

Vanbrugh's works were edited in 2 vols., 1893, by W. C Ward (portraits); *Select Plays* were issued in the Mermaid Series (ed. A E. H. Swaen) in 1896 *See* G. H Lovegrove's *Life, Works and Influence of Sir John Vanbrugh* (1902), Max Daniel's *Vanbrughs Leben und Werke* (1898), and *Swift's Works* (Bohn), xii. 80 sq. *The Complete Works of Sir John Vanbrugh* (Plays and Letters) edited by B Dobree and G Webb (Nonesuch Press, 1928), with introduction by B Dobree

VAN BUREN, MARTIN (1782–1862), 8th president of the United States, was born at Kinderhook, N.Y., on Dec 5, 1782, of Dutch descent. His father was a farmer and tavern-keeper. His education was limited to that which could be obtained in the common schools and at Kinderhook academy. In 1796 he began the study of law, completing his preparation in 1802 at New York, where he studied under William Peter Van Ness (1778–1826), an eminent lawyer and later Aaron Burr's second in the duel with Alexander Hamilton. In 1803 he was admitted to the bar and continued in active and successful practice for 25 years. His prac-

tice made him financially independent, and payed the way for his entrance into politics New York politics after 1800, the year of the election of Jefferson and the downfall of the Federalists, were peculiarly bitter and personal The Republicans were divided into three factions, followers respectively of George Clinton (and later of his nephew, De Witt Clinton), Robert R. Livingston and Aaron Burr, and such Federalist control as there was from time to time after 1799, depended upon coalition with one or other of these groups. Van Buren, who early allied himself with the Clintonians, served as surrogate of Columbia county from 1808 to 1813 In 1812 he entered the State senate, in which his career covered two terms (1812–20). In 1815 he became attorney general, an office which he held, still as a member of the senate, until 1819, when he was displaced to make room for a Federalist He had already, in 1808, removed from Kinderhook to Hudson, and in 1816 he took up his residence in Albany, where he continued to reside until he entered Jackson's cabinet in 1829. As a member of the State senate he supported the War of 1812 He was chosen to draft the resolution of thanks voted by the legislature to Gen Andrew Jackson after the battle of New Orleans He broke with De Witt Clinton in 1813, but nevertheless favoured, in 1817, Clinton's plan for the Erie canal. His attitude towards slavery at the moment was shown by his vote, in Jan. 1820, for a resolution opposing the admission of Missouri as a slave State. It is at this point that Van Buren's connection began with so-called "machine politics," a connection which has made his name odious to some historians of the period. He was a leading member of the "Albany regency," a group of politicians who for more than a generation controlled the politics of New York and powerfully influenced those of the nation, and who did more than any other agency to make the "spoils system" a recognized procedure in national, State and local affairs. Van Buren did not originate the system, for it was already well developed when he entered public life; but the nickname of "Little Magician" which presently attached to him testifies to the skill with which he exploited it.

In 1821 he was elected to the U.S. Senate in which his course was not altogether consistent, though in this respect he is not to be judged more harshly than some of his associates. He at first favoured internal improvements, and in 1824 proposed a constitutional amendment to authorize such undertakings, but the next year took ground against them. He voted for the tariff of 1824, then gradually abandoned the protectionist position. He early recognized the availability of Andrew Jackson, however, as a presidential candidate, and after the election sought to bring the Crawford and Jackson followers together, at the same time strengthening his control as a party leader in the Senate. Always notably courteous in his treatment of opponents, he showed no bitterness either towards J Q Adams or Henry Clay, and voted for Clay's confirmation as secretary of State notwithstanding the "corrupt bargain" charge; at the same time he opposed internal improvements and declined to support the proposal for a Panama Congress. In the debate on the "tariff of abominations" in 1828 he took no part, but voted for the measure in obedience to instructions from the New York legislature—an action which was cited against him as late as the presidential campaign of 1844 Van Buren was not an orator, but his more important speeches show careful preparation and his opinions carried weight; and the oft-repeated charge that he refrained from declaring himself on crucial questions is hardly borne out by an examination of his senatorial career. In 1827 he was re-elected to the Senate and became one of the recognized managers of the Jackson campaign.

In 1828 Van Buren was elected governor of New York for the term beginning Jan 1, 1829, and resigned his seat in the Senate. But on March 5 he was appointed by President Jackson secretary of State and he resigned the governorship. As secretary of State he took care to keep on good terms with the "kitchen cabinet," the group of politicians who acted as Jackson's advisers, and won the lasting regard of Jackson by his courtesies to Mrs. John H. Eaton, wife of the secretary of War, with whom the wives of the cabinet officers had refused to associate. He did not oppose Jackson in the matter of removals from office, but was not himself an active "spoilsman," and protested strongly against the appointment of Samuel Swartwout (1783–1856), who was later a defaulter to a large amount as collector of the port of New York. He skilfully avoided entanglement in the Jackson-Calhoun imbroglio. In the controversy with the Bank of the United States he sided with Jackson After the breach between Jackson and Calhoun, Van Buren was clearly the most prominent candidate for the vice presidency Jackson, in Dec 1829, had already made known his own wish that Van Buren should receive the nomination. In April 1831 Van Buren resigned and in August he was appointed minister to England, arriving in London in September. He was cordially received, but in February learned that his nomination had been rejected by the Senate on Jan. 25. The rejection was in fact the work of Calhoun, the vice president; when the vote was taken enough of the majority refrained from voting to produce a tie and give Calhoun his longed-for "vengeance." No greater impetus than this could have been given to Van Buren's candidacy for the vice presidency In May the Democratic convention, the first held by that party, nominated him for vice president on the Jackson ticket. No platform was adopted, the widespread popularity of Jackson being relied upon to win success at the polls. Van Buren's declarations during the campaign were vague regarding the tariff and unfavourable to the United States bank and to nullification, but he had already somewhat placated the South by denying the right of Congress to abolish slavery in the District of Columbia without the consent of the slave States. In the election he received 189 electoral votes, while Jackson received 219 for president. Jackson now determined to make Van Buren president in 1836. In May 1835 Van Buren was unanimously nominated by the Democratic convention at Baltimore. He expressed himself plainly during the canvass on the questions of slavery and the bank. In the election Van Buren received 170 electoral votes against 73 for William Henry Harrison, his principal opponent; but the popular vote showed a plurality of less than 25,000 in a total vote of about 1,500,000. The election was in fact a victory for Jackson rather than for Van Buren.

The details of Van Buren's administration belong to the history of the United States (*see* UNITED STATES). He took over all but one of Jackson's cabinet, and met with statesmanlike firmness the commercial crisis of 1837 No exhibition of ability or courage, however, nor yet the most skilful manipulation of the political machinery of the party could prevent continued hostility to him and to the methods for which he was widely believed to stand. Nevertheless, he was unanimously renominated by the Democrats in 1840 Charged with being "a Northern man with Southern principles," his nomination obviously failed to arouse enthusiasm or even inspire confidence. Yet the election of Harrison, the Whig candidate, was less of a revolution than many affected to think. On the expiration of his term Van Buren retired to his estate at Kinderhook, but he did not withdraw from politics or cease to be a figure of national importance He confidently expected to be nominated for president in 1844 but in the Democratic convention, though he had a majority of the votes, he did not have the two-thirds which the rule of the convention required, and after eight ballots his name was withdrawn. In 1848 he was again nominated, first by the "Barnburners" faction of the Democrats, then by the Free Soilers, with whom the "Barnburners" coalesced, but no electoral vote was won by the party. In the election of 1860 he voted for the fusion ticket in New York which was opposed to Abraham Lincoln, but he could not approve of President Buchanan's course in dealing with secession, and later supported Lincoln He died in Kinderhook on July 24, 1862. His memoirs, to 1834, were published in 1920 under the title, *The Autobiography of Martin Van Buren*

Van Buren was married in 1807 to Hannah Hoes (1783–1819).

The best biography of Van Buren is by Edward M. Shepard, in the "American Statesmen Series" (rev ed, Boston, 1889). The life by George Bancroft (1889) is highly eulogistic Von Holst's *United States*, MacDonald's *Jacksonian Democracy*, Garrison's *Westward Extension* and T C. Smith's *Parties and Slavery* (the last three in the "American Nation Series") give much attention to Van Buren's public career. The Van Buren mss. are in the Library of Congress *See* also James Schouler, "The Calhoun, Jackson and Van Buren Papers," Mass. Hist Soc. Proc, and ser., vol xvii, p 459–465 (Boston, 1903); "Correspondence Between George Bancroft and Martin Van Buren,"

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VAN BUREN, a city of Arkansas, U.S.A., 5 mi. N.E. of Fort Smith, on the Arkansas river and federal highways 64 and 71; county seat of Crawford county, served by the Frisco and the Missouri Pacific railways. Pop. (1950) 6,413. Van Buren is in the centre of the coal and gas fields of western Arkansas. Its industries include canning, preserving and freezing food. Founded in 1836, it is famous as the birthplace of Cyrus Adler, world-famous Jewish educator, and Bob Burns, radio and motion-picture star. It was incorporated in 1842.

VANCOUVER, GEORGE (*c.* 1757–1798), English navigator, was born in 1757. He entered the navy at the age of 13, and accompanied James Cook in his second (1772–74) and third (1776–80) voyages of discovery. After serving for several years in the West Indies, both under Rodney (his commander in the action of April 12, 1782) and under Alan Gardner (1786–89), Vancouver, on Gardner's recommendation, was appointed to command an expedition to the north-west coast of America, to take over from the Spaniards the territory they had seized (and subsequently relinquished) in that region, to explore the coast from 30° N. round to Cook's River (or Inlet), to search for an eastward passage to the Great Lakes, and to ascertain the true character of Juan de Fuca Strait. Vancouver, accompanied by Lieutenant Broughton, left Falmouth on April 1, 1791, and proceeded by way of the Cape of Good Hope to Australia, where he carefully surveyed part of the south-west coast, especially King George's Sound, whose value as a harbour he pointed out. He next made for Dusky Bay, New Zealand (which he was the first properly to explore), and thence sailing north-east, discovered Oparo islet (27° 36′ S.; 144° 12′ W.), and on Dec. 30 reached Tahiti, where he was again joined by Broughton, who meanwhile had discovered Chatham island.

After staying about three weeks at Tahiti and several weeks at the Hawaiian Islands, Vancouver on April 18, 1792, sighted the west coast of North America (California, then known as New Albion) in 39° 27′ N. He examined the coast up to 52° 18′ N. with minute care, surveying all inlets, discovering the Gulf of Georgia, and circumnavigating Vancouver Island.

After another visit (Feb.–March 1793) to the Hawaiian Islands, in whose races and affairs he took great interest, Vancouver resumed his exploration of the American coast in April, surveying north to 56° N., and south (past the Spanish Californian settlements) to 35° N.

During a fresh stay at the Hawaiian Islands (Jan.–March 1794) Vancouver accepted their submission to Great Britain, but his annexation seems never to have been officially ratified. Quitting the group again in March 1794, Vancouver sailed, by Chernigov Island and Kodiak Island, to Cook's inlet, which was now proved to be no river. After a fresh survey of much of the coast north of San Francisco, Vancouver set out homewards via Cape Horn and St. Helena in Oct. 1794. On the way he made a careful examination of Cape St. Lucas, the southern point of Lower California, the Galapagos Islands and some other points.

Vancouver reached the Thames on Oct. 20, and immediately set about the preparation of his narrative, but he died at Petersham in Surrey on May 10, 1798, before he had completed his task. His brother John, assisted by Captain Puget, published the complete record in 1798.

See *A Voyage of Discovery to the North Pacific Ocean and round the World . . . in 1790–95 . . . under Captain George Vancouver*, 3 vols. (1798), with an atlas of maps and plates

VANCOUVER, British Columbia, third city of Canada and its chief port, situated on the south side of Burrard inlet, had a population of 117,217 in 1921, and of 344,833 in 1931 (including annexations). The climate is equable and mild, July mean temperature 70° F. and January 33°. The growth of the city dates from the coming of the Canadian Pacific railway in 1885, and the increasing Oriental trade and the shipping of wheat to Europe by way of the Panama canal revolutionized the status of the port. In 1948 the tons (register) of shipping entered were 19,922,032 as compared with Montreal 7,226,441. The wheat storage capacity of the port reaches 18,716,500 bu. (Montreal, 15,162,000), and the whole crop of Alberta can be handled. The export trade is particularly active when the Great Lakes ports are closed by ice. Timber, canned and salt fish, flour and apples are other important articles of export. Industrial plants include a number of foundries, fish canning and curing and oil works, shingle, saw, paper and pulp mills, sugar refineries, breweries and shipbuilding yards.

The 35-ft. harbour, controlled after 1935 by the National Harbour board (replacing the local Harbour commission), is one of the finest natural harbours in the world, and at mid-century had 28 piers, 75 miles of railway and 31,436 ft. of berthing. The port is a terminus of the Canadian Pacific and Canadian National railway systems, and of the British Columbia Electric railway company's line.

North Vancouver, on the north shore of Burrard inlet nearly 2 mi. from the centre of the city, had a population of 15,579 in 1951, and is connected by Lion's Gate motor toll bridge and a railway bridge with Vancouver proper. Point Grey, a residential suburb, was annexed to the city, and contains the University of British Columbia, which replaced the British Columbia branch of McGill university. The municipality of West Vancouver adjoins North Vancouver.

Vancouver has an airport located on Sea Island 8 mi. from the city as the terminus of the Trans-Canada main line. (C. Cy.)

VANCOUVER, a city of southwestern Washington, U.S., at the head of deep-water navigation on the Columbia river (there crossed by the interstate highway bridge), 8 mi. N. of Portland, the county seat of Clark county. It is on federal highways 99 and 830; and is served by the Great Northern, the Northern Pacific, the Spokane, Portland and Seattle and the Union Pacific railways, motorbus lines and ocean and river steamers. The population was 41,664 in 1950 and 18,788 in 1940 by the federal census. It is the trading centre for large lumber and plywood operations, and for a diversified agricultural district noted for its prunes, filberts, walnuts, small fruits, poultry and dairy products. Vancouver is also an important grain-shipping point to eastern and foreign markets. It is the power distribution centre for the Bonneville and Coulee power projects. The main substation is located at the northern city limits. It has a large plant for production of aluminum pig. The manufactures are chiefly lumber and lumber products, plywood, paper, dried and canned fruits, aluminum, abrasives, chemicals, fruit juices and syrups, dairy products, furs, logging machinery, malts and cereal products. The state schools for the deaf and the blind are within the city limits. Also within the city boundary is Vancouver barracks, one of the principal U.S. army posts on the coast (established in 1848), and Barnes General hospital.

Vancouver, the oldest city of Washington, was founded in 1825 by John McLoughlin, chief factor of the Hudson's Bay company, who built a stockade (Fort Vancouver) on a site now included in the military reservation, and it was one of the company's important trading posts until 1846, when it was taken over by the United States. The village became the county seat in 1854 and was chartered as a city in 1889.

VANCOUVER ISLAND, the largest of an archipelago of innumerable islands which fringes the Pacific coast of Canada, and the largest island on the west coast of North America. It extends from 48° 20′ to 51° N., and from 123° to 128° 30′ W., and is thus 285 mi. long and from 40 to 80 mi. wide, with an area of about 12,408 sq.mi. It is bounded on the south by the Strait of Juan de Fuca, and is separated from the mainland by the Strait of Georgia and Queen Charlotte sound. The island was made a British crown colony in 1849 (having previously been held under grant by the Hudson's Bay company), and in 1866 it was united with British Columbia, which had become a crown colony

in 1858, the enlarged crown colony of British Columbia entered the Dominion of Canada as a province in 1871 The seat of the provincial government and chief port of Vancouver Island (pop, 1951, 215,003, including a few adjacent small islands) is Victoria (pop, 1951, 51,331). The coast line of Vancouver Island is generally precipitous The west coast is much broken by bays and inlets, which penetrate far inland Among these may be mentioned the Alberni canal, which is 20 mi long, with a fine harbour at its head, and the city of Port Alberni Nootka sound, 6 mi wide, and sending three arms inland, as well as Clayoquot, Esperanza, Kyuquot and Quatsino canals, also penetrate deeply into the island. The general height of the mountain range on Vancouver Island is from 2,000 to 3,000 ft , Victoria peak is 7,095 ft. high

There are extensive beds of coal, especially on the east coast, which are mined at Nanaimo (pop, 1951, 7,196), Comox, Ladysmith and other points, and there are large iron deposits. Copper and manganese are also mined. Vancouver Island is covered with many dense forests, which yield immense supplies of magnificent timber, constituting with the coal field and fisheries the chief resources of the island. There are some level tracts on the south-east coast, as well as in the narrow, well-watered valleys of the interior, which afford excellent agricultural land on which cereals of all kinds, as well as all the fruits of the temperate zone, flourish, and which are also suitable for raising sheep and cattle The climate of Vancouver Island, especially in the south, is wonderfully mild for the latitude. (*See also* BRITISH COLUMBIA.)

VANDALS, a term used by early writers only as a collective designation for a group of Teutonic tribes including, according to Pliny, the Burgundians and the Goths The Vandals as a separate people figure in the earliest legends both of the Goths and the Lombards, and first came into contact with the Romans during the Marcomannic War In the time of Aurelian they invaded Pannonia, and during the reign of Probus we find them fighting in Dacia In the time of Constantine I, according to Jordanes, they suffered a great defeat at the hands of Geberich, king of the Goths, their own king Visimar being killed, and the survivors were allowed by the Romans to settle in Pannonia.

Invasions.—In A D 406 they moved westward, according to some writers at the instigation of Stilicho, who is himself said to have been of Vandal origin, and crossing the Rhine at Mainz proceeded towards Gaul.

Owing to defeat at the hands of the Franks the Vandals could not settle in Gaul and in 409 their king Gunderic led them across the Pyrenees They appear to have settled in Spain in two detachments. One, the Asdingian Vandals, occupied Galicia, the other, the Silingian, Andalusia. The Silingian Vandals were well-nigh exterminated during the next 20 years but their Asdingian brethren marched across Spain and took possession of Andalusia In 428 or 429 the whole nation set sail for Africa, upon an invitation received by their king from Bonifacius, count of Africa, who had fallen into disgrace with the court of Ravenna Gunderic was now dead, and supreme power was in the hands of his bastard brother Gaiseric who was for 50 years the terror of Constantinople and Rome. Probably in the month of May 428, he assembled all his people on the shore of Andalusia, and numbering the males among them from the greybeard down to the newborn infant found them to amount to 80,000 souls. The nation was transported to Africa in ships supplied by Bonifacius Although he soon returned to the Imperial allegiance only three cities of Roman Africa—Carthage, Hippo and Cirta—remained untaken by the Vandals by May 430. At length (Jan 30, 435) peace was made between the emperor Valentinian III. and Gaiseric. The emperor was to retain Carthage and the small but rich proconsular province in which it was situated, while Hippo and the other six provinces of Africa were abandoned to the Vandal. Gaiseric observed this treaty no longer than suited his purpose. On Oct. 19, 439, he suddenly attacked and took Carthage. The Vandal occupation of this great city, the third among the cities of the Roman empire, lasted for 94 years Gaiseric seems to have counted the years of his sovereignty from the date of its capture. Henceforward he made of Carthage a pirate's stronghold, whence he issued forth, like the Barbary pirates of a later day, to attack, as he himself said, "the dwellings of the men with whom God is angry," leaving the question who those men might be to the decision of the elements. Almost alone among the Teutonic invaders of the empire he set himself to form a powerful fleet, and was probably for 30 years the leading maritime power in the Mediterranean Gaiseric's celebrated expedition against Rome (455), undertaken in response to the call of Eudocia, widow of Valentinian, was only the greatest of his marauding exploits He took the city without difficulty, and for 14 days, in a calm and business-like manner, emptied it of all its movable wealth Eudocia and her two daughters were carried into captivity.

Empire and Defeat.—There does not seem to be in the story of the capture of Rome by the Vandals any justification for the charge of wilful and objectless destruction of public buildings which is implied in the word "vandalism" It is probable that this charge grew out of the fierce persecution which was carried on by Gaiseric and his son against the Catholic Christians The bishops were almost universally banished, and the congregations were forbidden to elect their successors, so that the greater part of the churches of Africa remained "widowed" for a whole generation In 476, at the very close of Gaiseric's life, by a treaty concluded with the Eastern emperor, the bishops were permitted to return There was then a short lull in the persecution; but on the death of Gaiseric (477) and the accession of Hunneric it broke out again with greater violence than ever

On the death of Hunneric (484) he was succeeded by his cousin Gunthamund, Gaiseric having established seniority among his own descendants as the law of succession to the throne. Gunthamund (484–96) and his brother Thrasamund (496–523), though Arians, abated some of the rigour of the persecution, and maintained the external credit of the monarchy. On the death of Thrasamund, Hilderic (523–31), the son of Hunneric and Eudocia, at length succeeded to the throne He adhered to the creed of his mother rather than to that of his father; and, in spite of a solemn oath sworn to his predecessor that he would not restore the Catholic churches to their owners, he at once proceeded to do so and to recall the bishops. Hilderic, elderly, Catholic and timid, was very unpopular with his subjects, and after a reign of eight years he was thrust into prison by his cousin Gelimer (531–534).

The wrongs of Hilderic, a Catholic, with the blood of the emperor Theodosius in his veins, afforded to Justinian a long-coveted pretext for overthrowing the Vandal dominion. A great expedition under the command of Belisarius reached Africa in the beginning of Sept. 533 A large force of Vandals was then occupied in Sardinia under Gelimer's brother Tzazo, and the landing of Belisarius was entirely unopposed. He marched rapidly towards Carthage and on Sept 13, defeated Gelimer at Ad Decimum, 10 m. from Carthage. Next day he entered Carthage and ate the feast prepared in Gelimer's palace for its lord Belisarius, however, was too late to save the life of Hilderic, who had been slain by his rival's orders as soon as the news came of the landing of the imperial army. On the return of Tzazo from Sardinia a force was collected considerably larger than the imperial army, but the Vandals were defeated and Gelimer took to flight He took refuge in a mountain fortress called Papua on the Numidian frontier, and there, after enduring great hardships in the squalid dwellings of the Moors, surrendered to his pursuers in March 534. The well-known stories of his laughter when he was introduced to Belisarius, and his chant, "Vanitas vanitatum," when he walked before the triumphal car of his conqueror through the streets of Constantinople, probably point to an intellect disordered by his reverses and hardships. The Vandals who were carried captive to Constantinople were enlisted in five squadrons of cavalry and sent to serve against the Parthians under the title "Justiniani Vandali." Four hundred escaped to Africa and took part in a mutiny of the imperial troops, which was with difficulty quelled by Belisarius (536). After this the Vandals disappeared from history. The overthrow of their kingdom undoubtedly rendered easier the spread of Saracen conquest along the northern shore of Africa in the following century. (F. G. M. B ; T H)

BIBLIOGRAPHY.—Pliny, *Natural History*, iv 99; Tacitus, *Germania*,

cc. 2, 43, Ptolemy, ii, c 11, §§ 18 ff ; Julius Capitolinus, *De Bello Marcomannico*, 17, Vopiscus, *Probus*, 18; Dexippus, *Excerpta*, pp 19 ff (Bonn), and Jordanes, 4, 16, 22, Procopius, *De Bello Vandalico*, a first-rate authority for contemporary events, must be used with caution for the history of the two or three generations before his time The chroniclers Idatius, Prosper and Victor Tunnunensis supply some facts, and for the persecution of the Catholics Victor Vitensis and the *Vita Augustini* of Possidius may be consulted *See* also L Schmidt, *Geschichte der Wandalen* (Leipzig, 1901)

VANDAMME, DOMINIQUE RENÉ, COUNT (1770–1830), French soldier, was born at Cassel, near Dunkirk, on Nov 5, 1770 He enlisted in the army in 1786, served in Martinique in 1788 and on returning to France entered into the Revolutionary movement, raising a company of light infantry. He was promoted and after Hondschoote he was made general of brigade, serving in the Low Countries (1794), on the Rhine (1795) and in Germany (1796) In 1799 he was promoted general of division, and served in Holland, Germany and Switzerland He was a devoted servant of Napoleon. In 1805, for his leadership at Austerlitz, he was given the Grand Eagle of the Legion of Honour, and in 1806–07 he commanded a small corps of the *Grande Armée* which reduced the Silesian fortresses. In 1808 he was made count of Unebourg. In 1809 he served in the Eckmuhl campaign, but in 1812, while commanding the Westphalian contingent he quarrelled with King Jerome Bonaparte and returned to France He returned to the army in 1813, but his corps, sent against the line of retreat of the Allies at the battle of Dresden, surrendered at Kulm (*See* NAPOLEONIC CAMPAIGNS) At the end of the war he was forbidden to enter Paris When Napoleon returned Vandamme joined him and was made a peer of France and placed at the head of the 3rd corps in the army of the north (*See* WATERLOO CAMPAIGN, 1815) The Restoration first imprisoned and then exiled him. He died at Cassel on July 15, 1830

See Du Casse, *Le Général Vandamme et sa correspondance.*

VANDERBILT, CORNELIUS (1794–1877), American capitalist, was born near Stapleton, Staten island, N Y, on May 27, 1794 At the age of 16 he bought a sailboat, in which he carried farm produce and passengers between Staten island and New York, in 1813 carrying supplies to fortifications in New York harbour and the adjacent waters In 1817–29 he was a captain on a steam ferry between New York and New Brunswick. He developed an extensive carrying trade along the coast in a fleet which became so large as to win for him the popular designation of "Commodore." In 1849 he got from the Nicaraguan Government a charter for a route across the isthmus. In 1855–61 he operated a freight and passenger line between New York and Havre. In 1857–62 he sold his steamships and turned his attention to railways In 1857 he became a director, and in 1863 president, of the New York and Harlem Railway

He then acquired a controlling interest in the Hudson River Railway, of which he became president in 1865, and in 1868 he became president of the New York Central (between Albany and Buffalo), which in 1869 he combined with the Hudson River Road, under the name of the New York Central and Hudson River Railroad. His acquisition of the Lake Shore and Michigan Southern Railway in 1873 established a through line between New York and Chicago. At the time of his death (in New York city on Jan. 4, 1877) he controlled the New York Central and Hudson River, the Lake Shore and Michigan Southern, the Harlem, and the Canada Southern railways, and had holdings in many others He endowed Vanderbilt university.

His eldest son, WILLIAM HENRY VANDERBILT (1821–1885), was born in New Brunswick, N.J., on May 8, 1821. He was a clerk in a New York banking house from 1839 to 1842 In 1860 he was appointed receiver of the Staten Island Railway, of which he was elected president in 1862, and which he brought into connection with New York by means of a line of ferry-boats. He became vice president of the Hudson River Railway in 1865, vice president of the New York Central and Hudson River Railroad in 1869, and president in June 1877, succeeding his father as president of the Lake Shore and Michigan Southern, the Canada Southern, and the Michigan Central railways. He died in New York city on Dec. 8, 1885.

William Henry's eldest son, CORNELIUS (1843–1899), became assistant treasurer of the Harlem Railway in 1865, and treasurer in 1867; in 1877, after the death of his grandfather, he was elected first vice president of the New York Central, and in 1878 became treasurer of the Michigan Central and vice president and treasurer of the Canada Southern In 1883 he became chairman of the boards of directors of those two systems

See W A Croffut, *The Vanderbilts and the Story of their Fortune* (Chicago, Ill , 1886), D W Cross, "The Railroad Man of America," in *Magazine of Western History*, vol viii (Cleveland, Ohio, 1888), and Burton J Hendrick, "The Vanderbilt Fortune," in *McClure's Magazine*, vol xxxii (1908–1909).

VANDERGRIFT, a borough of Westmoreland county, Pennsylvania, U S A , on the Kiskimminetas river and the Pennsylvania railroad, 30 mi. N E of Pittsburgh. Pop (1950) 9,581 and 10,725 in 1940 It is in a farming and coal-mining region, which also has gas wells; and the borough manufactures sheet steel, steel castings and other commodities

VANDERLYN, JOHN (1776–1852), American artist, was born in Kingston, N Y., on Oct. 15, 1776 He was employed by a print-seller in New York, and was first instructed in art by Archibald Robinson (1765–1835), a Scotsman who was afterwards one of the directors of the American Academy He copied some of Gilbert Stuart's portraits, including one of Aaron Burr, who placed him under Gilbert Stuart as a pupil In 1796 Vanderlyn went to Paris, and in 1805 to Rome, where he painted his picture of "Marius amid the Ruins of Carthage," which was shown in Paris, and obtained a gold medal there This success caused him to remain in Paris for seven years, during which time he prospered greatly In 1812 he showed a nude "Ariadne" (engraved by Durand, and now in the Pennsylvania Academy), which increased his fame. When Aaron Burr fled to Paris, Vanderlyn was for a time his only support. Vanderlyn returned to America in 1815, but did not meet with success; he worked very slowly, and neither his portraits nor various panorama which he exhibited brought him any considerable financial return. In 1842, through friendly influences, he was commissioned by Congress to paint "The Landing of Columbus" for one of the panels in the rotunda of the Capitol at Washington Going to Paris, he employed to assist him a French artist, who, it is said, did most of the work. He died at Kingston, N Y , on Sept 23, 1852.

VAN DER STAPPEN, CHARLES (1843–1910), Belgian sculptor, was born in Brussels, September 1843 His first contribution to the Brussels Salon was "The Faun's Toilet" of 1869, and after this he soon became recognized as the leader, along with Paul de Vigne, of the new Belgian school of sculpture which, while remaining true to life, drew inspiration from Greek art and the Italian renaissance. Examples of Van der Stappen's decorative sculpture are seen in the decoration on the Palais des Postes, Brussels (1872), the pediment "Orchestration" for the Conservatoire de Musique, and the noble bronze group, "The Teaching of Art," on the façade of the Palace of Fine Arts, Brussels. He also executed the statues for the Alhambra Theatre and the caryatides for the house of the architect M. de Curté (1874). His best-known monuments are those to "Alexandre Gendebien" (1874) and "Baron Coppens," at Sheel (1875).

See *Charles van der Stappen*, by Camille Lemonnier; *Les Artistes belges contemporains* (1896) by E L de Taeye; *The Renaissance of Sculpture in Belgium*, by O. G. Destrée (London, 1895), *Charles van der Stappen*, by A. Goffin (1911).

VANDERVELDE, EMILE (1866–1938), Belgian statesman, was born on Jan 25, 1866 at Ixelles near Brussels. He studied law at Brussels university and in 1885 took his doctorate in social science. In the following year he joined the Belgian Labour Party and soon became its acknowledged leader. He first entered parliament in 1894 as Socialist member for the Charleroi constituency, but after 1900 was returned continuously by Brussels In the chamber he achieved both influence and prestige and played a prominent part in the struggle to attain universal suffrage, a struggle which resulted in more than one national general strike. On the outbreak of World War I, Vandervelde devoted himself to the problems of national defence, the liberation of his invaded country, and in Aug. 1914 was summoned to join the Government

as minister of state, later becoming member of the cabinet. At the time of peace negotiations and the signing of the Versailles treaty, he used his influence to obtain the insertion of labour clauses, relating especially to the eight-hour day As minister of justice in the Liberal-Catholic-Socialist cabinet formed after the war, Vandervelde effected great humanitarian and scientific reforms in the prison system. After the important successes achieved by the Labour party in the general elections of 1925 he entered the Socialist-Catholic coalition cabinet as minister for foreign affairs and played an important part in negotiating the Locarno pact in 1925, which he signed on behalf of Belgium. He retained the portfolio of foreign affairs in Jaspar's ministry of "national unity" He came to be regarded abroad as well as in Belgium as essential in Belgian foreign policy, partly because of his success at Locarno and the high esteem in which he was held by his foreign colleagues at Geneva. But he was constantly subjected to criticism because of his genuine internationalism, and early in 1927 he had some difficulty in soothing his non-Socialist critics In internal politics he fought for a reduction of the term of military service to six months and thorough reorganization of the army system This attitude of the Socialist members of the Jaspar cabinet was the immediate cause of its fall. Vandervelde was minister without portfolio, 1935–36, and minister of public health, 1936–37.

Considered by some to be the most powerful Socialist orator in the French language since Jaurès, Vandervelde played a very conspicuous role in all the international Socialist congresses after the beginning of the 20th century. In 1924 he was made professor of political economy at the University of Brussels.

Bibliography.—Among his works are *Le socialisme en Belgique*, with J Destrée (1898), *Le collectivisme et l'évolution industrielle* (1900, trans by R P Farley, 1907); *Essais sur la question agraire en Belgique* (1902); *La Belgique et le Congo* (1911); *La grève générale en Belgique, avril 1913* (1914), *Le socialisme contre l'état* (1918), *Réalisations socialistes* (1923); *Le parti ouvrier belge, 1885–1925* (1925)

VAN DE VELDE or Vandevelde, name of a family of Dutch artists active during the 17th century. The most notable members were:

Adrian van de Velde (1636–1672), landscape and animal painter, born at Amsterdam in Nov. 1636. He was a son of Willem van de Velde I (*see* below) He was trained in the studio of Jan Wynants, where he made the acquaintance of Philip Wouwerman, who seems to have helped him with his studies of animals He was employed by his master to introduce figures into his landscapes, and he rendered a similar service to Hobbema, Ruysdael, Verboom and others His favourite subjects are scenes of open pasture land with sheep, cattle and goats, admirably drawn and with clear, silvery colouring. He also painted a few excellent winter scenes with skaters, and executed a Passion series for the Spinhuiskerk at Amsterdam (now in the parsonage of the Augustinian church "De Ster"). In addition to his paintings, of which De Groot catalogued 387, he made about 30 etchings, they are distinguished by a pleasing tonality and by delicacy and certainty of touch. He died at Amsterdam on Jan. 21, 1672.

Jan van de Velde II (1593–after 1641), an engraver who excelled in portraiture, genre and biblical scenes, and views of towns and landscapes. There are 429 engravings by him extant. He was a brother of Willem van de Velde I (*see* below).

Willem van de Velde I (1611–1693), a celebrated draftsman of ships, born at Leyden. He was employed by the Dutch government to depict sea fights, and for that purpose accompanied the Dutch fleet during the war with England He went to England in 1672 with his son, Willem van de Velde II (1633–1707), a native of Amsterdam, and pupil of his father and of the marine painter Simon de Vlieger. Both artists were employed by Charles II, and afterward by James II, at a salary of £100 each "for taking and making draughts of sea-fights," the son's part being to reproduce in colour the drawings of the father. Willem the elder died at Greenwich in 1693. His epitaph in St. James's church records that he was "a painter of sea-fights to their Majesties." Willem the younger was made court painter in 1677. His first works represent views off the coast of Holland, with Dutch shipping. He died in London on April 6, 1707.

VAN DE VELDE, HENRY CLEMENS (1863–), Belgian architect, was born at Antwerp on April 3, 1863, and studied at the Antwerp academy, under the painter Charles Verlat and in Paris under Carolus Duran He turned to applied art about 1891–93 after "discovering" William Morris and the English arts and crafts movement. The furniture he designed for his own house at Uccle, near Brussels (1894–95), though exhibiting *art nouveau* forms, had its structure clearly emphasized by "directional" ornament, the interior was an early example of the tendency to dispense with strict room partition The four rooms he designed for the Paris art galleries of S Bing in 1896 profoundly influenced French design From 1902 to 1914 Van de Velde was director of the Weimar Kunstgewerbliches Institut, for which he designed a new building in 1906 He later became connected with the *Deutsche Werkbund* and in 1914 designed the theatre at the *Werkbund's* Cologne exhibition. He was director of the Brussels Institute des Arts Decoratifs, 1926–43, and professor at Ghent university, 1926–36, of whose library he was associate architect (1938). He supervised restoration work for the Belgian government after World War II

VAN DOREN, CARL CLINTON (1885–1950), U.S author, editor and critic, was born on a farm near Hope, Ill , Sept. 10, 1885 He graduated from the University of Illinois in 1907 and received his Ph D from Columbia university in 1911. His first book, a biography of Thomas Love Peacock, was also published in 1911. He taught English at Columbia from 1911 to 1930. From 1917 to 1921 he was managing editor of the *Cambridge History of American Literature*.

From 1919 to 1922 he was literary editor of the *Nation*, and from 1922 to 1925 literary editor of *Century Magazine*.

His writings ranged through surveys of literature to novels, biography and criticism. In 1939 he received a Pulitzer prize for his biography *Benjamin Franklin* (1938) His works included *The American Novel* (1921, revised 1940), *Contemporary American Novelists* (1922), *American and British Literature since 1890* (1925), in collaboration with his brother, Mark Van Doren, and revised in 1939; *American Literature. An Introduction* (1933), reissued as *What Is American Literature?* (1935). Some of his other important works were *James Branch Cabell* (1925); *Swift* (1930), *Sinclair Lewis* (1933); and his autobiography, *Three Worlds* (1936).

VAN DYCK, SIR ANTHONY (1599–1641), Flemish painter, was born in Antwerp on March 22, 1599 Though the name of Van Dyck is frequently met with in the list of Antwerp painters, Anthony's pedigree cannot be traced beyond his grandparents, who were silk mercers of some standing He was the seventh of 12 children of Frans van Dyck, an Antwerp merchant.

The boy was little over ten when he was apprenticed to Hendrick van Balen, the painter of many delicate little pictures and the master of Snyders. From a document in the state paper office at Brussels, relating to a lawsuit between a picture dealer and an Antwerp churchman, which arose out of the sale, in 1660, of a series of Apostles' heads ascribed to Van Dyck, it appears that, as far back as 1615, Van Dyck had worked independently, with pupils of his own, and that his pictures were valued by artists and amateurs.

Early Works.—Before he was 19 (Feb. 1618) Van Dyck became a full member of the Antwerp guild of painters,' and some idea of his ability at the time may be gained from the excellent portraits of an old lady and gentleman, formerly ascribed to Rubens, in the Dresden gallery But the same admiration cannot be accorded to the earliest religious composition known to have been painted by him, "Christ Falling under the Cross," in St. Paul's at Antwerp. At first sight it seems also that with him, as with most other Flemish painters of the period, every conception, whether sacred or profane, needed to be cast in the mould of Rubens. It would be too much, however, to assert that Van Dyck at this time stood under the guidance of that master, their association, indeed, does not seem to have begun until 1619, and Bellori (1672), who got his information from Sir Kenelm Digby, Van Dyck's bosom friend, related that he was first employed in making drawings (probably also chiaroscuros) for the use of the great master's engravers, and that

among works of the kind one of the first was the "Battle of the Amazons" (1619).

In 1620 Van Dyck was working with Rubens, for on March 20, in making arrangements with the Antwerp Jesuits for the decoration of their church, the master is allowed to avail himself of his pupil's assistance, and obtains for him the promise of a picture. Van Dyck left for England in the autumn of 1620. There is evidence in the order books of the exchequer of Van Dyck's presence in London till the end of February 1621 What Van Dyck did in London is not known That he was at the time a portrait painter of the rarest merit may easily be seen from the portrait of "Van der Geest" in the National Gallery (London), and from his own likenesses of himself when still quite young and beardless, in the National Gallery, in the Pinakothek at Munich and, as Paris, in the Wallace Collection.

Residence in Italy.—Van Dyck's next journey was to Italy. He left Antwerp on Oct. 3, 1621, and arrived at Genoa on Nov. 21. Though Van Dyck unquestionably first became acquainted with the masterpieces of the great Venetian colourists in Rubens's *atelier*, most of the pictures which were formerly ascribed to his earliest period probably date from the years of his Italian journey. In fact, studies for some of them can be found in the Chatsworth sketch-book. Among these early works are the "Martyrdom of St Peter" (Brussels), the "Crowning with Thorns" (Berlin), and the "Betrayal of Christ" (Madrid, a replica formerly Lord Methuen's is now in America). A sketch of the same subject is at Doughty House, Richmond.), "St. Martin dividing his Cloak" (Windsor Castle),—a magnificent production On a reduced scale, and with the omission of two or three figures, the "St. Martin" at Saventhem church is a reproduction of the picture at Windsor Castle

With the exception of a short visit to Antwerp at the time of his father's death in 1622, Van Dyck spent the next five years in Italy. There can be no doubt as to the great influence exerted by the works of Titian, Paul Veronese and other masters of the Venetian school in the development of his genius, still the individuality of the painter remains a striking feature of what may be termed his Italian works, especially portraits Their peculiar character seems to originate even more in the stateliness of his sitters than in any desire to follow individual predilection or prevailing fashion. It is difficult to trace with certainty the course of the artist's travels in Italy. He made a prolonged stay at Venice; at Rome, he resided with Cardinal Guido Bentivoglio, who had been papal nuncio in Flanders from 1607 to 1617. For this patron were painted several important works, the most renowned being the prelate's own portrait, now in the Pitti Palace at Florence Another work was a "Crucifixion" spoken of by Bellori —but which cannot be identified with certainty among the many replicas of the subject existing at Antwerp, Genoa, Vienna and Munich. He also painted religious subjects and portraits, such as the portrait of Duquesnoy, better known as Fiammingo, the famous sculptor, and those of Sir Robert Shirley and his wife, in Persian attire. In the company of Lady Arundel he travelled to Turin, but he was eager to reach Genoa; here he probably painted the portraits of Luke and Cornelis de Wael, now in the Pinacoteca Capitolina at Rome (a monochrome replica at Cassel). Genoa can still boast of a good number of his most attractive productions, portraits of the beautiful ladies and haughty cavaliers of the noble houses of Doria, Brignole Sale, Pallavicini, Balbi, Cattaneo, Spinola, Lommelini and Grimaldi It would scarcely be possible to speak too highly of such works as the portrait of the lady in white satin and the Durazzo children at the Durazzo Palace, the Balbi children from Panshanger now lent to the National Gallery, the Marchesa Balbi, formerly at Dorchester House, the equally beautiful portraits of the Lommelini and of the knight in black armour, buff jacket and boots in the Scottish National Gallery at Edinburgh, or the Marchesa Brignole Sale (Warwick Castle). Van Dyck's Genoese portraits are remarkable for their richness of tonality and what might be called royal splendour, perhaps never before attained in works of the kind. This we may suppose to have had its origin, not only in his recent study of Titian, but also in decorative necessities—the size of the palatial galleries and the rich hues of the Genoese velvets, on which these portraits were to find their place, obliging the painter to find a most uncommon strength of contrast. In Italy, more over, he found those gorgeous backgrounds—flowing draperies, beautiful gardens, ornamental pillars, marble terraces and balustrades—which elsewhere must be regarded as fictions merely Here, finally, he was called upon to paint some of his grandest equestrian portraits, and the often recurring grey steed with flowing mane (an admirable study of which belongs to Lord Brownlow) was first employed for the portrait of Antonio Giulio Brignole (still at Genoa). As with Rubens, Titian seems to have been paramount in Van Dyck's regard. We know he possessed copies of the master's best works, and several little sketches in the British Museum and in the Chatsworth sketch-book bear proof of his devout study of the great Venetian Some of Van Dyck's earlier paintings, religious and mythological—the "Tribute Money" (Palazzo Bianco), "Holy Family" (Turin), "Virgin and Saints" (Louvre), "Virgin" (Grosvenor House), are certainly Titianesque in the extreme.

In 1624 Van Dyck sailed from Genoa to Palermo and there painted several persons of rank, including the viceroy, Emmanuel Philibert of Savoy. While in Sicily he became acquainted with the painter Sofonisba Anguisciola (or Angussola), who was then ninety-six years of age and blind; and he was wont to say that he had received more valuable information from a blind woman than from many a seeing man. There is a "Virgin and Child" by Van Dyck at S. Caterina in Palermo, and a "Virgin and Child with Saints" in the same city. Bellori tells us that plague compelled him to leave abruptly, taking with him an unfinished picture of St Rosalia, completed in Genoa. The composition was repeated in Antwerp for the Bachelor's Brotherhood, a picture now in Vienna Van Dyck most probably remained in Genoa till 1626, and here in all likelihood he painted the De Jodes, father and son, the celebrated engravers, who are represented together in a masterly portrait in the Capitol at Rome

Traversing the Mont Cenis pass, Van Dyck stopped at Aix with Peiresc, the famous scholar and friend of Rubens, and probably proceeded straight to Antwerp. His beautiful portrait of Langlois, the Paris print-seller, from which it was conjectured that he spent some time at Paris, was unquestionably painted in Genoa By March 3, 1628 he was back at Antwerp. One of his sisters had died in a convent the year before, and he now made a will in favour of Susan and Isabella, two other sisters, also nuns That Van Dyck was in Antwerp on May 18, is proved by a letter from Lord Carlisle to Buckingham (Sainsbury, cili).

The Antwerp Period.—Great as may have been the strength of Italian reminiscence, from the moment Van Dyck again trod Flemish soil the influence of Rubens became predominant Among the earliest works after his return to Antwerp is the "Crucifixion," given to the Dominican nuns, in accordance with the wish expressed by the painter's dying father, and now in the Antwerp museum. The figures are life-size, and at the foot of the cross, besides a weeping angel, are St. Catherine of Siena and St Dominic Neither in type nor in general effect does it suggest the master's immediately preceding works. As a new feature we observe a kind of elegance, not entirely free from mannerism, which is often conspicuous with Van Dyck even when the technical excellence commands our warmest admiration Inspiration was far more limited with Van Dyck than with Rubens. His delicate nature led him to restrain his conceptions within the bounds of an academic evenness. To Van Dyck's second—more justly speaking third—manner belong some of his best religious works. The "Crucifixion" in the cathedral at Mechlin is termed by Sir Joshua Reynolds one of the finest pictures in the world. Still finer are the two works painted for the Antwerp Jesuits and now at Vienna—"The Mystic Marriage of the Blessed Herman Joseph" and "St. Rosalia Crowned by the Infant Saviour." To this period likewise belong the celebrated "Elevation of the Cross" at Courtrai and the "St. Augustine in Ecstacy," in the church of the Jesuits at Antwerp; the general effect of this last, according to Reynolds, is inferior to that of the beautiful engraving by De Jode, and also to the earl of Northbrook's mag

nificent sketch. Van Dyck's Flemish portraits indicate, technically speaking, a further step towards perfection. The darkness of the Genoese portraits has vanished, broad daylight now freely illuminates the model, and such works as the portraits of Francisco de Moncada (Louvre) and of the Count de Bergh (Prado) are perhaps as close to material excellence as any painting could be. The full-length likenesses of Philip Le Roy (1630) and his wife (1631) (Wallace Collection) and of Mary Louisa of Tassis (Prince Liechtenstein, Vienna) deserve to rank among the most beautiful portraits ever painted. The "Snyders" at Castle Howard is regarded by Waagen as not inferior to the most celebrated Raphaels, Titians or Holbeins; and of almost equal excellence are the "Wife of Colin de Nole" in the Munich gallery, the "Lady and her Daughter" at the Louvre, and the "Lady in Black" at Cassel

Rapidly rising to honour and wealth, Van Dyck shared with Rubens the official title of court painter, and he painted numerous portraits of the infanta in her monastic garb (Paris, Vienna, Turin, Parma, etc.). When Marie de Medici fled from France to Brussels (1631), she several times commissioned Van Dyck to paint her likeness, as well as those of Gaston of Orleans and his wife Margaret of Lorraine, and several of the personages of their court. From Gerbier's letters we learn that Van Dyck at this time was contemplating a journey to England, and desired commissions from the infanta and the queen of France to take over their portraits as presents for the king and royal family He soon travelled to The Hague to paint the prince and princess of Orange and their son. Early in 1632 Constantine Huygens, who was then living at The Hague, inscribes in his diary, "pingor a Van Dyckio." When, in March, Van Dyck sailed for England, he took these portraits with him.

Settles in London.—Gerbier's letters show that the king had personally desired his presence in London. As early as March 1629 Endymion Porter had been commissioned to order a picture from Van Dyck, "Rinaldo and Armida." The canvas, now belonging to the duke of Newcastle, is one of the master's finest creations Besides the title of painter in ordinary, and an annual pension of £200, he received a knighthood (July 5, 1632). He rapidly achieved popularity, and, as Walpole says, his works are so frequent in England that to most Englishmen it is difficult to avoid thinking of him as their countryman.

Few artists, whether in England or elsewhere, have more richly endowed their models with distinction of feature and elegance in bearing. Charles I. and Henrietta Maria, although pictured by several other painters, are known to posterity almost exclusively through Van Dyck, because of a particular power of expression and bearing which, once seen, it is impossible to forget. The artist was given a summer residence at Eltham Palace, and was frequently visited by the king at his studio at Blackfriars. Portraits now followed each other with great rapidity His mode of living and his love of pleasure sufficiently explain his great need of money. During his first year in England he painted the king and queen a dozen times. The first of these noble portraits is the admirable full-length of Charles I, with the queen and their two eldest children, at Windsor Castle. The style he adopted in England is generally termed his third manner; we might better say his fourth, as he already had a very particular style before he set out on his Italian journey. De Piles gives us some account of Van Dyck's methods at this period of his career He began with a small sketch on grey paper with black and white chalks, or a monochrome in oils. This study was passed on to assistants in order to be copied on the required scale. When the clothes were sufficiently advanced by the pupils from those sent by the model, as well as the background and accessories, the master was enabled in a few sittings of an hour each to complete the work. Van Dyck excelled in painting the hands; he is said to have kept special models for this part of his work. It need hardly be said that a system of this kind, although employed by Rubens for his larger creations, was exceedingly ill adapted to portrait painting. In Van Dyck's later productions we too often detect marks of haste, as if the brush were becoming a mere implement of trade.

Visit to the Netherlands.—Nearly the whole of 1634 and 1635 were spent by Van Dyck in the Netherlands, whence his brother, an Antwerp priest, had been called over by the queen to act as her chaplain. The archduchess died Dec. 1, 1633, and Van Dyck wished to get his official title renewed by her successor, Ferdinand of Austria, brother of Philip IV. On the arrival of the new governor Van Dyck was immediately called upon to paint his likeness (Madrid gallery). Another portrait of Ferdinand on horseback belongs to Mr Mainwaring, Oteley Park, Shropshire. The most important of Van Dyck's works, at any rate as a portrait painter, belong to this period. The picture representing in life-size the members of the Brussels corporation, which was destroyed by fire during the siege of 1695, is spoken of with intense admiration by several writers Bullart, for instance, is very enthusiastic about its fine colour and life-like qualities. Among the religious paintings of undisputed excellence belonging to the same period are the "Adoration of the Shepherds" in the church at Termonde, and the "Deposition," where the body of Christ rests upon the lap of the Virgin, in the Antwerp museum Among the portraits are the admirable full-length of Scaglia, the king's frequent agent in the Netherlands (formerly at Dorchester House), the equestrian portrait of Albert of Arenberg (Holkham Hall), and a portrait of the same nobleman on foot, in the black velvet Spanish dress with golden chamberlain's key (Althorp), an admirable half-length of a lady in black (Vienna gallery), and above all the grandiose picture in which John of Nassau is represented at full-length, with his wife and children.

Returns to London.—After being chosen honorary president of the Antwerp gild of St. Luke, Van Dyck returned to London before the end of 1635 In spite of the vast number of his later portraits, some of them deserve to be ranked among the most celebrated of his productions The group of three English royal children in the gallery at Turin (1635), the portraits of Charles I. in the Louvre and in the National Gallery, London, the picture of the Pembroke family at Wilton House, Sir George and Sir Francis Villiers at Windsor and in the National Gallery and the earls of Bristol and Bedford, at Althorp, all belong to the years following the master's return from the Netherlands.

He married, about the end of 1639, Lady Mary Ruthven, daughter of Sir Patrick Ruthven and granddaughter of the earl of Gowrie. There are several portraits of her by her husband, the most important being in the Munich gallery, in which she is represented in white satin, playing on the violoncello There is a capital engraving of her by Bolswert. In another picture (J. C. Harford, London) a handsome lady said to be Mary Ruthven, is represented as "Herminia Putting on Clarinda's Armour." There can be no doubt as to the model having been Margaret Lemon, a celebrated beauty, whose portrait was engraved by W. Hollar and J. Morin and painted by Van Dyck at Hampton Court. She was the most beautiful and celebrated, though far from being the only mistress of Van Dyck.

When the news of Rubens's death reached London (June 1640) Van Dyck contemplated a return to his native country, and a letter from Ferdinand of Austria to Philip IV. speaks of his intended journey to Antwerp on St. Luke's Day (Oct. 18) Rubens had left unfinished a series of paintings commanded by the king of Spain, and Van Dyck had been thought of to give them the finishing touch But he refused. It was then agreed that he should paint an independent canvas destined to complete the series Whether Van Dyck found it possible to work during his short stay in the Netherlands is doubtful It has been suggested that Van Dyck's principal object in travelling to the continent was to be entrusted with the decoration of one of the galleries of the Louvre. Unfortunately the great painter was thwarted in his aspirations. His health was beginning to fail.

The portraits of William II. of Orange and the Princess Mary, now in the museum at Amsterdam, are the last Van Dyck painted in England. Of works dated 1639 the portrait of the Countess of Portland (Darmstadt) is a fine example; and to the same year belongs a full-length portrait of Arthur Goodwin at Chatsworth. Van Dyck sailed in September, and probably spent some time with his Antwerp friends. Early in November he reached Paris, but on Nov. 16 he was compelled to resign his commissions

on account of the state of his health. Scarcely three weeks later (Dec. 9, 1641) he died at his residence at Blackfriars Van Dyck was buried in old St. Paul's, where a Latin inscription was placed on his tomb by Charles I.

An elegy in Cowley's *Miscellanies* speaks, not only of the painter's talent, but of his amiable disposition. We may perhaps point to the coincidence that a Mrs Cowley is in Van Dyck's will (of Dec 1) named guardian of his child, Justinana Anna, born only eight days before her father's death. The painter had in the Netherlands an illegitimate daughter, Maria Theresia, who was entrusted to his sister, and to whom he bequeathed £4,000 Lady Van Dyck became the second wife of Sir Richard Pryse of Gogerddan in Cardiganshire. She was dead in 1645. Justinana Van Dyck, who was married when scarcely twelve years old to Sir John Stepney of Prendergast, painted a "Crucifixion," with four angels receiving Christ's blood in chalices After the Restoration a pension of £200 for life was granted to Justiniana Van Dyck, who died before 1690

Properly speaking, Van Dyck cannot be said to have formed a school He was followed to London by some of his earlier collaborators, and there soon met a considerable number of others Jan van Reyn, David Beek, Adrian Hanneman, Mathew Merian, John Bockhorst (Lang Jan), Remy van Leemput and Peter Thys were foremost among foreigners, Henry Stone and William Dobson among Englishmen. To their assistance the master owed much; but they are also responsible for the vast number of constantly recurring copies which go by his name It often requires a very discriminating eye to distinguish some of these copies from the original paintings. No school more strikingly reflects the influence of Van Dyck than the British school Stone, Dobson, George Jameson, Robert Walker and Samuel Cooper were the most fortunate of his continuators, and such masters as Reynolds, Gainsborough, Lawrence and Raeburn owe much to their study of his works.

Though Van Dyck's reputation greatly suffered through the numerous copies he allowed his pupils to take from his works, the case is otherwise with engraving: Vorsterman, Pontius, Peter de Jode, P. Balliu and S. Bolswert were seldom more fortunate than when under his guidance. De Jode's "St. Augustine," Bolswert's "Ecce Homo" and "Crucifixion," Vorsterman's "Deposition," and especially Pontius's "Herman Joseph" rank among the masterpieces of the art of engraving. Van Dyck was himself an incomparable etcher. The art of portrait etching, scarcely in existence before his time, reached the highest point of excellence in his work. He etched some 18 plates for a collection of portraits generally called "the Iconography." Such prints as the portraits of Vorsterman, John de Wael, Snyders, Josse de Momper, Adam van Noort, and above all his own effigy, display a manner fresh and personal admirably suited to the medium. Print collectors pay extravagant prices for a first proof taken from the plates engraved by Van Dyck himself. Van Dyck also employed some of the best engravers of his time for this collection of illustrious heads Whether the whole series had been published before 1645 when it was issued by Hendrick is uncertain. Martin van der Enden, whose name appears on some of the plates was probably only a printer, who issued the plates separately as the work proceeded. Hendrick's edition contains 99 plates He used as a frontispiece the portrait of Van Dyck, with the following inscription: *Icones principum, virorum doctorum, &c. &c., numero centum ab Antonio Van Dyck pictore ad vivum expressae elusq. sumptibus aeri incisae*, 1645. Seventeen editions were published, the last in 1759, with 124 plates. Many of the plates are the property of the French Government, and belong to the Chalcographie Nationale in Paris. A relic of great importance is a sketch-book obviously used by the painter in Italy containing but few original compositions and chiefly studies of the Italian masters. This book, once in the possession of Sir Peter Lely, is now at Chatsworth.

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VAN DYKE, HENRY (1852–1933), American writer, was born in Germantown (Pa.), Nov. 10, 1852. He studied at the Brooklyn Polytechnic Institute, Princeton university (M.A., 1876), the Princeton Theological School, and the university of Berlin In 1879 he entered the Presbyterian ministry, becoming pastor at Newport, Rhode Island; in 1883 he became pastor of the Brick Presbyterian Church, New York City. In this capacity his preaching gave him a national reputation

In 1900 he became professor of English literature at Princeton. During 1902–3 he served as moderator of the Presbyterian Church in the United States. In 1908–9 he was American lecturer at the Sorbonne In 1913 President Wilson appointed him minister to Holland and Luxembourg, but he resigned in 1917.

Among his best works are his "outdoor essays," especially *Little Rivers* (1895) and *Fisherman's Luck* (1899). His short stories, notably *The Other Wise Man* (1896) and the collections *The Ruling Passion* (1901) and *The Blue Flower* (1902), were extremely popular. His other publications include *The Reality of Religion* (1884), *Days Off* (1907), *Out-of-Doors in the Holy Land* (1908); *Collected Poems* (1911); *Fighting for Peace* (1917); *The Valley of Vision* (1919); *Companionable Books* (1922), and (with Tertius Van Dyke) *Light My Candle* (1926), *The Man Behind the Book* (1929).

VANE, SIR HENRY (1589–1654), English secretary of state, born at Hadlow, Kent, on Feb. 18, 1589, was educated at Brasenose College, Oxford, entered Gray's Inn in 1606, and was knighted in 1611 He purchased various court offices, and sat in parliament for various constituencies from 1614 onwards. Vane was sent on many foreign missions, and in 1630 became one of the king's chief advisers. He was made a commissioner of the Admiralty in 1632 and for the colonies in 1636. He was one of the eight privy councillors appointed to manage affairs in Scotland on the outbreak of the troubles there, and on Feb. 3, 1640, through the influence of the queen and of the marquis of Hamilton and in opposition to the wishes of Strafford, he was made secretary of state in the room of Sir John Coke.

In the Short Parliament, which assembled in April, it fell to Vane to demand supplies He proposed that the king should give up ship-money and receive in return twelve subsidies. Parliament proved intractable and was dissolved on May 5 to prevent a vote against the continuance of the war with the Scots In the impeachment of Strafford, Vane asserted that Strafford had advised the king at a meeting of the privy council to employ the Irish army against England. He was on bad terms with Strafford, who had opposed his appointment to office Vane was accused of collusion and treachery, and there is no doubt that he desired Strafford's removal, believing that his sacrifice would satisfy the demands of the parliament. Nevertheless, the charge that he deliberately compassed his destruction is not proved Suspicions of his fidelity, however, increased, and after accompanying the king to Scotland in August 1641, he was dismissed from all his appointments on Nov. 4, on Charles's return.

Vane immediately joined the parliament; he was placed on the committee for Irish affairs on Dec. 13, was made lord lieutenant of Durham on Feb. 10, 1642, became a member of the committee of both kingdoms on Feb. 7, 1644, and in this capacity attended the Scots army in 1645, while the parliament in the treaty of Uxbridge demanded for him from Charles a barony and the repayment of his losses. He adhered to the parliament after the king's death, and in the first parliament of the Protectorate he was returned for Kent, but the House had refused to appoint him a member of the council of state in February 1650. He died in 1654

VANE, SIR HENRY (1613–1662), English statesman and author, known as "the younger" to distinguish him from his father,

Sir Henry Vane (*q v*), was baptized on May 20, 1613, at Debden, Essex After an education at Westminster, and at Magdalen Hall, Oxford, he was attached successively to the embassies at Vienna, Leiden and Geneva He had already acquired strong Puritan views, and, in 1635, in order to obtain the free exercise of his religion, he emigrated to Massachusetts, where he was elected governor in 1636 After one year in office, he was defeated by Winthrop.

Vane returned to England in August 1637 He was made joint-treasurer of the navy with Sir W Russell in January 1639, was elected for Hull in the Short and Long parliaments, and was knighted on June 23, 1640 He at once became one of the leaders of the parliamentary party, and in 1643 he was the leading man among the commissioners sent to treat for a league with the Scots Vane, who was bitterly opposed to the tyranny of the Presbyterian system, succeeded in getting the proposed bond between the parties termed the Solemn League and Covenant, and further in substituting the whole expression "*according to the word of God and* the example of the best Reformed churches" for the latter part alone He succeeded to the leadership of the party on Pym's death and was engaged in all the principal negotiations which followed. His leadership ended when the Presbyterian party obtained the supremacy in parliament in 1646 During the subsequent struggle he was one of the six commissioners appointed to treat with the army by the parliament, and endeavoured to effect a compromise, but failed, being distrusted by both the Levellers and the Presbyterians His views of government may be studied in *The People's Case Stated*, written shortly before his death

In spite, however, of these free opinions, Vane still desired the maintenance of the monarchy and the constitution He supported the renewal of negotiations with the king and was appointed in 1648 one of the commissioners for the treaty of Newport He showed a desire to come to terms on the foundation of toleration and a "moderate episcopacy," of which Cromwell greatly disapproved, and opposed the shaking off of the conferences He remained in retirement until after the king's death On Feb 14, 1649 he was placed on the council of state, though he refused to take the oath approving the king's execution Vane served on innumerable committees of importance, and was assiduous in his attendance. He furnished the supplies for Cromwell's expedition to Scotland, and was one of the commissioners to negotiate a union between the two countries He was a leading member of the committee dealing with foreign affairs, and in 1651 went on a secret mission to negotiate with Cardinal de Retz To Vane, as chief commissioner of the navy, belongs largely the credit of the victories obtained against Van Tromp

In domestic politics Vane continued to urge his views of toleration and his opposition to a state church. On Jan 9, 1650 he brought forward as chairman the report of a committee for the reform of the franchise on the property basis, the disfranchisement of certain existing boroughs, and increased representation to the large towns, the sitting members, however, were to retain their seats But Cromwell desired an entirely new parliament and the supremacy of the army representation On April 20 Cromwell forcibly dissolved the Long Parliament while in the act of passing Vane's bill. On the latter's protesting, "This is not honest; yea, it is against morality and common honesty," Cromwell fell a-railing at him, crying out with a loud voice, "O Sir Henry Vane, Sir Henry Vane; the Lord deliver me from Sir Henry Vane!" (Ludlow, *Mem* 1 353) Hitherto they had lived on intimate terms of friendship, but this incident created a permanent breach In his seclusion at Raby he now wrote the *Retired Man's Meditations* (1655) In 1656 he proposed in *A Healing Question* (reprinted in the "Somers Tracts," vol vi. ed Scott) a new form of government, insisting as before upon a Puritan parliament supreme over the army The seditious movements of the Anabaptists were attributed to his influence, and on July 29, 1656 he was summoned before the council Refusing to give security, he was a prisoner at Carisbrooke Castle from September to the end of the year. In the parliament of Richard Cromwell he was elected for Whitchurch, when he urged that the protector's power should be strictly limited

He allied himself with the officers in setting aside the protectorate and in restoring the Long Parliament, and on Richard Cromwell's abdication he became a member of the committee of safety and of the council of state appointed in May, was commissioner for the navy and for the appointment of army officers, managed foreign affairs and superintended finance He adhered to Lambert, remained a member of the government after the latter had turned out the Long Parliament, and endeavoured to maintain it by reconciling the disputing generals and by negotiating with the navy, which first deserted the cause In consequence, at the restoration of the Long Parliament he was expelled from the House and ordered to retire to Raby.

At the Restoration, Vane was imprisoned in the Tower by the king's order After several conferences between the houses of parliament, it was agreed that he should be excepted from the indemnity bill, but that a petition should be sent to Charles asking that his life might be spared The petition was granted But the new parliament of 1661 demanded his trial on the capital charge, and Vane was taken back to the Tower in April 1662 from the Scilly Isles, where he had been imprisoned On June 2 he appeared before the king's bench to answer the charge of high treason, when he made a bold and skilful defence, asserting the sovereign power of parliament in justification of his conduct. He was found guilty, and executed on June 14, 1662

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VAN GOGH: *see* GOGH, VINCENT VAN

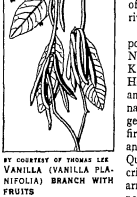
VAN HORNE, SIR WILLIAM CORNELIUS (1843–1915), Canadian financier, was born in Will county, Ill., U.S.A., Feb 3, 1843, of Dutch descent. He was educated in the common schools of the state, and in 1857 began work as office boy in a railway station. In 1881 he was appointed general manager of the Canadian Pacific railway For the successful completion of this great road his strong will and mental grasp were largely responsible, and he controlled and extended its operations. In 1884 he became vice-president of the line, in 1888 president, and in 1899 chairman of the board of directors. After the Spanish-American War (1898) he became one of the chief promoters of railway and industrial enterprises in Cuba. He died at Montreal on Sept. 11, 1915.

VANILLA, a flavouring agent largely used in the manufacture of chocolate, in confectionery and in perfumery. It consists of the fermented and dried pods of several species of orchids belonging to the genus *Vanilla* The name of the genus comes from the Spanish *Vamilla*, a diminutive of *vaina*, a pod. The great bulk of the commercial article is the produce of *V. planifolia*, a native of southeastern Mexico, but now largely cultivated in several tropical countries, especially in Bourbon, the Seychelles, Tahiti and Java The plant has a long fleshy stem and attaches itself by its aerial rootlets to trees; the roots also penetrate the soil The leaves are alternate, oval-lanceolate and fleshy; the light greenish flowers form axillary spikes. The fruit is a pod from 6 to 10 in. long, when mature, about half-an inch in diameter The wild plant yields a smaller and less aromatic fruit, distinguished in Mexico as *Baymilla cimarona*, the cultivated vanilla being known as *B. corriente*

Mexican vanilla is principally consumed in the United States. In Bourbon large areas are under cultivation; the crop is sent to Bordeaux, the chief centre of the trade in France. Its odour is said to differ from the Mexican variety in having a suggestion of tonka bean. The best varieties of vanilla pods are of a very dark chocolate brown or nearly black colour, and are covered with a crystalline efflorescence technically known as *givre*, the presence of which is taken as a criterion of quality. The peculiar fragrance of vanilla is due to vanillin, $C_8H_8O_3$, which forms this efflorescence Chemically speaking, it is the aldehyde of methyl-protocatechuic acid. It is not naturally present in the fleshy exterior of the pod, but is secreted by hair-like papillae lining its three internal angles, and ultimately becomes diffused through the viscid oily liquid surrounding the seeds. Besides vanillin, the pods con-

tain vanillic acid (which is odourless), about 11% of fixed oil, 2·3% of soft resin, sugar, gum and oxalate of lime.

Vanillin forms crystalline needles, melting at 81° C. and soluble in alcohol, ether and oils, hardly soluble in cold, but more so in boiling water. Vanillin has been found in Siam benzoin and in raw sugar, and has been prepared artificially from coniferin, a glucoside found in the sapwood of fir-trees, from asafoetida, and from a constituent of oil of cloves named eugenol. It is now prepared synthetically on a commercial scale in Germany.



BY COURTESY OF THOMAS LEE VANILLA (VANILLA PLANIFOLIA) BRANCH WITH FRUITS

VANINI, LUCILIO, or, as he styled himself in his works, GIULIO CESARE (1585–1619), Italian free-thinker, was born at Taurisano, near Naples. He studied at Rome, Naples, and at Padua, and was ordained priest. Subsequently he led a roving life in France, Switzerland and the Low Countries.

Vanini was obliged to flee from Lyons to England in 1614, but was imprisoned in London for some reason for 49 days. Returning to Italy he made an attempt to teach in Genoa, but was driven once more to France, where he tried to clear himself of suspicion by publishing a book against atheists, *Amphitheatrum aeternae providentiae divino-magicum* (1615). Though the definitions of God are somewhat pantheistic, the book is sufficiently orthodox, but the arguments are largely ironical, and cannot be taken as expounding his real views. Vanini expressly tells us so in his second (and only other published) work, *De admirandis naturae reginae deaeque mortalium arcanis* (Paris, 1616), which, originally certified by two doctors of the Sorbonne, was afterwards re-examined and condemned. Vanini then left Paris, where he had been staying as chaplain to the maréchal de Bassompierre, and began to teach in Toulouse. In Nov. 1618 he was arrested, and after a prolonged trial was condemned as an atheist. He was burnt on Feb. 9, 1619.

VANLOO, CHARLES ANDREW (1705–1765), subject painter, a younger brother of John Baptist Vanloo (1684–1745), a well known portrait painter, was born at Nice on Feb 15, 1705. He received some instruction from his brother, and like him studied in Rome under Luti. In 1734 he settled in Paris, and in 1735 became a member of the French academy; he was decorated with the order of St. Michael and appointed principal painter to the king. He died in Paris on July 15, 1765.

VANNES, a town of western France, capital of the department of Morbihan, 84 mi. N.W. of Nantes on the railway to Brest. Pop. (1936) 22,352. Vannes (*Dariorigum*), the capital of the Veneti (whence *Gwenea*, the Breton name of the town), led the Armorican league against Julius Caesar, who in 56 B.C. overcame their fleet and opened up their country by six roads. St. Paternus, the first bishop, was consecrated in 465. In the 5th century Vannes was ruled for a time by independent counts, but soon came under the yoke of the Franks. Nomenoé, the lieutenant of Louis I, the Pious, in Brittany, assumed the title of king in 843, and one of his brothers was the founder of a line of counts who resisted the Normans in the 9th and 10th centuries. Vannes became part of the duchy of Brittany at the end of the 10th century. The estates of Brittany met there for the first time in 1203. In the course of the War of Succession the town was besieged in 1342. Duke John IV built here the castle of L'Hermine and made it his habitual residence. In 1487 the town was for a year in the hands of Charles VIII of France. In 1532 Brittany was definitively united to France.

Vannes is 10 mi. from the open sea, at the confluence of two streams forming the Vannes river, which opens into the landlocked gulf of Morbihan about a mile below the town. The old town, lying on a hill facing the south, is surrounded by fortifications of the 14th, 15th and 17th centuries, pierced by four gates and flanked by nine towers and five bastions, connected by battlements. In the Constable's tower Olivier de Clisson was confined in 1387. The modern suburbs, with the port and public buildings, surround the old town. The archaeological museum includes one of the richest collections of prehistoric remains in Europe. The cathedral of St Peter, burned by the Normans in the 10th century, was rebuilt in the 13th, 15th and 18th centuries. It has remains of a cloister. The curious round Chapelle du Pardon to the left of the nave was built in 1537 in the Italian style. Among the industries are tanning and cotton weaving. The port of Vannes, to the south of the town, is formed by the Vannes river and is accessible only to small vessels.

VAN RENSSELAER, STEPHEN (1764–1839), U.S. political leader and soldier, "last of the patroons," was born at New York city, Nov. 1, 1764. He was fifth in descent from Killian Van Rensselaer, original patroon of Rensselaerwyk, N.Y. He was a member of the New York assembly 1789–90, 1808–10, and in 1818, a member of the state senate 1791–95 and of the national house of representatives 1822–29. He served as a major-general in the second war with Great Britain, commanding the first division of the detached militia of the state of New York, and on the 13th of October 1812 was defeated at the battle of Queenston Heights. Because he was a Federalist he was severely criticised and censured for this defeat and resigned from the army. At the close of the war the Erie Canal project was renewed, and from 1816 till his death he was a member of the board of canal commissioners, and for nearly 15 years was its president. In 1818 he was again elected to the assembly; in 1819 he became a regent of the state university of which he was for a time chancellor. From 1822 to 1829 he was a member of the national house of representatives, and there voted for John Quincy Adams for the presidency. He died at Albany (N.Y.), Jan. 26, 1839.

VANSITTART, HENRY (1732–1770 or 1771), Anglo-Indian governor, was born in London on June 3, 1732, and educated at Reading school and Winchester college. He joined the society of the Franciscans, or the "Hell-fire club" at Medmenham. In 1745 he entered the service of the East India company and sailed for Fort St. David. In 1760 he went to Bengal as president of the council and governor of Fort William; deposing the subadar of Bengal, Mir Jafar, he replaced him by his son-in-law, Mir Kasim. In 1762 he made a treaty with Mir Kasim, checking the system of private trading by the company's servants. The repudiation by the council of this treaty led to war with the subadar, and Vansittart resigned and returned to England in 1764. In 1769 he was made a director of the company, and left England for India, but his ship was lost at sea in 1770 or 1771.

VAN'T HOFF, JACOBUS HENRICUS (1852–1911), Dutch physical chemist, was born in Rotterdam on Aug. 30, 1852. He studied at the Polytechnic at Delft, at the University of Leyden, then under Kekulé at Bonn, Wurtz at Paris in the École de Medecine and, finally, with Mulder at Utrecht, where he obtained his doctorate in 1874. In 1876 he became lecturer in physics at the veterinary school, Utrecht. In 1878 he was appointed professor of chemistry, mineralogy and geology in Amsterdam university. In 1896 he went to Berlin as professor to the Prussian academy of sciences, largely because this post involved no burden of administrative duties. He accepted an honorary professorship in the university so that he might lecture if he wished. He was elected a foreign member of the Royal society in 1897 and awarded its Davy medal in 1893. He was the first recipient of the Nobel prize for chemistry (1901). This was awarded for "his services in connection with the discovery of the laws of chemical dynamics and osmotic pressure in solutions." He died on March 1, 1911, at Steglitz, Berlin.

Van't Hoff's first research (his doctorate thesis) was on cyanacetic and malonic acids but his earliest important contribution to science was made in 1874. Starting with the results of the work of Wislicenus (*q.v.*) on the lactic acids, van't Hoff showed that the four valencies of the carbon atom were probably directed in space towards the four corners of a regular tetrahedron. In this way optical activity, shown to be always associated with an "asymmetric carbon atom," could readily be explained. An identical idea was put forward two months later (Nov. 1874), quite

independently, by J. A. Le Bel (*q.v.*), whose name is generally linked with that of van't Hoff in connection with the theory of asymmetric carbon. Though they had been fellow students under Wurtz, they "never exchanged a word about the carbon tetrahedron, though perhaps both of us cherished the idea in secret." The concept was attacked by Kolbe (*q.v.*), but its value was soon universally realized and it laid the foundation stone of the science of stereochemistry (*q.v.*). In 1877 van't Hoff published his *Ansichten über die organischen Chemie*. The book is almost unreadable but the second part contains the beginnings of his studies in chemical thermodynamics and affinity.

In 1884 was published van't Hoff's second important work. It dealt with the application of thermodynamics to chemical reactions, and was probably his greatest contribution to physical chemistry. He developed the principles of chemical kinetics, described a new method of determining the order of a reaction, and applied thermodynamics to chemical equilibria. In the course of this work he deduced the connection between the equilibrium constant of a reaction and the temperature, in the form of an equation known as the "van't Hoff isochor." He generalized this in the form of the "principle of mobile equilibrium," a special case of the principle developed by Le Chatelier (*q.v.*) at the same time (1884). In the course of the same study van't Hoff introduced the modern concept of chemical affinity as the maximum work obtainable as the result of a reaction and showed how it may be calculated from measurements of osmotic pressure, gas pressure and the e.m.f. of reversible galvanic cells. In 1886 he published the results of his study of dilute solutions and showed the analogy existing between them and gases, since both obey equations of the type $pv=RT$. During the next nine years he developed this work in connection with the theory of electrolytic dissociation enunciated by Arrhenius (*q.v.*) in 1887. The abnormality in the case of electrolytes was explained by the equation $pv=iRT$, in which the factor i was a measure of the deviation from the simple expression. As part of this work he carried out a series of researches on the conditions of formation and decomposition of double salts, and on his translation to Berlin in 1896, he developed this into the important phase rule study of the formation of oceanic salt deposits with special reference to those at Stassfurt, Saxony. With Wilhelm Ostwald (*q.v.*) he started the important *Zeitschrift für physikalische Chemie* in 1887, and the first volume contained the famous paper by Arrhenius on electrolytic dissociation, along with the fundamental paper of van't Hoff. Van't Hoff's publications include *La Chimie dans l'Espace* (1875); German edition 1876, and English 1898, *Etudes de dynamic chimique* (1884), revised and extended by E. Cohen as *Studien zur Chemischen Dynamik* (1896); *Vorlesungen über Bildung und Spaltung Doppelsalzen* (1897); and *Zur Bildung der Ozeanischen Salzablagerungen*, (i. 1905; ii. 1909).

See E. Cohen, *Jacobus Henricus van't Hoff, Sein Leben und Werken* (Leipzig, 1912); also Essay in Bugge's *Das Buch der Grossen Chemiker* (1930); J. Walker, van't Hoff Memorial Lecture in *Journal of the Chemical Society* (London, 1913); W. Ostwald, *Berichte der deutschen chemischen Gesellschaft* (1911); G. Bruni, *Annual Reports, Smithsonian Institute* (1914); B. Harrow, *Eminent Chemists of our Time* (1920); W. P. Jorissen and L. T. Reicher, *J. H. van't Hoff's Amsterdamer Periode* (1912).

VAN WERT, a city of western Ohio, U.S., the county seat of Van Wert county, on federal highways 30, 127 and 224; 34 mi. S.E. of Fort Wayne, Ind. It is served by the New York Central and Pennsylvania railways. Pop. (1930) 10,364. It is in an agricultural and dairying region, and has some manufacturing industries. Van Wert was settled about 1840, incorporated as a town in 1848 and as a city in 1903. Peony culture and making of Liederkranz cheese are important industries.

VAPEREAU, LOUIS GUSTAVE (1819–1906), French man of letters and lexicographer, was born at Orleans on April 4, 1819. After 1870 he was appointed prefect of Cantal (1870) and of Tarn et Garonne (1871–73). From 1877 to 1888 he was inspector-general of public instruction. He was the author of some excellent editions of the classics, and of works on political and social questions, but he is famous for his valuable *Dictionnaire universel des contemporains* (1858; 6th ed., 1893), brought up to date in 1895 by a supplementary volume. He also drew up a *Dictionnaire universel des littérateurs* (1876). He died in 1906.

VAPHIO, an ancient site in Laconia, Greece, on the right bank of the Eurotas, some 5 m. S. of Sparta, famous for its "bee-hive" tomb, excavated in 1889 by Dr. Tsountas. A walled approach, or δρόμος, about 97 ft. long, leads to a corbel-vaulted chamber 33 ft. in diameter, in the floor of which the grave was cut. The tomb, which probably belonged to Amyclae rather than to Pharis, as is commonly stated, is now almost entirely destroyed. Its contents (in the National Museum in Athens) are typical of the "First Late Minoan" period (about 1500 B.C.) and include engraved gems and amethyst beads, articles in gold, silver, bronze, lead, amber and crystal; also an iron ring, unusual at this early date. By far the finest objects are two golden cups with scenes in relief, picturing the capture of bulls.

See C. Tsountas, *Ἐφημερὶς Ἀρχαιολογική* (1889), 136–172; J. G. Frazer, *Pausanias's Description of Greece*, iii. 135 f. (with full bibliography); R. C. Bosanquet, *Journal of Hellenic Studies* (1904), xxiv. 317 ff., A. Riegl, *Jahreshefte d. osterr. arch. Institutes* (1906), ix. 1 ff.

VAPORIZATION, a general term denoting the change of state of any substance from solid or liquid to vapour. The converse change from vapour to liquid or solid is most often called condensation, though there are many other special terms employed in particular cases. The general phenomena of change of state as affected by heat have been described in the article HEAT. The most accurate methods of measuring the latent heat of vaporization or condensation are discussed in the article CALORIMETRY, and the application of the laws of thermodynamics to the subject is included in the article THERMODYNAMICS. Important practical applications of the properties of vapours will be found in other articles, such as LIQUEFACTION OF GASES; DISTILLATION; STEAM; STEAM ENGINE; TURBINE: STEAM. The chief object of the present article is to discuss the *physical* explanation of the phenomena, and to show how the various properties of vapours can be represented by equations, so that the effects to be expected under any conditions can be calculated.

Gases and Vapours.—In effect all gases may be regarded as vapours, since all may be liquefied and solidified under suitable conditions. Conversely we should expect that all vapours would behave as gases under conditions sufficiently far removed from those at which the corresponding liquid can exist. This is found to be the case for all stable vapours, which approximate more and more closely to the gas equation $pV=RT$ as the temperature is raised or the pressure reduced. In this equation V represents the volume occupied by unit mass at a temperature T on the absolute scale, and pressure P in any convenient units. The constant a is the factor required for reducing PV to heat units, and the value of the constant R in heat-units per degree is $1{\cdot}985/m$, where m is the molecular weight corresponding to the chemical formula for the molecule of the vapour considered. At any temperature below the boiling-point of the liquid, if the volume of the vapour is reduced, the deviations from Boyle's law will seldom exceed 1 per cent. But a sharp limit is set to the application of the gas equation by the *saturation-pressure* at which the vapour begins to condense. The pressure then remains constant, as the volume is further reduced at constant temperature, until the whole of the vapour is condensed. By experiments of this kind, Dalton established the law of saturation pressure, that for each vapour there is a unique relation between pressure and temperature defining the state in which alone the liquid and vapour can exist together in equilibrium.

Empirical Formulae for Saturation Pressure

$\log p = A + BT$	Dalton, 1800
$\log p = C \log (A - BT)$	Young, 1820
$\log p = AT/(B+CT)$	Roche, 1830
$\log p = A + Bt^1 + Ct^2$	Biot, 1844
$\log p = A + B \log t + C \log (T+c)$	Bertrand, 1887
$\log p = A - B/T - C(36t - t^3)/T$	Thiesen, 1900
$\log p = A - B/T - C \log t - DT + ET^2 + FT^3 + GT^4$	Goodenough, 1915

Biot's formula, though apparently the most ungainly and difficult to work, possesses some practical interest because it was adopted by Regnault (1847) for representing his observations on the saturation presses of steam, which were made with a mercury manometer 70 ft. high, and were much the most accurate

obtained for many years In spite of the five empirical constants in Biot's formula, Regnault found it necessary to use different formulae above and below 100° C. At that time the laws of thermodynamics had not been elucidated sufficiently to permit their application to the problem, but some theoretical basis might have been expected in the case of the later formulae

Theoretical Equation of Saturation Pressure.—The law according to which the saturation pressure of any vapour varied with the temperature was discovered by Carnot in 1824 by the direct application of his principle to the case of vaporization, and was first stated in the form.—"The increase of saturation pressure per degree is equal to the latent heat per unit increase of volume in vaporization multiplied by a function of the temperature (Carnot's function) which is the same for all substances" The law could not be applied until the form of this function had been determined Accordingly Carnot utilized the relation in the first instance for calculating values of his function from the very scanty and inaccurate data available for the latent heats of various substances But this failed to give any conclusive result owing to the poverty of the data (*See* THERMODYNAMICS) Clapeyron (1834) first stated the equation in the analytical form in which it is generally known as Clapeyron's equation,

$$L\ F't=(V-v)\ (dp/dt)_s \qquad (1)$$

in which L is the latent heat of vaporization corresponding to the increase of volume V−v from liquid to vapour, F't is Carnot's function of the temperature and $(dp/dt)_s$ denotes the increase of the saturation pressure per degree Ultimately, as the result of Joule's experiments on the mechanical equivalent of heat, denoted by J, and of Regnault's experiments on the gas-scale of temperature, denoted by T, it gradually became obvious (*see* HEAT) that Carnot's function must be very nearly equal to J/T. The absolute scale of temperature T was accordingly defined on Kelvin's suggestion by the condition T=J/F't, in which it is understood that the appropriate numerical value of J must be employed, depending on the units in terms of which heat and work are measured in the equation Putting a for 1/J, Clapeyron's equation may be written in the form,

$$L/ap(V-v)=(T/p)\ (dp/dT)_s \qquad (2)$$

The expression on the left is the ratio of the latent heat L to the equivalent $ap(V-v)$ of the external work of vaporization in heat units The expression on the right is the most convenient method of stating the rate of increase of saturation pressure with temperature, since it has the same numerical value, for a given substance under given conditions, in all systems of units. To find the expression for p in terms of T, we have merely to integrate equation (2) after substituting appropriate expressions for L and V in terms of p and T.

Rankine (1851) was the first to show that the total heat of an ideal vapour reckoned from the state of liquid at 0° C should be $H=L_0+St$, where S is the specific heat of the vapour at *constant* pressure, and L_0 the latent heat of vaporization at 0° C The total heat of the *liquid* reckened from 0° C is simply $h=st$, where s is specific heat of the liquid, and is taken as constant. Hence the latent heat L at any temperature t will be approximately,

$$L=H-h=L_0+(S-s)t. \qquad (3)$$

If the vapour also satisfies the gas law, as is generally the case at low pressures, we may substitute $ap\,V=RT$ in (2), and neglect v, which is generally less than a thousandth of V at atmospheric pressure. Equation (2) then reduces to the simple form, $L/RT^2=(dp/dt)/p$, which is easily integrated with the value of L from (3), and gives a theoretical equation for p,

$$\log_e p=A-B/T-C\log_e T \qquad (4)$$

where $B=L_0/R+(s-S)T_0/R$, $C=(s-S)/R$, and A is the constant of integration This equation must necessarily give a good first approximation to the saturation pressures if the values of the constants L_0, s, and S are correct Thus in the case of steam, if we take $L_0=594$ J, $s=0\cdot9967$ (the minimum specific heat of water) $S=0\cdot477=13R/3$, equation (4) gives values at low pressures which are correct to 0·1° C at a temperature as high as 60° C Beyond this point the approximation begins to fail, chiefly in the first instance because apV begins to deviate appreciably from the ideal value RT above assumed At 100° C the value of p given by (4) is already about 1·5% too small, corresponding to an defect of the same order of magnitude in the value of V This agreement verifies Clapeyron's equation (2), and the assumption $ap\,V=RT$ at low pressures, as well as equation (3) for L, but it is necessary to obtain consistent expressions for the defect of both L and V from these ideal values before equation (4) can be extended to higher pressures Rankine, who first gave a correct deduction of (4) (Trans. R.S.E 1865), came to the conclusion that both L and V must show an increasing defect from their ideal values as the pressure increased, but he was unable to trace the required connection between them Equation (4) is generally attributed to Dupré (1869), who deduced it by assuming a linear formula for the latent heat, and used it as a purely empirical formula by calculating the coefficients from observations at high pressures Bertrand, in his treatise on Thermodynamics, followed the same course, which is necessarily unsatisfactory, because it does not comply with the theoretical conditions, or give the true relations of the constants B and C to L and S.

Deviations of a Vapour from the Ideal State.—The manner in which a gas passes into a vapour and finally condenses, must be studied in the first instance by observing the gradual deviations from the gas law $apV=RT$, as the pressure is increased The simplest way of doing this is to find the departure from Boyle's law at various constant temperatures, which gives the whole story if the range of temperatures is sufficiently extended. Regnault (1847) was the first to make observations of this kind with sufficient accuracy in the case of CO_2. Rankine (1854) succeeded in representing these experimental results by a fairly simple equation in a convenient form,

$$P+A/V^2T=RT/aV. \qquad (5)$$

The second term, in which A is an empirical constant, represents the deviations from the gas law, and tends to vanish when V or T is large It is of the dimensions of a pressure, and may be interpreted as an internal pressure, varying as the square of the density, which is added to the external pressure P, and tends to reduce V below the ideal value According to Boyle's law, the product PV of the observed values of P and V at various pressures should be constant at each temperature at which observations are made, and should give a horizontal straight line when PV is plotted against P Equation (5) when plotted in this manner, gives a series of parabolas, each with its axis horizontal and its vertex at a height equal to half the initial value of PV This is easily seen by multiplying equation (5) by PV^2, which gives it in the form of a quadratic in (PV),

$$(PV)^2-(PV)(RT/a)+AP/T=0 \qquad (5)a$$

the two roots of which become equal when $P=RT/2aV$, and are imaginary at higher pressures The equation would evidently fall before this point was reached, but was found to be quite satisfactory for the restricted range of Regnault's experiments. It also represented his observations on the pressure-coefficient of CO_2 very closely, and Joule and Thomson found that it also satisfied their results for the cooling effect in expansion through a porous plug They found however that (5) was very inconvenient in form for their purpose, because it gave P as a quadratic function of 1/V, whereas they wanted V explicitly as a function of P They therefore transformed equation (5) by multiplying throughout by V/P, and making the approximation $PV=RT/a$ in the small term A/PVT, thus obtaining,

$$V=RT/aP-Aa/RT^2. \qquad (6)$$

The small term Aa/RT^2 is now of the dimensions of a volume, and may be interpreted as a first approximation to the reduction of volume A/PVT due to the internal pressure A/V^2T, as in equation (5) It also might be interpreted on the kinetic theory (which was expressly designed to explain the pressure of gases and vapours without assuming imaginary forces of attraction or repulsion between the molecules) as being due to a reduction in the

effective *number* of molecules per unit mass owing to the formation of multiple or complex molecules by coaggregation. This process is well known to occur in analogous chemical problems, where the proportions of different molecules existing in a gas mixture can be analysed and verified. On this view, the reduction of V below the ideal value RT/pP is due to a corresponding reduction in the number of *effective* molecules; and the formation of complex molecules is regarded as the first stage in the transition from the state of vapour to the state of liquid, in which nearly all the molecules are coaggregated. The reduction of volume $A_2/R^{1/2}$ given by the Joule-Thomson equation (6) is a function of the temperature only, and should be a very good first approximation to the coaggregation at low pressures according to the kinetic theory. If the isothermals are plotted on the PV—P diagram, they will all be straight lines, as is easily seen by multiplying (6), by P, so as to give the product PV. The slope of successive isothermals is proportional to $1/T^2$, and diminishes with rise of temperature. The diminution of slope with rise of temperature is to be expected on thermodynamic grounds, if the molecules combine with evolution of heat, which would afford the most natural explanation of the latent heat of condensation. The term A/PVT representing the reduction of volume according to Rankine's equation, though fitting exactly with the hypothesis of an internal pressure varying as the square of the density, might equally well represent the effect of coaggregation We might expect that the complex molecules would begin to combine *with each other* as the proportion of such molecules in the mixture increased with increase of density, and that the slope of each isothermal would increase accordingly, giving the parabolic form $(5)a$ in place of the rectilinear-isothermals given by (6). This is certainly true at high pressures near saturation, though the isothermals approximate more nearly to straight lines at temperatures above the critical point; but neither of these equations could be expected to apply to the liquid state, or even to the vapour in extreme cases, beyond the limits of the observations on which they were founded

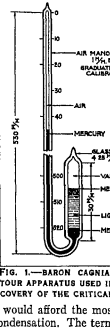


FIG. 1.—BARON CAGNIARD DE LA TOUR APPARATUS USED IN THE DISCOVERY OF THE CRITICAL POINT

The Continuity of State.—The theory of the continuity of state, which is now so familiar as an explanation of the relations between liquid and vapour, appears to have originated from the experiments of Andrews (*Phil. Trans.* 1869) on the properties of carbonic acid (CO_2) between the temperatures of 13° and 48° C, including the critical region. The vapour was confined in a capillary tube by a pellet of mercury, and the apparatus was arranged so that the volume could be varied by means of a screw plunger, while the tube was maintained at a steady temperature in a water bath. A similar capillary containing air subject to the same pressure was employed as a manometer (for details of apparatus *see* article MANOMETER). The isothermal curves obtained by plotting simultaneous values of P and V observed at the temperatures of 13.1°, 21.5°, 31.1°, 35.5° and 48.1° C., are shown in fig. 2B. They showed the well known discontinuities, required by Dalton's law, at the commencement and conclusion of condensation, but the sharp corners were rounded off at these high pressures, and the pressure did not remain quite constant during condensation, but showed a rise of about 2 per cent attributed by Andrews to an impurity of about 2 parts of air in 1,000 of CO_2. The dotted line shown in the figure has been added to Andrews' original diagram to indicate the saturation lines for the liquid and vapour, meeting at the critical point 31.1°, with the critical isothermal as a common tangent. At any point within the dotted boundary, *e.g.*, at 21.5°, the fluid exists partly in the state of vapour and partly in that of liquid, in stable equilibrium with the vapour, as is usually observed during the condensation of a vapour by compression at constant temperature. But Andrews showed very conclusively that a vapour could be transformed into a liquid by a continuous process without any breach of homogeneity, or separation into the two states of liquid and vapour, provided that the change was effected along any path on the diagram which did not intersect the dotted boundary curve. Thus if the vapour were taken at a temperature of 48°, and at a pressure of 80 atmospheres, and were then cooled *at constant pressure* to a temperature of 13°, at which it was certainly liquid, the fluid remained homogeneous throughout the process, and showed no sign of separation into two states at any point He concluded from these experiments that "the gaseous and liquid states are only widely separated forms of the same condition of matter, and may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present any interruption or breach of continuity"

James Thomson (*Proc. R.S.* 1871) extended this view to the region included by the boundary curve. He maintained that the discontinuities ordinarily shown at the beginning and end of condensation, were apparent rather than real. He quoted Donny's experiments as showing that, in the absence of dissolved air, the liquid curve AB in fig 2 A, could be traced along the extension BM to pressures far below the saturation line BCD, without any formation of vapour. It was possible to imagine the vapour curve ED similarly extended in the direction DN to pressures above saturation. This had been suggested by Kelvin (*Phil Mag.* 1870) on theoretical grounds, though it had not then been proved by experiment. The two curves thus extended might be joined into one continuous isothermal by the intermediate branch MCN. This branch would involve unstable conditions (V increasing with P) and could not be realized in practice, though it might be represented by some type of equation such as a cubic. If this could be done, it would have the great advantage of representing both liquid and vapour by a single equation of state, which would take account of all possible modes of transformation.

The Equation of van der Waals.—The continuous isothermal of James Thomson was first realized in the form of an equation by van der Waals in his famous essay *On the Continuity of the Liquid and Gaseous States* (Leyden, 1873), which put the whole theory in a more definite form. He assumed that the cohesion of the liquid, shown by Donny's experiments, could be attributed to an internal pressure, such as that invoked by Laplace to account for the surface tension He considered that this internal pressure should depend on the attraction of contiguous parts of the fluid for each other, and should vary as the square of the density, or as $1/V^2$. It would then also explain the deviations of the vapour from the ideal state, as in Rankine's equation for CO_2. Thus both liquid and vapour would be represented by the same equation, which implied that the molecules were identical, and that the two states differed only in density. The only modification necessary in Rankine's equation was the inclusion of the co-volume b in the last term, to represent the irreducible volume of the molecules themselves at high pressures, as demonstrated by Natterer (1854) This also had the effect of transforming the equation into a cubic in V as required by the theory of the James Thomson isothermal. We thus obtain the equation,

$$P+A/V^2=RT/a(V-b) \qquad (7)$$

The factor T in Rankine's expression for the internal pressure was omitted by van der Waals on the ground that an internal pressure, representing a force of attraction between the molecules, should be independent of the temperature. But this does not make any material difference to the critical relations. It will be evident that, for given values of P and T, equation (7) gives a cubic in V, and may have three real roots within certain limits representing the points of intersection, B,C,D, in fig. 1A, of the isothermal of T with the line of constant pressure P. The smallest of these roots, given by the point B, may be identified with the volume of the liquid, v, and the largest, given by the point D, with that of

the vapour, V, the middle root C corresponding to the unstable intermediate state imagined by James Thomson. The isothermal curve shown in the figure 1A, corresponds roughly with that given by equation (7) at 21.5°C, or T=294.6. As the temperature is raised towards the critical point at 31.1° C, the line BCD becomes rapidly shorter, and the three roots finally coalesce at the critical point, where the isothermal has a point of inflection with a horizontal tangent as shown in Andrews' diagram, fig 1B. The condition for three equal roots at this point gives the critical relations,

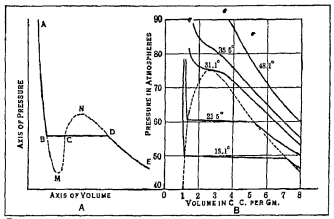


FIG. 2.—(A) JAMES THOMSON ISOTHERMAL, (B) ISOTHERMALS OF CO_2 (ANDREWS)

$$V=v=3b,\ P=A/27b^2,\ T=8A/27bR, \qquad (8)$$

as given by van der Waals, omitting the reduction factor a. These relations give the values of V, P and T, at the critical point in terms of the constants A, b and R, or *vice versa*. It will be seen that the results depend mainly on the value assigned to b, which is very small, and could not be determined satisfactorily from Regnault's observations at comparatively low pressures. The value of the constant A was taken from Regnault's observations, following Rankine's procedure, but that of b was selected to fit the critical temperature, T=304°, which was known with a fair degree of accuracy. The calculated values of the critical pressure and volume did not agree very well with Andrews' observations, but these were somewhat uncertain. The *qualitative* agreement was incredibly perfect in all essential respects with the James Thomson theory, and the equation of van der Waals was immediately accepted as the true and final solution of the problem.

Maxwell's Theorem.—The continuous isothermals represented by equation (7) could easily be plotted on the PV diagram as shown in fig 2, but an exact *quantitative* comparison was difficult, because van der Waals' theory, as originally presented, gave no indication of the manner in which the line BCD, representing the saturation pressure, should be drawn in relation to the continuous isothermal. This question was first solved by J. C. Maxwell (1875), who showed by a simple application of Carnot's principle, that the work of vaporization must be the same along either path, or that the line BCD at each temperature must cut off positive and negative loops of equal area from the continuous isothermal. The work of vaporization along BCD is simply $p(V-v)$; that along the curve is the integral of pdV from (7) between the same limits. The integration is easy, and gives the condition,

$$p(V-v)=(RT/a)\log_e(V-b)/(v-b)+A/V-A/v \qquad (9)$$

Fig. 3 shows the saturation lines correctly drawn in accordance with Maxwell's rule in relation to the isothermal curves given by (7) for the temperatures 0°, 10°, 20° and 30° C. Below 0° down to −50° C, the saturation pressures given by (7) are marked on the saturation line aC_w for the liquid. The dotted curve AC shows the saturation line for the liquid and the saturation pressures as actually observed. Comparing the two curves, we see at once that the values of v calculated from (9) are all nearly 100% too large, and that the actual increase of saturation pressure between 10° and 30° C is nearly double that given by (7). This was not noticed at the time, because the saturation pressures were difficult to calculate from (9), and the volumes of the liquid were considered to be of little importance. Equation (7) gives a very simple expression for the internal latent heat L_i regarded as being equivalent to the work done against the internal pressure A/V^2 when the volume is increased from v to V at constant temperature. We find immediately, $L_i=A/v-A/V$ in work units. The work-equivalent of the latent heat L as ordinarily measured is obtained by adding to L_i the external work $p(V-v)$. L could also be calculated directly from Clapeyron's first relation (*see* article on THERMODYNAMICS, equation 29) by integrating $T(dp/dt)_v$ from v to V, along the continuous isothermal given by (7). We thus obtain, in work units, a quite different expression, namely, $L=(RT/a)\log_e(V-b)/(v-b)$; but it is easy to see that the two expressions for L are equal and exactly consistent with Maxwell's condition (9). These expressions show that any error in v will entail a corresponding error in L as calculated from (7), as is found to be the case on comparison with actual measurements of L which have since become available.

Clausius' Equations for Carbonic Acid and Steam.—To deduce the equation of saturation pressure from (9) in the form of a relation between p and T, as in (4), it would be necessary to eliminate V and v with the aid of (7), which is satisfied by both. This proved to be extremely difficult, as is shown by the case with transcendental equations. Clausius (*Phil Mag.* 1882) first succeeded in finding a practical solution in the form of a table of corresponding states, giving the values of p, V and v, as fractions of the critical pressure and volume, in terms of the temperature expressed as a fraction of the critical temperature. The table in this form could be applied to any equation of the type (7) provided that A were a function of the temperature only. If A were constant, as assumed by van der Waals, the saturation pressures given by the table could not be made to agree at all with observation. But by choosing a suitable expression for A as a function of the temperature, the saturation pressures could always be fitted as closely as desired, if the function were sufficiently complicated. In the case of CO_2, in order to make the saturation pressures as given by (7) agree with those observed by Andrews over the very limited range of his experiments, it sufficed to replace Rankine's T in the expression for the internal pressure, making it $A/\sqrt{T}$ as in (5). In order to make the equation represent the volumes of the liquid more closely, Clausius also found it necessary to replace V^2 in this term by $(V+b'')^2$, the empirical constant b'' being chosen to make the calculated value of v agree with observation at 20° C. The equation thus modified and

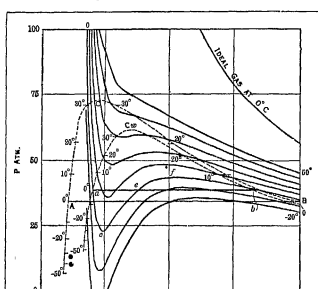


FIG. 3.—ISOTHERMALS GIVEN BY VAN DER WAAL'S EQUATION

developed normally takes the form shown in (10),

$$P+A/T(V+b'')^2=RT/a(V-b') \qquad (10)$$

which is still often quoted as applicable to CO_2, and gives fair agreement with observation from 0° to 30° C. But in spite of these additional complications, the equation would be of little use for practical purposes at low temperatures (where it is most

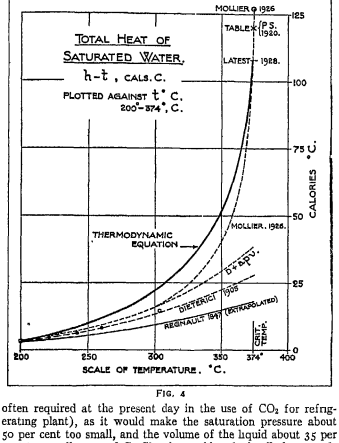


FIG. 4

often required at the present day in the use of CO_2 for refrigeratng plant), as it would make the saturation pressure about 50 per cent too small, and the volume of the liquid about 35 per cent too small at −50° C. Clausius could undoubtedly have made a much better approximation to the saturation pressures, if accurate observations of p had been available over a wider range, but the volumes of the liquid, and the values of the latent heat (which are most important for practical purposes) would still have been most unsatisfactory.

Owing to the restricted range of the observations available for CO_2, Clausius also applied his method to steam, for which Regnault's values of the saturation pressures were above suspicion, and extended over a much wider range. Having succeeded in representing the observed steam-pressures over the range 0° to 330° C by means of an equation similar to (10), but with a somewhat more complicated expression for A as a function of the temperature, Clausius was able to calculate the values of the critical temperature and pressure from the critical relations, which were very similar in form to (8). These gave the values, $t=332°$ C, and $p=134$ atmos., and should have afforded a good test of the theory, but no satisfactory observations were available for comparison. The old estimate, $t=362°$ C, made by de La Tour, for a solution of soda, might not apply to pure water, and the temperature was somewhat doubtful. The values given by Clausius brought the properties of steam more nearly into correspondence with those of CO_2, and the theory of the continuity of state was by that time so firmly established that everyone assumed that all the other properties of the fluid must fall naturally into line if the saturation pressures were correct. The value of the constant b'' was adjusted, as in the case of CO_2, to make the calculated value of v correct at 20° C, but the value given by the equation was nearly 100% too large at 300° C. This was regarded as unimportant, because engineers at that time were in the habit of neglecting the volume of the liquid, but the discrepancy would necessarily make a corresponding error in the calculated values of the latent heat according to van der Waals' theory. Some ten years later Cailletet and Colardeau succeeded in measuring the saturation pressures of steam up to the critical point, which they estimated as 365° C, confirming the old value given by de La Tour. They found the critical pressure at this point to be nearly 200 atmospheres, which greatly exceeded the value given by Clausius. Meanwhile more and more complicated equations on the lines of van der Waals' theory, were still being evolved by mathematicians, who were strongly attracted by the conception of an internal pressure applying equally to the gaseous and liquid states, but were not greatly concerned with the practical question of agreement with actuality. The qualitative agreement with the properties of the vapour were sufficiently striking to arrest attention, while the discrepancies with regard to the properties of the liquid and the latent heat entirely escaped notice owing to the extraordinary difficulties involved in the experimental measurement.

Thermodynamic Equation for the Liquid.—The failure of so many ingenious attempts to construct an equation of the van der Waals' type capable of representing the properties of the liquid satisfactorily, might be taken as strong presumptive evidence that his fundamental assumption of identity of molecular structure was unsound. The proved facts with regard to the continuous transition from vapour to liquid, or *vice versa*, at high pressures might just as well be explained on the hypothesis that the fluid consisted of a mixture of molecules of different types, the composition of the mixture being capable of continuous variation according to the conditions of temperature and pressure. If two phases or mixtures of different molecular composition were capable of coexistence in thermodynamic equilibrium under any given conditions, the fluid would tend to separate into two parts according to general laws, which were first comprehensively stated by J. Willard Gibbs (1875) in his papers on the equilibrium of heterogeneous substances. That a simple substance like water might possibly contain molecules of different types, was first suggested by Rowland as an explanation of the remarkable variation of the specific heat of water near the freezing point, which he attributed to the presence of a small proportion of *ice* molecules. The measurement of the specific heat of water up to 100° C by the continuous electric method (*see* CALORIMETRY) suggested that the variation at higher temperatures could be explained by supposing that water contained its own volume v of saturated steam, which would contribute the fraction $v/(V-v)$ of the latent heat of vaporization L to the total heat h of the water. This gave the very simple and convenient expression for h (*Phil. Trans.* 1902)

$$h=st+vL/(V-v)=st+av\mathrm{T}(dp/dt) \qquad (11)$$

which appeared to be capable of taking account of the variation of specific heat of the liquid at higher temperatures, and at the same time fitted perfectly with Clapeyron's equation, (2), and with all the properties of the liquid in relation to the vapour. Thus if we add L to both sides of (11) we obtain,

$$\mathrm{H}=st+\mathrm{VL}/(V-v)=st+a\mathrm{VT}(dp/dt) \qquad (12)$$

which gives the corresponding relation for the total heat H of the saturated vapour at the same temperature. Moreover it gives equally simple and exact expressions for the entropy of the liquid and vapour in equilibrium, namely,

$$\Phi=s\log_e(\mathrm{T}/\mathrm{T}_0)+vL/\mathrm{T}(V-v) \qquad (13)$$

$$\Phi=s'\log_e(\mathrm{T}/\mathrm{T}_0)+\mathrm{VL}/\mathrm{T}(V-v) \qquad (14)$$

From (11) and (12) we obtain a very useful relation between the volumes and total heats of the liquid and vapour at saturation,

$$v/\mathrm{V}=(h-st)/(\mathrm{H}-st) \qquad (15)$$

and from (11) and (13) we obtain a simple expression for the Gibbs' function, $\mathrm{G}=\mathrm{T}\phi_v-h$, which has the same value for water at saturation as for wet steam of any quality at the same temperature and pressure, namely,

$$\mathrm{G}=\mathrm{T}\phi_v-h=s\mathrm{T}\log_e(\mathrm{T}/\mathrm{T}_0)-st \qquad (16)$$

One of the chief advantages of (11) is that it completely solves the problem of finding the theoretical equation of saturation pressure so far as the liquid is concerned. As indicated above, Rankine had to neglect v entirely and to assume that s was constant. Whereas in (11) s denotes the constant minimum specific heat of the liquid, and the second term takes complete account of the variation of h in terms of the volume v. This term is exactly eliminated by adding the expression for L from Clapeyron's equation, leaving (12) as the equation to be integrated, from which the troublesome terms representing the volume of the liquid, and the variation of its specific heat, have both automatically disappeared. We have only to find consistent expressions for H and V, and the equation must be the exact differential of the corresponding equation of saturation pressure. The equation for the liquid was verified indirectly by the fact that this method gave correct values of the saturation pressures of steam up to 200° C, when the defect of H from Rankine's ideal value was determined by the differential throttling method. The corresponding values of V, as given by the Joule Thomson equation (6), were verified up to the same limit by the subsequent observations of Knoblauch (1905).

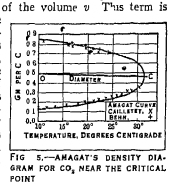


FIG 5.—AMAGAT'S DENSITY DIAGRAM FOR CO_2 NEAR THE CRITICAL POINT

Another method, which appears simpler at first sight, but requires equivalent integrations, is to find a consistent expression for the entropy Φ_x, from those for H and V, by integrating $(dH/T)-a(V/T)dP=dQ/T$. The value of $T\Phi_x-H$ for the vapour is then equated to the Gibbs' function (16) for the liquid. This necessarily gives the same result as integrating Clapeyron's equation in the form (12). It was also found that, if an equation of the van der Waals type, giving consistent values of H and V for the vapour, were combined with equation (11) for the liquid (instead of assuming *the same* equation for liquid and vapour), the combination would give much better results for L, and even for p itself, than Clausius' method. This afforded further presumptive evidence in favour of (11) as a suitable equation for the liquid.

Modified Joule-Thomson Equation.—The modification (6) of Rankine's equation which was adopted by Joule and Thomson to represent the deviations of gases from the ideal state, proved more convenient in practice than that of van der Waals, because it gave V directly in terms of P and T, instead of giving P as a cubic function of V, and also gave a much better account of the properties of CO_2 at moderate pressures. In applying the same equation to steam and other gases and vapours (*Proc. R.S.* June 1906, *Phil. Mag.* Jan. 1903) it was put in the more general form,

$$V-\frac{b}{\eta}=RT/aP-c \qquad (17)$$

in which b is the covolume as in van der Waals's equation, and c represents the reduction of volume due to coaggregation or pairing of molecules. To a first approximation, c is a function of the temperature only, as in the original Joule-Thomson equation (6), but it may vary with temperature in different ways for molecules of different types. Thus in the case of steam, in order to satisfy the adiabatic equation, $P/T^{10/3}=$constant, cP/T must be constant along any adiabatic, in which case c must vary as $1/T^{10/3}$. The value of c was determined by the throttling method on this assumption, and found to be 26·3 c.c/gm. at 100° C. The equation in this simple form gave very convenient expressions for the total heat H, and the entropy Φ of the dry vapour. (*See* THERMODYNAMICS.) When taken in conjunction with equation (16) for the liquid, it appeared that the effect of coaggregation on the saturation pressures could be represented by simply adding the term $a(c-b)p/RT$ to Rankine's theoretical equation (4) for an ideal vapour, which was about 1·5% in error at 100° C without this addition, though agreeing closely with observation at low pressures. The addition of the term required by (18) to represent the coaggregation, brought the values of p into good agreement with Regnault's observations up to 200° C. Beyond this point the values of p given by the modified equation (4) began to deviate gradually from observation, until they were about 15% too small at 365° C according to the observations of Cailletet and Colardeau. It was evident that the first approximation, represented by c, though very good at moderate pressures, or at high superheats, would necessarily fail at high pressures near saturation, because it took no account of the higher degrees of coaggregation due to the combination of the complex molecules with each other. This effect could most easily be represented by employing, in place of c for the coaggregation, a series of the form,

$$c(1+Z+Z^2+Z^3+\text{ etc. }\dots)=c/(1-Z) \qquad (18)$$

representing a geometrical progression with first term c and common ratio Z, where $Z=kcP/T$, being proportional to the mass of the coaggregated molecules present in the vapour. It was found however that, in order to represent the values of p satisfactorily at pressures up to 200 lb., the second term Z in this series must be absent, and that the common ratio should be Z^2 instead of Z, giving the sum of the series in the form $c/(1-Z^2)$. This was confirmed by the observations on the values of V up to the critical point described in the preceding section. Unfortunately the value

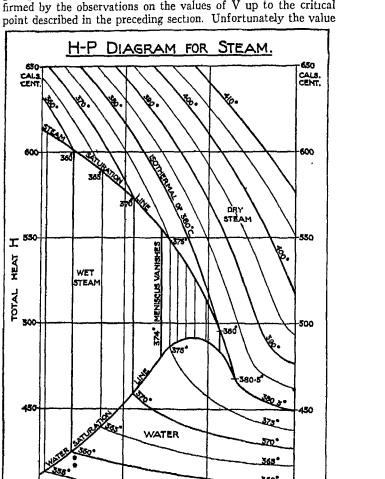


FIG. 6

of Z thus found would not necessarily give correct values of H, unless the adiabatic equation, which required an expression of this type for the coaggregation, remained true up to the critical point. No values of H were at that time available beyond 200° C, and the series suggested by the observations of V was quite inconsistent with the orthodox theory of the critical state, which could not be questioned without the most conclusive experimental evidence. The only practicable method of verifying the adiabatic at such high pressures would be to measure the values of H and h, in addition to those of V and v, which would be a very laborious

and expensive undertaking.

The probability of this solution was first suggested by measurements of the saturation volumes of water and steam in sealed tubes of quartz-glass, which showed that the meniscus vanished at 374° C, and that the densities did *not* become equal at this point, as commonly assumed, but were 0·438 gm /c c for the liquid and 0·264 gm /c c. for the vapour. Moreover, the difference of density could be traced nearly up to 380° C, with suitable illumination, under favourable conditions, and the coefficients of expansion remained finite. These phenomena could not be reconciled with van der Waals's theory, but could be represented satisfactorily by the modified equation (17) with the series $c/(1-Z^2)$ in place of c. Many other stable liquids showed similar effects when carefully purified, but the equilibrium under these critical conditions might be completely upset by small traces of air or other impurities. In order to complete the proof, it was necessary to measure the total heats of both water and steam in the critical region. This had not previously been attempted, owing to grave experimental difficulties, but was successfully accomplished by the jacketed condenser method as described in the article CALORIMETRY.

H-P Diagram for Steam.—The application of the method described above proved to be less troublesome than in the case of water, because no air cushion was required to protect the gauge from vibration, since the steam itself acted as a perfect cushion, and the gauge readings were always steady. It was most important however to keep a continuous check on the purity of the water, and especially on the absence of air, which appeared to have a profound effect on the attainment of true equilibrium between the complex molecules at high pressures near the critical point. The apparatus required for *eliminating air* was very simple and effective. The water for supplying the pump was passed through two boilers in series, which were kept boiling with a free escape of steam. Before reaching the first boiler the water was heated nearly to the boiling point by passing through a regenerator. Most of the air was carried off with the steam from the first boiler, the remainder, to a very small fraction, was eliminated by the second. The air-free water then returned through the regenerator, and was further cooled to atmospheric temperature before being delivered to the pump. With ordinary distilled water, which may contain from a tenth to a twentieth of its volume of air at atmospheric pressure (about 1 part in 10,000 by weight) an almost continuous stream of bubbles could be observed issuing with the condensate through the glass inspection tube attached to the outlet of the condenser. It was impossible under these conditions to obtain consistent values of H owing to accidental fluctuations in the air content of the water. With the air-free apparatus in action, not a single bubble could be seen in the course of an hour's run, and the observations near saturation became incredibly more consistent. The elimination of air appeared to be just as important as in the case of the observations on the saturation volumes in the quartz tubes by the static method. It was also important to keep the fluid in the superheater at a steady temperature for a sufficient time to permit the attainment of true equilibrium before passing into the high-pressure pocket where its initial temperature and pressure were measured. It was then throttled to atmospheric pressure before entering the condenser, where its *total heat* was measured by observing the rise of temperature of a steady stream of cooling water, and deducing the increase of total heat as explained in the article CALORIMETRY.

The results thus obtained on the basis of the above are exhibited in the annexed figure 3, in which the observed values of the total heats are plotted against the pressure, and the temperatures are indicated by isothermal lines. The observations of H and h confirmed those of the saturation volumes by showing that the *saturation lines* for water and steam could be traced beyond 374° C and appeared to meet in a sharp cusp tangential to the isothermal of 380·5° C, which made an abrupt bend at this point, and became parallel to the lower isothermals of water, showing that all the active molecules of steam were condensed. Taking $V-b$ from the modified equation (17), the observed values of H for dry steam were found to agree with the fundamental relation,

$$H-B=(13/3)aP(V-b)+abP, \qquad (19)$$

as required by the equation for the adiabatic. (*See* THERMODYNAMICS.) The observations of h for the liquid verified equation (11), which explains the peculiar form of the water saturation line, since it requires that the active molecules of steam in the liquid must be condensed with increase of pressure at the same rate per unit volume as in the vapour.

A further verification of the system of equations (11), (17), and (19), was afforded by calculating the values of the saturation pressure from the theoretical equation given by (11) and (17) as above explained. These agreed with the pressures previously observed by Holborn and Baumann (1910) to within 0·3° C on the average over the whole range from 0° to 374° C. But the equation went further and continued to give values of p agreeing with observation up to 380·5° C, where it came to a stop, and refused to give any solution at higher temperatures, thus verifying the limit observed by direct experiment. (*Proc. Roy. Soc.* Sept. 1928.)

The theory of the continuity of state, though very fascinating, was most artificial, and was founded on a somewhat inadequate experimental basis. It has now served its turn, and may have to give place to an experimental study of the molecular structure of liquids as affording a more natural explanation of the phenomena of change of state. (H. L. C.)

VAR, a department of France, formed in 1790 of a part of Lower Provence, but in 1860 reduced by the transfer of the district of Grasse to the newly formed department of the Alpes-Maritimes, which is the reason why the Var does not now flow in the department to which it gives its name. It is bounded north by the department of the Basses-Alpes (the Verdon river forming the boundary), east by that of the Alpes-Maritimes (the Siagne stream forming the limit), south by the Mediterranean, and west by the department of the Bouches-du-Rhône. Pop. (1936) 398,662. Area 2,326 sq mi.

The east of the department is built up of the Estérel and the Massif des Maures, a block of Archaean and Palaeozoic rocks, the two parts named being separated by the Argens river; this massif reaches a height of 2,500 feet. The rest of the department is mostly made up of the east-to-west lines of the Alpes de Provence which include the chain of Sainte Beaume (3,786 ft.) in the west, but rise to 5,620 ft. at the Signal des Chens in the northeast. The valley lines for the most part run east and west between the hills, but the Gapeau river makes its way to the coast southwards between the outliers of Sainte Beaume and the Massif des Maures, and other streams have north-to-south sections cutting through lines of hills. The coast shows evidences everywhere of a recent sinking movement and has numerous islands, notably the Iles d'Hyères, Porquerolles, Ile de Riou, etc. The harbour of Toulon is a famous case of a sunken valley. The climate is mild on the coast, St. Raphael and Hyères being much frequented winter resorts. The department now forms the bishopric of Fréjus (4th century) which is in the ecclesiastical province of Aix-en-Provence.

The chief industries are spinning and weaving of silk, manufacture of soap, paper, cork, pottery and tanning. Tobacco is grown and there is much fishing for tunny and anchovy. Trade is in wood and coal. Cut flowers are largely exported from Hyères. The department forms the bishopric of Fréjus (4th century), under Aix-en-Provence. It is in the *académie* (educational division) of Aix, where is its court of appeal, and is in the region of the XV army corp. There are two arrondissements (Draguignan and Toulon), 30 cantons and 151 communes. The principal towns are Toulon, La Seyne, Hyères, Draguignan, its political capital, Brignoles and Fréjus.

VARALLO SESIA, a town of Piedmont, Italy, in the province of Novara, from which it is 34 mi. N.N.W. by rail, situated in the valley of the Sesia, 1,480 ft. above sea-level. Pop. (1936) 3,642 (town); 8,540 (commune). The churches of S. Gaudenzio S. Maria delle Grazie and S. Maria di Loreto, all contain works by Gaudenzio Ferrari (1471–1546), who was born in the neighbouring Valduggia, while the Sacro Monte, a place of pilgrimage rising above the town (1,995 ft.), is approached by a path leading past 45 chapels.

VARAŽDIN, a town of Croatia, Yugoslavia. Pop (1931) 14,609. Varaždin possesses an old castle, a cathedral, several churches, monasteries and schools, and a university There are woollen mills, and trade in timber, wine, pigs, fruit, tobacco, spirits, stoneware and silk. Coal is mined in the Varaždin Mts The celebrated sulphur baths of Constantins-Bad or Toplitz, known to the Romans as Thermae Constantianae, are about 10 mi. S. Varaždin was occupied by Italian troops in World War II.

VARDANES, the name of two Parthian kings

VARDANES I succeeded Artabanus II, probably his father, in A.D. 40 (Joseph. *Ant.* xx. 3, 4), but had continually to fight against his rival Gotarzes (*q.v.*). The coins show that he was in full possession of the throne from 42 to 45. In 43 he forced Seleucia on the Tigris to submit to the Parthians again after a rebellion of seven years (Tac. *Ann* xi. 9). Ctesphon, the residence of the kings on the left bank of the Tigris, opposite to Seleucia, naturally profited by this war; and Vardanes is therefore called founder of Ctesiphon by Ammianus Marc xxiii. 6, 23 He also prepared for a war against Rome, with the aim of reconquering Armenia (*cf.* Joseph, *Ant* xx 3, 4), but did not dare to face the Roman legions (Tac. *Ann.* xi. 10). In a new war with Gotarzes he gained a great success against the eastern nomads In the summer of 45 he was assassinated while hunting, and Gotarzes became king again.

VARDANES II. rebelled against his father Vologaeses I. in A D 54 (Tac. *Ann.* xiii. 7). We know nothing more about him and it is not certain whether the coins of a young beardless king, which are generally attributed to him, really belong to him (Wroth, *Catalogue of the Coins of Parthia*, p L. ff.).

VARENIUS, BERNHARDUS (BERNHARD VAREN) (1622–1650), German geographer, was born at Hitzacker on the Elbe, in the Luneburg district of Hanover. Varenius studied medicine at Königsberg and Leyden universities intending to practise at Amsterdam. But the recent discoveries of Tasman, Schouten and other Dutch navigators, and his friendship for Blaeu and other geographers, attracted Varenius to geography. He died in 1650

In 1649 he published, through L. Elzevir of Amsterdam, his *Descriptio Regni Japoniae* which included a Latin translation of part of Jodocus Schouten's account of Siam (*Appendix de religione Siamensium, ex Descriptione Belgica Jodoci Schoutenii*), and chapters on the religions of various peoples In 1650 appeared, also through Elzevir, his best-known work, *Geographia Generalis*, in which he endeavoured to lay down the general principles of the subject on a wide scientific basis. The work is divided into—(1) absolute geography, (2) relative geography and (3) comparative geography. The first investigates mathematical facts relating to the earth as a whole, its figure, dimensions, motions, their measurement, etc. The second part considers the earth as affected by the sun and stars, climates, seasons, the difference of apparent time at different places, variations in the length of the day, etc The third part treats briefly of the actual divisions of the surface of the earth, their relative positions, globe and map-construction, longitude, navigation, etc.

Varenius, with the materials at his command, dealt with the subject in a truly philosophic spirit; and his work long held its position as the best treatise in existence on scientific and comparative geography The work went through many editions. Sir Isaac Newton introduced several important improvements into the Cambridge edition of 1672; in 1715 Dr. Jurin issued another Cambridge edition with a valuable appendix; in 1733 the whole work was translated into English by Dugdale, and in 1736 Dugdale's second edition was revised by Shaw. In 1716 an Italian edition appeared at Naples; in 1750 a Dutch translation followed; and in 1755 a French version, from Shaw's edition, came out at Paris.

See Breusing, "Lebensnachrichten von Bernhard Varenius" (*Geogr Mittheil.*, 1880); H Blink's paper on Varenius in *Tijdschr van het Nederl. Aardrijkskundig Genootschap* (1887), ser. ii pts. 3; and F. Ratzel's article "Bernhard Varenius," in *Allgemeine Deutsche Biographie*, vol. xxix. (Leipzig, 1895).

VARESE, a town and provincial capital of Lombardy, Italy, 18 m. by rail W. of Como, and 37 m. N.W. of Milan, 1,253 ft. above sea-level. Pop. (1936) 23,348 (town); 44,832 (commune). It is a favourite summer and autumn resort of the Milanese. The church of S. Victor has an ancient baptistery (dating from the 9th century but rebuilt in the 13th) The fine campanile of the church is 246 ft high. To the northwest is the pilgrimage church of the Madonna del Monte (2,885 ft).

VARGAS, GETULIO DORNELLAS (1883–), president of Brazil, born April 19, 1883, at São Borja, Rio Grande do Sûl. was graduated with a degree in law and social sciences from the University of Pôrto Alegre in 1907. After serving in the legislature of Rio Grande do Sul, he became president of the state, 1928–30. Vargas was president of Brazil, 1930–45, and in 1946 was elected to the national senate Elected in Oct. 1950, he again became president of Brazil in Jan 1951.

VARIA (mod Vicovaro), an ancient village of Latium, Italy, in the valley of the Anio, on its right bank, and on the Via Valeria, 8 mi. N E of Tibur (Tivoli) It was probably an independent town and not within the territory of Tibur, and Horace speaks of it as Sabine. Some remains of its walls, in rectangular blocks of travertine, still exist; and there is a chapel of S. Giacomo with beautiful carvings by Domenico Capodistria (d 1464 there) and Giovanni Dalmata. One mile to the east is a picturesque gorge of the Anio, in which may be seen remains of the ancient aqueducts which supplied Rome, consisting partly of rock-cut channels and partly of ruined bridges. above it is the monastery of S. Cosimato. Close to this point begins the valley of the Digentia (mod Licenza) in which Horace's Sabine farm was situated.

For a full description *see* G. Lugli in *Monumenti dei Lincei* xxxi (1924) 457 *sqq.*; and for a short account, G. H. Hallam, *Horace at Tibur and the Sabine Farm* (Harrow, 1927).

VARIABLES, CEPHEID: *see* STAR: *Variable Stars: Cepheid Variables.*

VARIABLE TRANSMISSION GEARS: *see* POWER TRANSMISSION.

VARIATION. All kinds of living organisms vary. It is the business of the biologist to find out the range of such variation in wild and domesticated animals and plants; to decide what share of variation is due to hereditary and what to environmental causes; and to see whether heritable variations, which are the raw material of evolution, can be artificially produced in the laboratory. (*See* also SELECTION; EVOLUTION, ORGANIC; HEREDITY.) (X.)

VARIATION IN NATURE

The variation of animals and plants in nature is, so far as known, subject to the fundamental laws revealed by experiment and pedigree-breedings (*see* HEREDITY). Only by such experiments and culture is it possible to decide authoritatively how a given variation is produced and whether it is heritable or not. Nevertheless it is desirable to know—(a) the actual kinds of variation that occur in nature, (b) which of these we may assume to be heritable and (c) the effect which isolation (topographical, habitudinal, etc) and interbreeding may have on the distribution of variant characters in nature. Variation in the habits of animals, the food they eat, their breeding-seasons and all their complex inter-relationships is moreover of cardinal importance in evolutionary studies and can only be effectively observed among animals in nature The kinds of structural variation that occur in nature will be best illustrated by means of the following classification which, although it is not exhaustive, will show the circumstances in which such variation typically occurs.

1. Variation regularly occurring in the presence of a given environmental condition or factor

(a) Gross variation in form and size associated with the excess or deficiency of some tissue-forming substance.

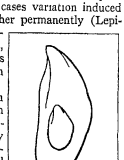
The periwinkle, clam and mussel when living in water of reduced salinity (*e.g.*, in the Baltic Sea) are found to be smaller than in normal sea-water. Low night-temperature and inferior soil render various hawkweeds (*Hieracium*) living at high altitudes more stunted than those living at lower altitudes.

(b) Special modifications.

The tail-lamellae of the brine shrimp (*Artemia salina*) are reduced in water of high salinity. The shape of the common cockle (*Cardium edule*) is more elongate in water of salinity above

that of normal sea-water Terrestrial animals living in damp situations or in humid atmosphere are often darker than representatives of the same species which live in drier conditions This is recorded among slugs (Leydig), birds (Swarth) and mammals (Sumner) The greater part of the variation exemplified by (a) and (b) is in all probability non-heritable. Experiment has however shown that in a few cases variation induced by external causes may be inherited either permanently (Lepidoptera, *Harrison and Garrett*) or temporarily (Amphibia, *Kammerer;* Crustacea, *Agar*). Similarly the colour-differences recorded by Sumner (*see* above) have been shown to be hereditary

A series of allied varieties or races which replace each other in succession, either in time or place, will sometimes exhibit progressive modification Such variation may be simply correlated with a change in geographical position, the causes of structural change being obscure



FROM GRIMPE AND WAGLER, "DIE TIERWELT DER NORD UND OSTSEE" (AKADEMISCHE VERLAUSGESELL SCHAFT, LEIPZIG).

FIG 1—SPECIMEN OF NORTH SEA AND BALTIC MUSSELS, THE SMALL FORM BEING CHARACTERISTIC OF THE BALTIC SEA

2 Variation resulting from adaptation to diverse conditions.

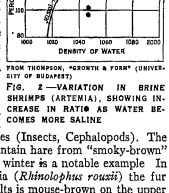
In the arrow head (*Sagittaria*) the same plant may have some leaves adapted for aerial and others for aquatic conditions. Protective "mimicry" affords some striking examples of this type of variation among animals (*see* MIMICRY).

3. Variation known to be heritable but not referable to known external causes

Many variations in colour, form and pattern that are known by experiment to be hereditarily stable have been recognized in nature Such variations may be distributed at random through a large natural population, or the latter may be divided into topographically isolated races or colonies, each of which has a more or less distinct appearance. These divergences may likewise be associated with other modes of isolation, *e.g*, with mutual sterility, difference in breeding-period, etc. Other examples of this kind of variation are to be found in the "colour-phases" of mammals (*e g*, foxes) and birds Stresemann's important work on the occurrence and heredity of such colour-phases in the latter should be consulted (Bibliography). It is also known in flowers.

4. Variation due to accident, interference with growth-processes, etc.

It is not always easy to differentiate between this type of variation and that described in (1). For example the shells of the water snail *Planorbis* seem to assume the uncoiled ("scalariform") form in water of unusually high temperature. This may be described as an accidental malformation, but it is actually produced by a particular state of the medium in which these snails live. Scalariformity is more obviously "accidental" when produced in the Gastropod *Trochus* by parasitic infection. Plant lice sometimes produce green colour in flowers and the attacks of a rust fungus (*Aecidium*) produce shorter and broader leaves in *Euphorbia cyparissias*



FROM THOMPSON, "GROWTH & FORM" (UNIVERSITY OF BUDAPEST)

FIG. 2—VARIATION IN BRINE SHRIMPS (ARTEMIA), SHOWING INCREASE IN RATIO AS WATER BECOMES MORE SALINE

5. Seasonal Variation.

This is a familiar phenomenon among vertebrate animals, and is also known among invertebrates (Insects, Cephalopods). The change of coat-colour in the mountain hare from "smoky-brown" in summer to white or "blue" in winter is a notable example In the rufous horseshoe bat of India (*Rhinolophus rouxii*) the fur after the spring and autumn moults is mouse-brown on the upper surfaces. This changes in course of time into brighter colours, probably owing to oxidation of the pigment.

6 Variation due to sexual dimorphism and growth-changes

Strictly speaking this should not come under the rubric of variation as described here; but it is important to notice that some of the differences in size, colour and shape among animals of the same species may be due to these causes

The data presented above relate only to the structure of animals and plants Although the distinction between structural characters and those of physiological constitution and habits is arbitrary, it is convenient to retain the distinction in a survey of this kind. Our knowledge concerning modes of variation other than that of structure is less complete. Each species is probably as variable in its physiological constitution as it is in its structure This has been shown by exact tests, and also may be inferred from such facts as the infection of hosts belonging to different families and genera by individuals of the same species of parasite, the occupation by members of the same species of habitats radically different in physical and bionomic factors, varying susceptibility to disease and so on. The variability of habits may be illustrated by Darwin's observations on the behaviour of the great titmouse, certain individuals of which species sometimes behave as birds of prey.

A number of highly important considerations are omitted from this discussion The problem of intermediacy, the degree of variability in different species of the same genus, the relation between natural variation and classificatory units, observations on the effect of Natural Selection and on the first appearance, increase or decrease of variant individuals are dealt with in the undermentioned works

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(G. C. R.)

of the *variation* which actually occurs, *differences* in heredity or *differences* in environment?" If, now, we take variation in the larger sense, to include differences between all living things, it is obvious that, all in all, differences in environment are an insignificant cause of the existng variation as compared with hereditary differences, and this is usually true even of two individuals chosen from closely related yet different species. On the other hand, within a given population of one species, the variation due to environment is sometimes comparable to, or even much greater than, that dependent on the genes. Which sort of variation predominates, and to what extent, will depend on many circumstances, and to answer our question will therefore require separate study, and often elaborate experimentation and measurement, in the case of each population considered and even in the case of different characteristics in the same population. The unravelling of any intimate combination of hereditary and environmental effects will usually demand either that we hold the effective features of the environment constant (often an impossible operation), or else that we secure a set of individuals identical in their genes (as a result of inbreeding, twinning or asexual reproduction); under such circumstances the residual variation, due to the influence that was not held constant, may then be ascertained.

It is especially desirable to discover not only the extent of variation due to environmental differences, but the principles governing the production of this variation. This quest, however, leads to a study of all the intricacies of embryonic development, physiology and mechanistic biology in general. Although the details of the chemistry and physics comprised in these phenomena are for the most part scarcely guessed, we at least know, from our observations on the grosser visible occurrences, that the processes whereby most adult organs and characteristics are formed are highly involved, interdependent in a complicated way and composed of many successive reactions. Make one change, and effect follows effect until the final result bears no resemblance to the initial one. So, for example, a quantitative change in some primary process may appear in the adult as a qualitative change, and vice versa. It should also be observed that there are often regulatory mechanisms which automatically compensate for effects produced, as in regeneration of a lost limb or in the accelerated growth of a child following temporary stunting.

Genetics has adduced cogent evidence that, despite the strong influence of the environment in modifying the body as a whole, and even the protoplasm of its cells, the genes within the germcells of that body retain their original structure without specific alterations caused by the modification of the body, so that when the modified-individual reproduces it transmits to its offspring genes unaffected by its own "acquired characters." The offspring, then, will not tend to repeat the parental modifications, unless the same peculiar environment is itself repeated. Our sins and our successes are not reborn in our children, though the latter may inherit our original tendency and capacity for these. Modifications, therefore, unlike mutations, cannot be a cause of biological evolution or degeneration. Now, if modifications acquired before the conception of children are not visited upon the latter, it certainly holds true that any modifications acquired by the mother after the embryos are partly developed, but prior to their birth, would not be transmitted to them. Mothers may rest assured that there is no more ground either *a priori* or in observation, for supposing that a fright received during pregnancy (or before) will give their child a fearsome disposition than that it will give him spots.

Variation Due to Segregation and Recombination of Genes.—Whenever an individual breeds, having received a different hereditary contribution from its two parents, its offspring will tend to vary from one another. Thus, if we had received a gene for brown eyes from our mother, and one for blue eyes from our father, then, although we ourselves would have brownish eyes (brown being said to be "dominant" and blue "recessive"), nevertheless we would transmit our gene for brown only to half of our reproductive cells, and the gene for blue, unalloyed by brown, to the remainder. This process of separation is called segregation (*see* HEREDITY). If our parents had given us different genes for hair-form also, we would produce reproductive cells having all the possible assortments of the two pairs of genes, namely, some having "brown curly," others "blue straight," still others "brown straight" and the rest "blue curly." This phenomenon is recombination. Since such variation can be produced in our children only in respect to genes which already differed from one another in our parents, it is evident that the primary cause of this variation lies in the events whereby these genes came to differ in the first place, that is, in the gene-mutations such as originally changed a gene for brown eyes into the gene for blue. These mutations, that make possible the recombinations of to-day, may have happened in the remote past.

The explanation of segregation and recombination is to be found in the behaviour of the chromosomes, those tiny separate filamentous bodies, visible under the microscope, which contain the invisible genes "linked" together within them, like beads in so many separate chains. Several or many chromosomes, each probably containing hundreds of different genes of distinctive natures and effects, are contained in each of the two uniting reproductive cells derived from the two parents. While the majority of the genes from one parent are always like those from the other, since the parents are in general similar organisms, yet in the case of most matings there are some gene-differences, and these give an opportunity for the operation of the segregation and recombination processes above mentioned, after the individual formed by the union of the two cells in question develops and reproduces reproductive cells for a still later generation.

It will be seen that the more gene-differences exist the more different combinations can then be formed. The numerical relations resulting from recombination are calculable according to definite laws, provided the effects of the genes concerned, and their positions in the chromosomes, have been determined by prior experimentation. The character-effects of untried combinations cannot, however, be predicted with certainty, as unexpected developmental results, including even new traits, are occasionally produced by recombination. As some new combinations may be more advantageous for the race than the original combinations, the function of recombination, of segregation, and in fact of sexual reproduction itself, becomes explained in terms of their value in evolution.

The development of most characters depends on the combined action of numerous genes. A difference in any one of these genes may affect either the quality, or the degree of development of the character in question. Now, when a number of mutations, in different genes all concerned with the same character (*e.g.*, stature), have some time previously occurred in a population, random crossing and recombination will result in the transmission, to different offspring, of many different assortments of the mutated and non-mutated genes. Thus the population may tend to exhibit many different grades of expression of the character. These grades will often differ only by small steps, which become blurred into an apparently continuous gradient through the effect of environic modifications. Such quantitative variation, as well as all other variation of recombinational origin, is of course especially evident when individuals are bred which resulted from the crossing of widely different stocks, in which many differing gene-mutations had become established since these stocks diverged from their common ancestor.

Many abnormal types of recombination occasionally occur, owing to such disturbances of chromosome-behaviour as the loss or reduplication of a chromosome or section of a chromosome, or the reduplication of one or more entire sets of chromosomes. When such an occurrence alters the proportions existing between the different kinds of genes (by changing the numbers of some and not of others) there generally results a combination of various (usually detrimental) abnormalities at once. At other times, a chromosome may become broken in two, or two chromosomes unite to form one, or a piece broken off one chromosome and united to another. The genes thereby become rearranged, but the characteristics of the individual probably remain little affected, since they depend rather on the kind and numbers of

different genes present than on their arrangement X-rays, cold and other influences are known to induce such disturbances of chromosome behaviour

Mutations in the Genes.—It has been found in fruit flies (*Drosophila*) that any given gene, existing in a fly at the present day, has probably remained constant in its composition for several thousand years. This stability is not passive, for, as every organism grows and reproduces through a process of repeated cell growth and cell division, each gene must repeatedly reproduce itself, and in so doing it must each time construct a daughter-gene that possesses exactly its own peculiar structure. Occasionally, however, something goes wrong, and either the mother-gene becomes altered in its composition or else the daughter-gene is not formed exactly in the image of the old gene As a result of this mutation there arises a new type of gene, having a different effect upon the organism, and this mutant gene is then capable of reduplicating its own new type—a process which it usually performs with as constant accuracy as that which the old gene had exhibited It is this peculiarity of the gene—its retention of the power of self reduplication despite the occurrence of alternations (mutations) in its composition—which makes heritable variations possible, and hence organic evolution.

There is evidence that, when one gene in a cell mutates, the thousands of others, even including the similar or identical gene derived from the other parent, remain unaffected and constant The mutation, then, may be regarded as an "accident" of submicroscopic dimensions, dependent on the occurrence of certain "chance" configurations of atoms, electrons and energy-quanta within or near the gene in question It is not strange, in view of this, that it has not yet been proved possible, by particular external conditions, to dictate the occurrence of specified types of gene mutations in preference to others.

Though the kind of mutation which shall occur has not been brought under control, experiments with a number of different organisms have shown that heavy treatment with X-rays will make the mutational accidents in general occur far more frequently than otherwise, so that gene mutations of varied kinds may be produced at a rate in some cases more than a hundred times higher than that at which they previously were found to occur This raises the conjecture, as yet untested, that possibly the γ-rays (related to X-rays) which originate in minerals of the earth's crust have played an essential role in the causation of the varied "natural" mutations through which evolution has come about However, there is evidence that temperature, genetic composition, and perhaps other factors, also affect the general frequency of gene mutations No particular stage in the life cycle is known to be especially favourable for the occurrence of gene mutations; certainly they may happen either in embryos or in adults, and in somatic as well as in germinal tissue, though of course only mutations in germ cells can be inherited

Though most gene mutations seem, in the sense above explained, to be accidents, some genes appear to be less stable than others, and a few are definitely known to be exceedingly mutable (ever-sporting) In the latter cases, which may represent changes of a different sort from most gene mutations, the stability of the mutable gene may be much affected by specific conditions. These effective conditions differ in different cases Some are determined by the nature of the tissue and developmental stage in question, others by the external environment, and still others by the genetic composition.

A given gene has the capability of mutating in various ways so as to form a number of different kinds of genes (multiple allelomorphs). Usually the effects of these differing changes in a given gene resemble each other strongly, and often, though not always, the discernible differences between them lie chiefly in the degree of change produced There are also numerous cases on record of mutations that seem quite identical in kind with other mutations which occurred independently in homologous genes of other individuals belonging to the same or a related species. Not infrequently, too, different kinds of genes (nonhomologous) will, on mutating, produce similar or indistinguishable final effects on the characteristics of the organism. In this connection it is found that certain character changes can be produced by mutations in a greater number of different genes, and hence tend to occur more commonly, than others.

The most frequently produced effect, so far as known, is the lethal effect; that is, mutant genes are usually so deleterious in their action that they tend to kill the organism. When they are not positively lethal they are usually retrograde in direction, and hinder rather than help the organism to fulfil the functions of its existence. Such results are to be expected of accidental changes occurring in any complicated organization. A race, therefore, will tend gradually to undergo degeneration in any respect in which selection (natural or artificial) does not persistently weed out the degenerative mutations that continue to occur It can be only the rare mutations that are helpful which furnish material for evolution. These latter, however, when they show, will tend to multiply.

As a matter of fact, most gene mutations never show. For most (though not all) mutant genes are recessive to the type from which they arose, and in their cases an obviously mutant individual cannot appear unless—usually many generations subsequently to the original gene mutation—two reproductive cells, each bearing the identical mutant gene, meet in fertilization

Both conspicuous and inconspicuous, minor and major, fundamental and superficial character changes are produced by gene mutation, and either one character or several at once may be altered by a single gene change. The more far-reaching the change, the more apt it is to be deleterious rather than advantageous. Hence geneticists are returning to a view essentially similar to Charles Darwin's (though now much more highly elaborated), namely, that the origin of one species from another usually involves the accumulation of numerous selected small steps of heritable variation.

See Animal Breeding; Breeds and Breeding; Chromosome; Cytology; Gene, Heredity, Plant Breeding.

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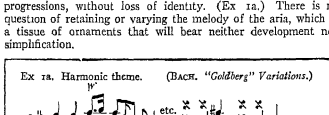
VARIATIONAL PSYCHOLOGY: *see* Differential Psychology.

VARIATIONS, in music, the term given to groups of progressively developed versions of a complete self-contained theme, retaining the form of that theme though not necessarily its melody This is the classical sense of the term, but there are modern developments of the variation form to which this definition is at once too broad and too precise to apply. The aesthetic principle of variations appeared at very early stages of music. During the 16th century an artistically mature variation form automatically rose in the polyphonic treatment of Gregorian hymns verse by verse. Accordingly, the hymns and Magnificats of Palestrina might be described as contrapuntal sets of variations on ecclesiastical tunes, like rich and free examples on the simple plan shown later by Haydn's variations on his Austrian national anthem in the "Emperor" quartet (opus 76, no 3). Already in the 16th century instrumental music was climbing up the trellis of a primitive variation form. A favourite plan (*see* the *Fitzwilliam Virginal Book, passim*) was to put together several popular or original tunes, with an ornamental variation sandwiched between Sometimes sets of variations on a single tune were produced with excellent effect, as in Byrd's variations on "The Carman's Whistle." Such variations were naturally grouped in order of increasing brilliance, and they often include passages that would catch the greatest pianoforte players.

In the 17th century a highly artistic form of variation solved with great simplicity the problem of expanding instrumental pieces to a length admitting of growth to a big climax. This was the ground bass, a single phrase placed in the bass and repeating itself ad infinitum. It originated in the dance forms of the *passacaglia*

and the *ciaconne*. Both were in slow triple time, the chaconne having a strong accent on the second beat, while the passacaglia, by some chance, developed the liberty to transfer its theme to other parts than the bass. The genius of Purcell was cruelly hampered by the non-existence of large musical forms in his time, and he seized upon the ground-bass with avidity. By the time of Bach and Handel lighter sets of variations, consisting essentially of embroidery on a melody, had come into vogue. Bach's *Aria variata alla maniera Italiana* tells us where this fashion began; and in France the *air et doubles* was taken over from early English virginal music. Doubles are variations each of which divides the rhythm into quicker notes than the one before. The most familiar example is that known as "The Harmonious Blacksmith" in Handel's E major suite. Sometimes the air itself was stated in a tangle of ornamentation, while the doubles simplified the melody and varied the accompaniment. But Bach had meanwhile applied the principle of the ground-bass to variations on a complete symmetrical movement in binary form. His Air and 30 Variations, commonly known as the "Goldberg" variations, is (with the exception of Beethoven's 33 *Veranderungen* on a waltz by Diabelli) the most gigantic set of variations in the world. A melodically interesting ground-bass could not be maintained on so large a scale; but the 32 bars of Bach's theme are so many clear harmonic steps which can be represented by many analogous progressions, without loss of identity. (Ex 1a.) There is no question of retaining or varying the melody of the aria, which is a tissue of ornaments that will bear neither development nor simplification.

Ex 1a. Harmonic theme. (BACH. *"Goldberg" Variations.*)



Ex. 1b.
Var. 25.



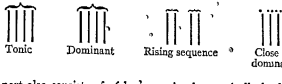
The rise of the sonata style again brought the melodic embroidery variation into prominence; for in sonata forms we identify themes entirely by their melodies. Now, with not more than three or four exceptions, the best sets of variations by Mozart and Haydn are movements in their sonata works; and their independent sets are either early or perfunctory exercises and encore-pieces. Two common mistakes of professional and amateur criticism are, first, the judging of Haydn's and Mozart's variations by these parerga, and secondly, the much graver error of despising the embroidery variation on principle. It is either vulgar or sublime. And it is handled lovingly by precisely the greatest masters of deep harmonic and rhythmic variation, Beethoven and Brahms. Haydn is fond of a special form first known in Philipp Emanuel Bach. It consists of alternating variations on two themes, alternately major and minor; the first a rich and complete binary melody, and the other a shorter binary melody, often beginning with the same figure as the first. The first theme usually returns as if it were going to be unvaried, but its first repeat is an ornamental variation. The form is rarely worked out far enough to include more than one variation of the second theme; and sometimes (as in the famous "Gypsy" trio) there are new episodes instead of variations of the second theme, so that the form becomes a sectional rondo. The only strict example of Haydn's type of alternating variations in later music is the first allegretto of Beethoven's pianoforte trio in E flat (op 70, No. 2); but a magnificent application of it, without change of mode, though with a wide range of key, is shown in the slow movement of his C minor symphony.

Beethoven, in his last works, invented another variation-form on two themes, of which the second is in a different key and time. The examples of this are the slow movement of the 9th symphony and the Lydian figured chorale in the A minor quartet. In the slow movement of Brahms's F major string quintet (op. 88), the alternation of the two keys gives rise, in the last line of the movement, to one of the most astonishing dramatic strokes in all music. Beethoven uses embroidery variations as means of obtaining extraordinary repose in slow movements. The extreme case of this is the slow movement of the sonata op. 57 (commonly called "Appassionata"), which is described in the article on SONATA FORMS. In this, and in many other instances, his method is that of the *air et doubles*, which grows to a natural climax which can subside into the rhythm of the plain theme. Until his latest works, such sets of variations are never finished. Their dramatic intent is that of a repose which is too unearthly to last; and at the first sign of dramatic motion or change of key the sublime vision "fades into the light of common day," a light which Beethoven is far too great an idealist to despise. *See* the andante of the B flat trio (op. 97); and the slow movement of the violin concerto, which contains two episodic themes in the same key. In his later works Beethoven found means, by striking out into foreign keys, of organizing a coda which finally spins down in fragmentary new variations, or even returns to the plain theme. Thus he was able to end his sonatas, opp. 109 and 111, with solemn slow movements.

Beethoven also found other applications of the variation forms. Thus the finale of the Eroica symphony has not only the theme but many other ideas in common with the brilliant set of variations and fugue for pianoforte on a theme from *Prometheus* (op 35); and the fantasia for pianoforte, chorus and orchestra, and the choral finale of the 9th symphony, are sets of melodic variations with freely-developed connecting links and episodes. In the case of the 9th symphony, a second thematic idea eventually combines with the figures of the first theme in double fugue.

But Beethoven's highest art in variation-form is independent of the sonata. From his earliest display of pianoforte playing, the wonderful 24 variations on a theme by Righini, to his supreme variation-work, the 33 on Diabelli's waltz, he uses and transcends every older means of variation and adds his own discoveries. Before Beethoven the basis of variations might be a ground bass, a melody or a harmonic scheme. Beethoven discovered that rhythm and form can, with a suitable theme, be a solid basis for variations. The aria of Bach's Goldberg variations is in its phrasing as uniform as a chess-board; and if its harmonies had not a one-to-one correspondence with each variation the form would be lost. But there are themes, such as Haydn's Chorale St. Antoni, which Brahms varied, where the phrasing is interesting in itself. A similar example is the theme by Paganini (Ex. 2a) which inspired Brahms to compose two complete sets on it.

The climax in the history of variations dates from the moment when Beethoven was just about to begin his 9th symphony, and received from A. Diabelli a waltz which that publisher was sending round to all the musicians in Austria, so that each might contribute a variation to be published for the benefit of the sufferers in the late Napoleonic wars. Diabelli's theme was absurdly prosaic, but it happened to be, perhaps, the sturdiest piece of musical anatomy that Beethoven (or any composer since) ever saw; and it moved Beethoven to defer his work on the 9th symphony! The shape of Diabelli's waltz may be illustrated by a diagram which represents its first 16 bars; the upright strokes (not the spaces) being the bars, and the brackets and dots (together with the names underneath) indicating the rhythmic groups. The sec-



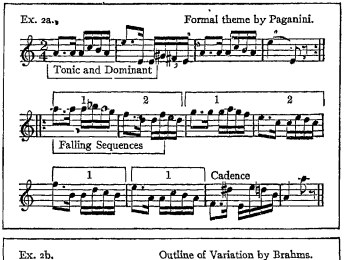
ond part also consists of 16 bars, moving harmonically back from the dominant to the tonic, and rhythmically the same as the first part. This plan is astonishingly elastic. The alternation of tonic and dominant in the first eight bars may be represented by another familiar form in which three bars of tonic and a fourth of dominant are answered by three bars of dominant and a fourth of tonic; as in variation 14 (which must be reckoned in half-bars). Again, when the theme answers the tonic by the dominant it raises the first melodic figure by one step, and this may be translated by the answer on the supertonic harmony. In the course of 50 minutes a few of these 33 variations become vague as to more than the beginnings and cadences of the theme; and there are three simple variations in which one would like to ask Beethoven whether he had not inadvertently omitted a bar; but the momentum of the theme is never lost; and after a group of three slow and rather free variations this momentum breaks into an entirely free fugue (variation 32) on a salient feature of what must by courtesy be called Diabelli's melody. A free fugue is a favourite solution of the problem of the coda in a set of variations The momentum produced by the revolution of true variations in the orbit of the theme gives the key to the whole problem. A fugue solves it by flying off at a tangent. Very sublime is the way in which Beethoven, after letting his fugue run its torrential course, returns to the orbit of his theme in an ethereal little minuet with a short coda of its own which, 16 bars before the end, shows signs of beginning to revolve again.

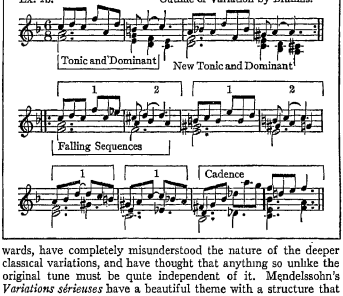
Again, let us regard the period of the theme not as an orbit but as diurnal rotation. We can then describe the codas of Brahms's Paganini-variations as produced by accelerating the spin till it breaks away for a while and then resumes for a few final catastrophic whirls; exactly like a dying top (though this, of course, does not accelerate its spin). Without acceleration Beethoven ended his wonderful C minor variations (most perfect of passacaglias) in this way. Brahms found in Haydn's Chorale St. Antoni the opportunity for another method. He took the first five bars as a ground-bass, within which narrow orbit the finale moves until its climax broadens out into the rest of the glorious theme, and so rounds off the whole work.

Bach poised the contrasts and climaxes of the Goldberg variations so accurately that the ending of the whole by a simple *da capo* of the theme is astonishingly effective. It is as if a charming old ancestress of a living line of great folk were to step from the frame of her Holbein portrait and bow to her assembled posterity.

To speak of the progress in variation-form since Beethoven is like speaking of the progress in reinforced concrete since the Parthenon. The classical variation-form is limited only by the composer's imagination and technique; and the removal of its foundations does not enlarge it at all. There is no reason to condemn other kinds of variation; and many great and beautiful works in non-classical variation-form exist, from Schumann's *Études Symphoniques* to Elgar's "Enigma" variations and Dohnányi's *Variations on a Nursery Tune*. But no "free" variation that breaks down the phrasing of its theme and follows its own discursive ways will ever achieve anything externally so unlike the theme as a strict harmonic and rhythmic variation on classical lines. (*See* Ex. 2b.) Nor will a series of such variations acquire anything like the classical momentum. On the contrary, in clumsy hands the free variation becomes apologetic in the way in which it offers raw chunks of the original melody as evidence that it has not forgotten its duty, like Lewis Carroll's poetic *Tema con Variazioni*, the preface to which is an unconscious epitome of modern misunderstandings of the form.

Variation writers may be scientifically classified into those who know their theme and those who do not. There is no reasonable doubt that many very clever composers, from Mendelssohn on-





wards, have completely misunderstood the nature of the deeper classical variations, and have thought that anything so unlike the original tune must be quite independent of it. Mendelssohn's *Variations sérieuses* have a beautiful theme with a structure that might have given rise to splendid features; but Mendelssohn simply ignores this structure and replaces it by weaker things in almost every variation. Schumann shows more insight. He has no great grip of his theme, but he tries to distinguish by titles those variations which are true from those which are episodic; thus in the *Études Symphoniques* the etudes are numbered separately from the variations; the andante of the F major quartet is called *quasi variazioni*; and the strictest set he ever wrote (on a theme by Clara Wieck) is called Impromptus.

Brahms stands alone in his grip of his theme. Reger is no nearer the classical form in his variations than in his other works The present state of the form seems to indicate that if the composer does not aim at strict variations his most vital results will be on the line of melodic development, as in the above-mentioned works of Elgar and Dohnányi, the Symphonic Variations of Dvořák, and those variations of Reger which are closest to this type. (D. F. T.)

VARIATIONS, CALCULUS OF: *see* CALCULUS OF VARIATIONS.

VARICOSE VEINS. Varicose veins is the term usually applied to enlarged, dilated and tortuous superficial veins of the lower extremity The condition is one of the most common human ailments which is amenable to surgical treatment. It has been recognized since the time of Hippocrates and probably dates back to the time when man first assumed the erect position. The disease has never been recognized in quadrupeds.

The most important causative factor is the hydrostatic pressure of the blood in the veins (*q* v.) in the erect position. Normally, there are bicuspid valves in the veins which permit the blood to

flow only toward the heart. Because of the segmental arrangement of this system of valves, the venous pressure becomes greatly lowered during muscular activity

In most instances of varicose veins, there is apparently a defective system of valves in the upper part of the extremity so that with increasing age the veins become more dilated Eventually, the entire system of veins, down to and including those over the foot, becomes dilated and tortuous. There is a definite hereditary factor in the disease. It is also believed that occupations which require a great deal of standing, or even sitting with little muscular activity in the lower extremities, are chief causative factors.

Abdominal tumours, especially the pregnant uterus, which increase pressure within the abdomen and thereby interfere with the return of blood from the extremities, may also play a role An additional contributing factor during pregnancy may be one of the hormones (not identified at mid-20th century). The veins of the legs frequently become greatly dilated before the uterus has enlarged to any great extent.

Varicose veins rarely are a serious threat to life or limb. Treatment is sought frequently because of the disfiguring appearance The most common symptom is pain in the region of the dilated veins

In cases of long-standing varicosities, changes may develop in the skin, resulting in a chronic irritation known as varicose eczema or dermatitis which may even progress to chronic ulceration In a few instances when the veins are very large, the individual may complain of faintness and a rapid heart beat, the result of the pooling of a large volume of blood in these venous reservoirs

Spontaneous clotting may develop because of the stagnation of the blood, resulting in a condition called venous thrombosis or thrombophlebitis. In rare instances, a varicose vein may rupture with considerable loss of blood Bleeding under these conditions can be quickly controlled by elevating the leg above the level of the heart and applying a pressure pad over the bleeding point.

The treatment of varicose veins has gone through many cycles At mid-20th century the most satisfactory method yet developed consisted of removing the main venous trunks, the internal and external saphenous veins, by surgery. This is performed through a few incisions and is accomplished by a process of subcutaneous stripping of the veins. The complications of this form of treatment, if it is performed carefully, are very few and the results excellent. The simple types of varicose ulcer, a complication of varicose veins, are also curable by this method of treatment. Attempts to cure the condition by the injection of sclerosing solutions alone have not been successful.

The time-honoured use of an elastic stocking or bandage may give relief from pain but is not curative. It may be recommended, however, in aged patients who are not fit subjects for a surgical operation.

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(R. R. L.)

VARIETY THEATRE: *see* THEATRE.

VARIOLITE, in petrology a basaltic or doleritic rock with prominent spheruliţic (variolitic) texture, the spherulites or varioles consisting usually of radial aggregates of feldspar. These varioles, especially on weathered surfaces, appear as pale-coloured spots, giving the rock a pockmarked appearance. The name is from Lat. *variola*, smallpox, in allusion to this characteristic feature

The variolitic texture of the basic rocks is closely akin to the spherulitic texture of the acid lavas, as seen in rhyolites, etc.

Variolites frequently form the tachylytic selvages of dolerite dikes (*see* TACHYLYTE), and also appear in the form of pillow lavas (*see* SPILITE). The varioles are usually rounded in outline and are often about ¼ in. in diameter, but may much exceed this size With few exceptions they are built up of divergent fibres of feldspar embedded in dark brown glass. As varioles are frequently much decomposed, the glassy matrix is represented by secondary alteration products or has been devitrified. (C. E. T.)

VARLEY, JOHN (1778–1842), English water-colour painter, was born at Hackney, London, on Aug 17, 1778. His father discouraged his leanings toward art, and placed him under a silversmith But after his father's death the lad found work with an architectural draughtsman, who employed him to sketch the principal buildings in the towns they visited. His spare hours were employed in sketching from nature, and in the evenings he was permitted, like William Turner and Thomas Girtin, to study in the house of Thomas Monro

In 1798 he exhibited his first work, a "View of Peterborough Cathedral," in the Royal Academy

In 1799 he visited north Wales, and in its wild mountain scenery found the subjects best suited to his brush. He returned to the same district in 1800, and again in 1802, and the impressions then received powerfully influenced the whole course of his art In 1804 he became a foundation member of the Royal Society of Painters in Water-Colours, and he contributed more than 40 works to its first exhibition

He had married in the previous year, and, in order to provide for the wants of an increasing family, he produced for the dealers much work of a slight and commonplace character. He also taught drawing, and some of his pupils, such as John Linnell and William Hunt, afterward became well-known.

He was a firm believer in astrology and casted horoscopes It was at his house that his friend William Blake sketched his celebrated "Visionary Heads." Varley died at London on Nov. 17, 1842.

Varley's landscapes are graceful and solemn in feeling and simple and broad in treatment, being worked with a full brush and pure fresh transparent tints, usually without any admixture of body-colour.

Though his works are rather conventional they are excellent in composition Some of his earlier water-colours, including his "Views of the Thames," were painted upon the spot, and possess greater individuality than his later productions, which are mainly compositions of mountain and lake scenery, produced without direct reference to nature.

Among his literary works are *Zodiacal Physiology* (1828), *Observations on Colour and Sketching from Nature* (1830); and *A Practical Treatise on Perspective, and Principles of Landscape Design for Young Artists.*

VARNA (STALIN), a fortress, seaport, district capital and episcopal city of Bulgaria, on the Stalin gulf, an inlet of the Black sea, in 40° 12′ N. and 27° 56′ E. Pop (1947) 77,792. Varna is built on the hilly north shore of the bay, overlooking the estuary of the Devna river It is the eastern terminus of the railway to Rustchuk and Sofia. The "Varna quadrilateral," so important in Bulgarian military history, consists of the fortresses of Varna, Shumla, Rustchuk and Silistra (*q.v.*). Varna ranks with Burgas as one of the two principal seaports of Bulgaria. Its deep and capacious bay is sheltered from northerly and northeasterly winds, and the harbour works are modern

The principal exports include cattle and dairy produce, grain, lamb and goat skins, and cloth (*shayak*); the imports include coal, iron and machinery, textiles, petroleum and chemicals. The headquarters of the Bulgarian Steamship Co, which traded with Turkey, Greece and Russia, were established there. Its trade was affected by the cession of the Dobruja to Rumania until 1940, but it became a popular seaside resort. During World War II, Germany used the port as a shipping supply base to provision axis armies fighting in the U.S.S.R

Varna was the ancient Milesian colony of *Odessos*, founded 585 B.C. Close by was fought in 1444 the battle in which Murad II slew Wladislaus III of Poland and Hungary, and routed his forces under Hunyadi János. Varna was occupied in 1828 by the Russians, in 1854 by the allies, who there organized the invasion of

the Crimea, and in 1877 by the Egyptian troops summoned to the defense of Turkey against the Russians. By the treaty of Berlin (1878) it was ceded to Bulgaria. Long the seat of a Greek metropolitan, it became in 1870 the seat of a Bulgarian bishop.

In 1949 it was renamed Stalin and made the capital of a newly formed district of the same name.

VARNHAGEN VON ENSE, KARL AUGUST (1785–1858), German biographer, was born at Dusseldorf on Feb. 21, 1785. He studied at Berlin, Halle and Tübingen. He began his literary career in 1804 as joint-editor with Adelbert von Chamisso (*q.v.*) of a *Musenalmanach*. In 1809 he joined the Austrian army, and was wounded at the battle of Wagram. Soon afterward he accompanied his superior officer, Prince Bentheim, to Paris, where he carried on his studies. In 1812 he entered the Prussian civil service at Berlin, but in the following year resumed his military career, this time as a captain in the Russian army. He accompanied Tettenborn, as adjutant to Hamburg and Paris, and his experiences were recorded in his *Geschichte der Hamburger Ereignisse* (London, 1813), and his *Geschichte der Kriegszüge des Generals von Tettenborn* (1815). At Paris he entered the diplomatic service of Prussia, and in 1814 acted under Hardenberg at the congress of Vienna. He also accompanied Hardenberg to Paris in 1815. He was resident minister for some time at Karlsruhe, but was recalled in 1819, after which, with the title of "Geheimer Legationsrat," he lived chiefly at Berlin. He had no fixed official appointment, but was often employed in important political business. In 1814 he married Rahel Levin (1771–1833) sister of the poet, Ludwig Robert (1778–1832). By birth she was a Jewess, but before her marriage she made profession of Christianity. She was a woman of remarkable intellectual qualities, and exercised a powerful influence on many men of high ability. After her death her husband published a selection from her papers, and afterward much of her correspondence was printed. Varnhagen von Ense died suddenly in Berlin on Oct. 10, 1858.

He made some reputation as an imaginative and critical writer, but he is famous chiefly as a biographer. He possessed a remarkable power of grouping facts so as to bring out their essential significance, and his style is distinguished for its strength, grace and purity.

BIBLIOGRAPHY.—Among his principal works are *Goethe in den Zeugnissen der Mitlebenden* (1824); *Biographische Denkmale*, 5 vol (1824–30), 3rd ed. (1872); and biographies of General von Seydlitz (1834), Sophia Charlotte, queen of Prussia (1837), Field-Marshal Schwerin (1841), Field-Marshal Keith (1844), and General Bülow von Dennewitz (1853). His *Denkwurdigkeiten und vermischte Schriften* appeared in 9 vol. (1843–59), the two last volumes appearing after his death. His niece, Ludmilla Assing, between 1860 and 1867, edited several volumes of his correspondence with eminent men, and his *Tagebucher*, 14 vol (1861–70). *Blatter aus der preussischen Geschichte* appeared in 5 vol (1868–69); his correspondence with Rahel in 6 vol (1874–75); and with Carlyle (1892). His selected writings appeared in 19 vol. in 1871–76. There is also an extensive literature dealing with Rahel Varnhagen von Ense; see especially her husband's *Rahel, ein Buch des Andenkens*, 3 vol (1834); *Aus Rahels Herzensleben* (1877); E. Schmidt-Weissenfels, *Rahel und ihre Zeit* (1857); *Briefwechsel zwischen Karoline von Humboldt, Rahel und Varnhagen von Ense* (1896); O Berdrow, *Rahel Varnhagen* (1900).

VARNISH. Varnish is a homogeneous organic composition which, when thinly spread in liquid form, dries on exposure to air or to heat to a hard transparent film which decorates and protects the surface to which it is applied. The decorative effect is sometimes enhanced by incorporating soluble dyes or transparent pigments, to form colour varnishes; or varnishes may be used as the "vehicles" or binders in opaque pigmented compositions; *i.e.*, enamel or paint (*qq.v.*).

Varnish dates from prehistoric times. The ancient Egyptians melted soft resin, such as sandarac, mastic or pitch, with oil to form a varnish which was applied warm with the finger or a knife (precursor of modern "hot-melt" varnishes). On the mummy cases in the British Museum the varnish still retains its lustre, with surface uncracked and undamaged. Theophilus, in the 11th century, told how to make an oil varnish by dissolving molten resin in hot oil; but the first description of a linseed-oil varnish thinned with oil of turpentine, with litharge as a drier, appeared about the middle of the 18th century.

Varnishes are composed in general of four kinds of ingredients: (1) resins or gums, to impart hardness and lustre; (2) drying oils, to add flexibility and toughness; (3) volatile solvents, to thin the varnish to suitable consistency for application, and (4) driers and other modifiers, to hasten the drying rate, control the lustre, etc. Oil (or oleoresinous) varnishes usually contain all four of these, but one or more may be omitted. Lithographic varnishes, also sometimes called stand oils, consist simply of linseed oil (or, rarely, another drying oil), thickened by polymerization at about 270°–315° C. for varying periods according to the final viscosity desired. Largely used in both lithographic and typographic printing inks, they illustrate a type of varnish with only one kind of ingredient, and stand at infinity on the scale of length (measured by the number of gallons of oil per 100 lb. of resin). However, even the drying oil is replaced in some modern oil varnishes (then more properly called synthetic-resin varnishes) by a flexible alkyd or similar resin. Upon application of oil varnishes, the volatile solvent (if present) evaporates and leaves a soft film of oil (and resin) which subsequently dries or solidifies by absorbing oxygen from the air and polymerizing to more complex molecules.

At or near the zero end of the scale of length are the spirit varnishes, which are solutions of resins or cellulose compounds in a volatile solvent. Hard, dry, but often somewhat brittle, resinous films remain upon evaporation of this solvent. The term lacquer is commonly used in the English-speaking world for spirit varnishes based on nitrocellulose or other cellulose compounds, (or, in recent practice, on vinyl, acrylic or amide polymers), whether clear or pigmented. Entirely different in composition from these are the much older oriental lacquers. The name is derived from lac (the resinous secretion of the lac insect, *Tachardia lacca*), which from ancient times was used in India in molten form to produce lacquered ware; in China and Japan lacquer was the name given to the film formed by the sap of the Tsi-chou tree (*Rhus vernicifera*), a milky emulsion which has the peculiar property of hardening only in a moist atmosphere. Employed usually in numerous thick coats, these Chinese and Japanese lacquers attain a remarkable degree of hardness, lustre and durability. In some of their characteristics the cellulose lacquers closely approach them.

Asphaltum varnishes or black japans (*see* BLACK VARNISH) may be either of the oil or spirit type, the light-coloured resin being replaced by bitumens such as gilsonite, manjak or Egyptian asphaltum, or still residues (sometimes blown, or thickened by bubbling air through them) from distillation of petroleum or of fatty acids (stearine pitch). Varnishes of another small class, called hot-melt, containing no solvent, are solid at ordinary temperatures; liquefied by heating and applied as molten fluids, they return to the solid state on cooling without requiring either evaporation, oxidation or polymerization.

Water-thinned varnishes form a class which grew rapidly in importance during World War II when nonflammable binders were needed for paints to be shipped in concentrated form and thinned with water.

The earlier vehicles for water paints (alkali-solubilized casein, glues, dextrin, seaweed alginates, gum arabic, etc.) were largely supplanted by modified oils and synthetic resins, made water-dispersible yet water-resistant after drying. In late developments, vast employment was made of latices of polymers or co-polymers akin to the synthetic rubber group (styrene-butadiene, acrylonitrile, vinyl, acrylic esters, etc.), some of which impart strong resistance to staining and scrubbing. Such latices or emulsions, along with colloidal dispersions of the same types of resin in volatile thinners which do not dissolve them at ordinary temperatures (organosols) or in nonsolvent plasticizers (plastisols) came into wide use as transparent varnishes for coating paper, textiles and similar materials.

The varnish maker has striven constantly to make his varnishes flow more smoothly, dry faster, harder and tougher, and show better adherence, flexibility and durability so as to resist the strains of expansion and contraction of the wood, metal, plaster or other substrate, and the deteriorating effects of exposure to

heat, cold, ultraviolet light, moisture, alkali and other destructive factors. Natural resins and linseed oil permitted only limited attainment of these objectives, but with the ever-widening choice of synthetic polymers great improvement continued

Manufacture of Oil Varnish.—In the older form of the art which was almost universally practised up to about 1900, but which slowly lost importance after that time, the manufacture of an oil varnish began with hard fossil gums. These were natural resins exuded from ancient trees (some species of which are no longer extant) and made hard, brittle and lustrous by centuries of burial or exposure. They were dug, cleaned and assorted according to size, colour, hardness, etc , and shipped to the markets. The varnish maker crushed them to about ½ in. lumps and weighed the charge, of 50 lb. to 150 lb , into a copper or iron varnish pot or kettle, of a capacity of 40 gal to 150 gal A removable cover had a short central chimney for the escape of fumes, and holes near the edge for a metal stirrer and, sometimes, a thermometer. Smaller pots were lifted by hand, larger ones were rolled on low trucks, over a fire of coke, gas or fuel oil just below floor level. As the pot was intermittently heated to a final temperature of 330°–340° C , the gums, insoluble in oils before this "running" process, became pasty and eventually liquid, losing by volatilization and partial decomposition from 20% to 35% of their weight. The chemical nature of this change, and indeed the structure of the resin molecules themselves, had not been fully determined at mid-20th century, but the process was believed to involve depolymerization and partial conversion of complex organic acids from dicarboxylic to monocarboxylic types At a critical point as the melting process was completed, according to the judgment of the operator, addition of the preheated linseed (or other) oil, with vigorous stirring, was begun Heating was continued until solution was complete, as indicated by the clarity of a drop let fall from the stirrer upon a piece of glass The driers (consisting of oxides or salts of lead, manganese or cobalt, or combinations of them, in amounts sufficient to provide from about 0 03% to 0.6% of metal based on the oil) were next added and the mixture further boiled until these were dissolved as soluble soaps and the desired degree of bodying, or polymerization, attained. At a safe distance from the fire the pot was cooled somewhat, and the contents were thinned to a suitable consistency, by slow addition (with stirring) of turpentine or white spirit. The varnish was strained or filtered to remove dirt, pumped into storage tanks and allowed to age.

Varieties of oil varnish were differentiated as to oil length and as to use . Short-oil varnishes provided the extreme hardness needed for smooth rubbing with pumice stone, and sometimes further polishing with rottenstone or rouge, for fine cabinet and carriage work, among these were piano polishing varnish (5 gal. to 8 gal) and carriage rubbing and polishing varnish (6 gal. to 10 gal.). Japan gold size was an 8 gal. varnish for gilders' use and for binding coach colours, it dried in two hours or less In the medium-length group were floor, interior and gear varnishes (12 gal. to 20 gal). Body finishing (20 gal. to 30 gal.) and spar varnishes (25 gal. to 40 gal), requiring maximum flexibility, were in the long-oil group Flat varnishes for furniture and architectural work dried with a mat surface; baking or stoving varnishes (frequently containing no driers) were used over printed tinplate; insulating varnishes provided high resistance in electrical equipment.

Many other special types of oil varnishes were offered, with properties controlled by regulating the choice of resin or of oil, the degree of running, the subsequent cooking or the final blending of finished stocks.

A modification of varnish making technique was brought about by the introduction of tung (or China wood) oil, which began to reach Europe and America in important amounts about 1890–95. It bodies rapidly, forming a solid gel when heated alone at 285° C. for 6 to 12 mn.; it dries faster and harder than linseed and is more water-resistant, and it is improved rather than debased by being cooked with rosin (colophony), the resin of the pine tree, which had previously been regarded as a cheap adulterant for the fossil resins. Longer, paler, more flexible, more durable varnishes of equal or better drying speed and hardness began to replace the older types. They could be cooked in half the time or less, and, with rosin replacing fossil gum, premelting was unnecessary.

After the introduction of alkyd resins in the decade from 1925 to 1935, many firms began to make varnish in fixed closed chemical-processing kettles, of a capacity of 500 gal. and up. These are usually of stainless steel, heated either directly by gas, oil or electricity, or jacketed for heating by circulating heat-transfer fluid; they are provided with mechanical stirrers, pumps for applying pressure or vacuum, condensers for reflux or distillation, temperature-recording devices and piping for filling and emptying.

Oil is drawn by gravity from weighing tanks, heated and combined with synthetic resin which may be added in lump or liquid form, in many cases this resin is first manufactured in the same kettle. The progress of cooking is judged mainly from the temperature graph, and checked by taking samples at intervals which are tested for acidity, viscosity, curing time, etc When the batch is ready for thinning it flows by gravity to a large reducing tank that is placed on a scale and contains the proper amount of solvent. Here the varnish is thoroughly mixed by mechanical agitators, then filtered, aged and blended as before. With the change to synthetic resins, differentiation by oil-lengths became obsolete, but differentiation by uses is even more varied Finishes specifically designed for such individual uses as the various parts of television cabinets, aircraft, washing-machines, etc. are readily available

Manufacture of Spirit Varnishes and Lacquers.—Being mere solutions of resins, cellulose derivatives, proteins and the like in volatile solvents, spirit varnishes and lacquers are readily made by agitating the ingredients in large tanks with mechanical stirrers, or in rotating barrels or churns, until solution is complete (about 2 hrs. to 24 hrs.), rarely the resin is first melted, then thinned, or the mixture is refluxed. Filtering and aging complete the process. The cellulose esters by themselves lack adherence and flexibility; resins (nondrying alkyd or similar) and plasticizers are almost always added to overcome these deficiencies. French polish (*q.v.*), made by dissolving either bleached or amber shellac in methylated spirit, is one of the important types of spirit varnish. Crystal paper varnish, a water-white solution of 7 lb to 8 lb dammar gum in 1 gal. of turpentine, is used for varnishing wallpapers and delicate interior work; a similar varnish serves as vehicle in some interior white enamels.

Raw Materials for Varnishes.—In contrast to the limited number of materials available to the varnish maker prior to the 20th century, the considerable array at hand by the beginning of World War II was further broadened by intensive research to meet the needs of that conflict. Research in the fields of plastics, textiles and rubber brought out many new resins and elastomers which, with or without modification, were adapted for varnish use

Resins—(*See* also RESINS: *Synthetic Resins.*) Natural resins (other than shellac and rosin) in general originate in the Congo, Zanzibar and north coast districts of Africa, in New Zealand, the Netherlands East Indies, Malaya, the Philippine and nearby islands, and in South America. They are classified in various categories as spirit-soluble or (potentially) oil-soluble; as fossil (such as animi from Zanzibar, kauri from New Zealand, Congo and Boea copals, the latter from Netherlands Indies), semi-fossil (Batu and East India, of the dammar family) and "recent," or from living trees (dammar, sandarac, accroides, soft Manilas, elemi and mastic), and in degrees of hardness and insolubility, depending usually upon their age. Amber from the shores of the Baltic has long been too rare and high-priced for the varnish use it once had.

Ester gum, the earliest (about 1900) synthetic resin, was made by esterifying rosin (essentially abietic acid) with glycerine. By cooking it with tung oil in lengths of 40 gal to 50 gal., spar varnishes (so named because they were suitable for use on masts and spars of ships) could be made which dried hard overnight and withstood boiling water, or long immersion in cold water, without injury. Being compatible also with nitrocellulose, ester gum is largely used in lacquers. About 1910, coumarone-indene poly-

mers made from coal-tar light oil, and phenol-formaldehyde-rosin-glycerine (modified phenolic) condensates patented by Kurt Albert and F. N. Berend (albertols) were introduced These brought still faster drying rates, embodied in the so-called four-hour varnishes, but they tended to discolour on exposure In 1928 came the first "100% phenolic" oil-soluble resin, a thermoplastic condensate of paraphenyl phenol with formaldehyde, followed later by a number of resins of better colour retention made from alkyl-substituted phenols. With these resins, 20-gal varnishes were found more durable than longer ones, reversing the usual rule, they showed remarkable resistance to water and chemicals. Similar in general properties to the modified phenolics are the maleic ester gums or maleic alkyds (glycerides of an adduct of rosin with maleic or fumaric acid). They are pale, hard, colour-retentive, and find use in lacquers as well as oil varnishes New ways were found of improving rosin by hydrogenation or dehydrogenation, polymerization or esterification with pentaerythritol, sorbitol and other polyhydric alcohols. Other hard resins for oil varnishes, such as those made by chlorinating natural or synthetic rubber, paraffin wax or diphenyl; by condensing or "cyclizing" rubber; by polymerizing terpenes; by combining olefines with diolefines, or by special treatment of petroleum residues, have their special uses such as in finishes for concrete, aluminum bronze paints, etc.

One of the most important groups of synthetic resins is the alkyd or glyptal, basically the chemical combination of a polyhydric alcohol (*e.g.*, glycerine, glycol, pentaerythritol) with a polybasic acid (such as phthalic, maleic or sebacic) and a fatty acid (or mixture of acids such as those of linseed, soybean or castor oils). The alkyd resins can replace, in part or in whole, the blend of natural fossil or other hard gum with drying oil of the earlier varnish type. They can be modified by changing each of the three types of ingredient and their relative proportions over a wide range of properties, from hard and brittle to extremely flexible, tough and durable. Those made with nondrying fatty acids are much used in lacquers and particularly in stoving finishes; in these last, a very great advance resulted from the introduction of butylated amine-formaldehyde resins (urea or melamine), as hardeners: increased hardness and toughness, improved colour-retention at high temperatures, and reduction in baking time to a few minutes In the late 1940s, epoxy resins, made by polymerizing the reaction product of bis-phenol with epichlorhydrin, provided additional hardness, adherence, flexibility and alkali resistance. This reaction product, itself a resin, has residual hydroxyl groups and may be combined with fatty acids, amines or polyamides to enhance these properties.

New insulating varnishes developed during World War II enabled motors to deliver two or three times their rated horsepower by running much hotter without burning out. These were based on silicone resins in which silicon partially replaces carbon in a complex molecular structure. From these resins were later developed varnishes which, although they are expensive and require high stoving heats, have such good resistance to high temperatures and to weathering that their use on such things as heater parts, smokestacks and outdoor signs gradually increased. Copolymers of silicone resins with alkyds have intermediate properties.

For spirit varnishes of the alcohol type, shellac and the other forms of lac, and the "recent" natural resins (*i.e.*, sandarac, Melengket and Loba manilas, elemi and accroides) are augmented by rosin-fumaric acid and terpene-maleic anhydride adducts and by other modifications of rosin, as well as by the protein from maize and the polyvinyl formal resins (including acetals and butyrals) Polyamide resins (compounds of glycols with the amides of dimerized fatty acids), allyl starch and allyl sucrose and modifications of nylon were developments of the 1940–50 decade. In the hydrocarbon-soluble group are the polymers of styrene and methyl styrene, polyvinyl acetate, one or two of the acrylic-ester polymers, and many of the above-mentioned oil-soluble materials. Resins requiring ketone or ester-type solvents are the polymers and copolymers of vinyl chloride, vinylidene chloride and of most of the esters of acrylic and methacrylic acids.

Of the cellulose derivatives, nitrocellulose is most common; the less flammable but more expensive acetate, propionate and acetate-butyrate meet some special requirements. The ethers, ethyl cellulose and to a very limited extent benzyl cellulose, are of increasing interest (Methyl cellulose, hydroxyethyl cellulose, and sodium carboxymethyl cellulose are water soluble and are used as grease resistant clear varnishes or as protective colloids in emulsion finishes)

Plasticizers.—To impart necessary flexibility, plasticizers must almost always be added, not only to cellulose lacquers but to those based on vinyl resins, etc. They include (1) oils, such as raw or blown castor, blown linseed or soybean; (2) chemical solvents of extremely low volatility (esters, ketones, aromatic hydrocarbons, etc). tricresyl phosphate, dibutyl, diamyl or dioctyl phthalate and some of the sebacates are among the best-known of the scores of compounds available; and (3) certain resins of the thermoplastic or polyester type

Drying Oils.—Linseed oil, expressed from flaxseed (*Linum usitatissimum*) grown in Canada, the United States, India, Argentina, U.S.S.R and other parts of Europe, is the mainstay of the varnish industry, but until supplies from China were cut off during World War II and in some later years, tung oil (from the seeds of *Aleurites fordii* or *A cordata*) was gaining rapidly, as was also perilla oil (*P. ocimoides*) of later introduction from Manchuria. Tung orchards in the U.S. and some South American countries, planted from about 1925, did not produce enough oil to meet world demands. These three vegetable oils, with the fish oils (menhaden, sardine, pilchard) and the semidrying oil from soybeans, made up 98% of the total oils used by the varnish industry in 1935. Oiticica oil, from *Licania rigda* of Brazil, an oil somewhat similar to tung, entered world commerce in the 1930s, and with dehydrated castor oil, which simultaneously began to be prominent, largely filled the gap in tung oil supplies. Sunflower, safflower, poppyseed, maize and many other oils have been used in limited amounts. Synthetic drying oils are mentioned below

For varnish making the natural oils (other than tung and oiticica) are refined by heating with small amounts of lye or of sulphuric acid, which precipitate the traces of chlorophyll and mucilaginous matter (chiefly phosphatides) remaining in them when pressed from the seed; otherwise a discolouring "break" or cloud forms during the cooking of the varnish. Sometimes the oils are prebodied, either by themselves or with driers, before incorporation into varnishes, or they may be blown with air, introduced through perforated pipes, at temperatures of 60°–120° C., causing partial oxidation and thickening Boiled oil is usually made by simply dissolving small amounts of soluble driers (the resinates, linoleates, naphthenates, etc , of lead, manganese or cobalt) in linseed oil at moderate temperature.

Thinners or Solvents.—Turpentine is the essential oil (largely pinene, $C_{10}H_{16}$, and its isomers and polymers) distilled from "gum thus," the sap obtained by tapping various species of pinus (*P. palustris*, U.S.; *P. maritima*, France; *P. sylvestris*, U.S.S.R.), or steam-distilled from chipped wood from the stumps, or (from about 1945) recovered as a by-product in making wood pulp for paper. It has excellent solvent properties for resins and oils, but by 1930 it had become too scarce and expensive for most varnish purposes. Distillates from petroleum in approximately the same boiling range (155°–175° C.), called white spirit or mineral spirits, had almost entirely replaced it. These distillates, consisting mostly of aliphatic hydrocarbons, are not as powerful solvents for some of the highly polymerized synthetic resins or oxidized oils; upon strong dilution with these thinners, cloudiness or precipitation may sometimes result. Toluene, xylene and high-boiling aromatic hydrocarbons derived either from coal tar or petroleum are partially or wholly employed for such difficultly-soluble varnish bases.

In spirit varnishes, single or blended solvents are chosen (to fit the solubility of the particular resin) from among the alcohols, hydrocarbons, ketones, chlorinated hydrocarbons, esters, etc. For cellulose lacquers, the main solvents are esters (ethyl, butyl and amyl acetates and propionates, and many others); ketones (acetone, methylethyl ketone, methylisobutyl ketone, etc.); ether alcohols (ethoxy- and butoxyethanol, etc.) and their acetates,

and the nitroparaffins Alcohols, not in themselves solvents for cellulose nitrate or acetate, increase the solvent power of esters.

A considerable proportion of toluene or other hydrocarbon diluent (a nonsolvent for the cellulose compound) is generally used, partly to reduce cost and partly to assist in dissolving resins in the composition; thus, a common blend is three parts ethyl or butyl acetate, one part of the corresponding alcohol, six parts toluene Care must be taken in compounding such solvents to avoid "blushing" or whitening of the film, caused either by too much diluent, by slower evaporation of diluents than of solvents, or by condensation and absorption of moisture from humid air because of the cooling effect of too-rapid evaporation.

The increasing use of spraying (either cold or hot), dipping, tumbling, roller-coating, etc., in place of brushing, especially in the application of industrial finishes, requires a choice of thinners whose rate of evaporation is suitable for each particular method.

Other Raw Materials.—As catalysts for the oxidation-polymerization reaction, soluble salts or soaps of metals with two valence levels (especially cobalt, manganese and lead) are effective, lead tends to dry the film throughout, the other two are so-called top driers. Other elements, such as iron, vanadium, zinc (for hardening) and calcium (to minimize wrinkling), are sometimes employed. Waxes, or silica of impalpable fineness produce flat or mat finishes without reducing transparency. Modern varnishes may include minute amounts of surface-active agents to aid in application, in incorporation of pigments and (with latices) to stabilize the emulsions; antioxidants, to reduce the tendency to form a skin over the liquid surface in a partly filled container, and other additives for special purposes.

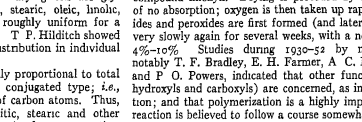
Chemistry of Drying Oils.—Natural drying oils are glycerides of various fatty acids—palmitic, stearic, oleic, linoleic, linolenic, etc.—in proportions which are roughly uniform for a given oil, but differ from one oil to another T P. Hilditch showed that the acids followed the law of even distribution in individual molecules

Speed and hardness of drying are roughly proportional to total unsaturation, especially where this is of conjugated type; *i.e.*, with double bonds joining adjacent pairs of carbon atoms. Thus, linseed oil contains about 8% of palmitic, stearic and other saturated acids which contribute nothing to its drying properties, 5% of oleic with one double bond (in 9-position, *i.e.*, joining the 9th and 10th carbon atoms from the carboxyl end), 48% of linolic with two double bonds (9, 12) and 34% of linolenic with three double bonds (9, 12, 15). Wilt resistant strains of flax yield oils with lower percentages of unsaturated acids, the drying quality being sacrificed to some extent in order to assure a sufficient crop Perilla oil, with 42% each of linolic and linolenic acid, dries and bodies even faster than linseed Some of the fish oils contain acids with 4 or 5 double bonds, but this is offset by higher percentages of saturated acids. The very low linolenic acid content of most semidrying oils (soybean, poppyseed, maize, etc.) accounts for slower drying and softer films, but less discoloration on aging (especially in the dark).

Tung oil contains about 73% of elaeostearic acid, with three conjugated double bonds (9,11, 13). This structure is responsible for the rapid polymerization of the oil either when heated alone to above 250° C, or in films. The surface layer of such films (of the raw or blown oil) expands on drying to form wrinkles or "crystals" in a frosted effect, which may be made use of in specialty finishes, although the oil is usually "gasproofed" by heating below 250° C., either alone or with rosin or other resins. Licanic acid, chief component of oiticica oil, differs from elaeostearic only in having a keto group in the 4-position; thus oil bodies and dries a little slower than tung, but shows a similar frosting tendency.

The observation that conjugated unsaturation confers not only faster bodying and drying, but also better water resistance and durability upon oils led to attempts to produce it in slower or nondrying oils. Johann Scheiber and Hanns Ufer in Germany found that from ricinoleic acid (12-hydroxy-9-octadecenoic acid), a chief component of castor oil, a molecule of water could be removed by heating with catalysts to about 275° C., and an additional double bond thus formed. A large amount of castor oil has, since about 1938, been dehydrated by such treatment, and a "frosting" drying oil produced, by most processes in use, about 17%–26% of the oil takes the conjugated (9, 11) form, while the balance goes to the unconjugated (9, 12) form with a methylene group between the double bonds. Later, it was found that by special catalytic treatments linseed, soybean and other nonconjugated oils could be converted up to about 30% to the conjugated form, and their drying speed and hardness improved; indeed there is strong evidence that the ordinary heat-bodying of these oils produces a small amount of conjugation by intramolecular rearrangement. Castor-oil dehydration opened the door to much experimentation and progress in oil technology previously limited to refining and bodying processes; nature's products are no longer accepted as the last word. Among the methods of improvement, applied chiefly to linseed, soybean and fish oils with or without preliminary polymerization to a viscosity of about 30 poises, are segregation into portions of greater and less unsaturation by differential solubility in acetone, furfural or other solvents; fractional distillation of the fatty acids, the more unsaturated of which are then re-esterified with glycerine, pentaerythritol, sorbitol or other polyhydric alcohol; treatment with maleic anhydride, which by the Diels-Alder reaction forms an adduct at the double bonds, and copolymerization with cyclopentadiene, styrene, methacrylic acid and other unsaturated compounds.

The mechanism of drying of linseed and other drying oils was still imperfectly understood at mid-20th century. Drying was formerly considered to be caused entirely by the absorption of oxygen at double bonds of the acid chains to form a complex solid compound linoxyn. Drying is preceded by an induction period of no absorption; oxygen is then taken up rapidly as hydroperoxides and peroxides are first formed (and later decomposed), then very slowly again for several weeks, with a net gain in weight of 4%–10%. Studies during 1930–52 by many investigators, notably T. F. Bradley, E. H. Farmer, A C. Elm, J. L. Overholt and P O. Powers, indicated that other functional groups (*e.g.*, hydroxyls and carboxyls) are concerned, as in alkyd resin formation; and that polymerization is a highly important factor. The reaction is believed to follow a course somewhat as follows. During the induction period the tocopherols or other natural antioxidants present in the oil are oxidized; then oxygen adds (to form peroxides or hydroperoxides), either at the double bonds of the dienoic or trienoic acids of the glyceride or at the active methylene group between them. Dehydration of the peroxides appears to account for formation of carbonyl groups and evolution of water; some reduction also probably occurs Shifts of double bonds to conjugated positions may immediately follow, leading to cross-linking of the acid chains in the same, or more often in different, molecules by a Diels-Alder mechanism to form a cyclohexenic adduct:



Some linking or "vulcanization" by oxygen probably also occurs. Thus dimers and trimers of the glyceride molecules are formed; the viscosity increases rapidly, ending in gelation and the formation of a dry film. The conjugation already present in tung, oiticica and dehydrated castor oils explains their faster reaction.

In blowing oils, much the same sequence of transformation is set in motion; in thermal polymerization, conjugation is a slower process but it does take place and the bodying is caused by polymerization alone.

Resins containing unsaturated fatty acids (*e.g.*, alkyds) undoubtedly owe their drying properties largely to this same mechanism; it contributes an added functionality to that which, as shown by W. H. Carothers and R. H. Kienle, is involved in the original formation of resins by polymerization or condensation of monomers.

Varnish films deteriorate or fail in service largely through at-

tack at weak molecular linkages such as those of the ester type. Durability increases as these are replaced by stronger ones like those of the ether or the carbon-to-carbon type, as in many of the newer synthetic varnishes. (*See also* OILS, FATS AND WAXES.)

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(C. R BN)

VARNUM, JAMES MITCHELL (1748–1789), U.S. Revolutionary soldier and public official, was born at Dracut, Mass., on Dec 17, 1748 After attending Harvard college, he studied at Rhode Island college (later Brown university, Providence, R.I), where he was graduated in 1769. Two years later, after reading law in the office of the attorney general of Rhode Island, he was admitted to the bar and began to practise law. He soon became known for his eloquence.

After serving as a colonel and later as a brigadier general in charge of Rhode Island troops, he was appointed a brigadier general in the Continental army in 1777. He held various commands, winning commendations though he was unsuccessful in defending Forts Mercer and Mifflin on the Delaware river During the winter of 1778 he was at Valley Forge with George Washington, and he later served in the campaign in Rhode Island

Varnum resigned from the Continental army in March 1779, but he served as major general of the Rhode Island militia from 1779 until 1788.

He was a member of the Continental congress at various times during the period from 1780 to 1787.

Varnum was appointed U S. judge in the Northwest territory, for which he helped write a legal code. He died at Marietta, O., on Jan 10, 1789.

James Varnum's brother, JOSEPH BRADLEY VARNUM (1750/51–1821), who served as an officer in the Massachusetts militia, became speaker of the U S. house of representatives and was a U.S. senator from Massachusetts from 1811 until 1817 He was a strong advocate of the War of 1812. Before serving in the federal congress, Joseph Varnum had been a member of the Massachusetts legislature, to which he returned as a state senator

See J M. Varnum, *The Varnums of Dracut in Mass.* (1907).

VARRO, MARCUS TERENTIUS (116–27 B C), Roman antiquarian and man of letters, was born at Reate. He studied at Rome under L. Aelius Stilo, the first Roman grammarian, and at Athens under Antiochus of Ascalon. In politics he espoused the side of Pompey. He disapproved, apparently, of the first triumvirate (that of Pompey, Caesar and Crassus, 60 B.C.), which he ridiculed in a book called *The Three-headed* (Τρικάρανος: *cf.* Appian *Civil War*, ii.9, καί τις αὐτῶν τήνδε τὴν συμφοροσύνην συγγραφεὺς, Οὐάρρων ἐνὶ βιβλίῳ περιλαβὼν ἐπέγραψε Τρικάρανον). Under Pompey he saw considerable military service and was engaged in several operations during the Civil War Before the battle of Pharsalia he went to Epirus, and along with Cicero and Cato, he awaited at Dyrrachium the issue of the conflict. His personal relations with Caesar were friendly, and when, after the defeat and Pompey, Caesar secured the restoration of some of Varro's property, which had been seized by Mark Antony, Varro showed his gratitude by dedicating to him the second part of his *Antiquitates*. He also assisted Caesar in collecting Greek and Latin literature for the great public library which he contemplated. On the formation of the second triumvirate (that of Octavianus, Antony and Lepidus 43 B.C.), Varro was proscribed, but through the good offices of Q. Fufius Calenus he was able to come to terms with the triumvirs and the remaining years of his long life were spent in study and writing.

Volume of Writings.—Varro was not only the most learned of Romans, but also the most voluminous of Roman writers (*homo πολυγραφώταros* Cic., *Ad Att*, xiii.12). Aulus Gellius, iii., 10 17 quotes Varro as saying that "he had now entered on the 12th hebdomad of years (*i.e.*, was between 78 and 84), and up to that day had written 70 hebdomads (*i e*, 490) of books, of which some considerable number had not appeared, his libraries having been plundered when he was proscribed." Jerome's catalogue of his works is preserved in a mutilated form in Rufinus, pref. to translation of the homilies of Origen. From this and other evidence Ritschl puts the number of his separate literary works at 74 and the number of "books"—counting, for example, the 150 *Menippean Satires* as 150 "books"—at about 620.

Conspectus of Writings.—His work, which survives only in fragments, with the exception of the *De Lingua Latina*, of which six books are extant, and the *Rerum Rusticarum libri tres* which is extant almost entirely, may be considered under various heads:

1. *Saturae Menippeae* in 150 books These were medleys in prose and verse in the style of Menippus, a Cynic philosopher of the first half of the 3rd century B.C. (Aul. Gell., ii. 18.6). The titles, often Greek, of the individual Satires are of the most varied kind—sometimes personal names of gods or men; sometimes proverbs, Greek or Latin, *e.g*, *Nescis quid vesper serus vehat* (You know not what evening may bring forth), Δὶς παῖδες οἱ γέροντες (Old men are in their second childhood), Γνῶθι σεαυτόν (Know thyself). And the range of subject is no less wide and varied—eating and drinking (*Est modus matulae, περὶ μέθης, περὶ ἐδεσμάτων, ὀψοκίων*), literature (*Parmeno*), philosophy (*περὶτκλους, περὶ αἱρέσεων, armorum iudicium*), politics (the Τρικάρανος mentioned above), praise of the good old times (*Sexagesis*, Γεροντο-διδάσκαλος, Bimarcus)—in a word, Varro might have said with Juvenal (i. 85): *quidquid agunt homines, votum timor ira voluptas gaudia discursus, nostri est farrago libelli.* So far as can be judged from the fragments the Menippean Satires had no great merit either of style or content, but the frequency with which they are quoted in later writers suggests that they were the most generally popular of Varro's writings.

2. *Logistoricon libri LXXVI.*, treatises on philosophical, historical and other subjects, generally with a chronological basis, *e g*, *Catus aut de liberis educandis* (Aul. Gell , iv.19, *cf* xx.11); *Orestes vel de insania* (Aul Gell., xiii 4); *Pius aut de pace* (Aul Gell, xvii.18); *Sisenna vel de historia* (Aul Gell., xvi 9).

3 *Imagines* in 15 books. This consisted of 700 biographies of famous Greeks and Romans, each biography being accompanied by a portrait of the subject and an explanatory metrical *elogium*. This was probably the first Latin illustrated book, but Cratenas, the medical attendant of Mithridates VI. (120–63 B.C.) had shown the way to an illustrated book (Ῥιζοτομικὸν) on plants. The number of biographies, 700, is explained by Varro's curious affection for the number 7 (*hebdomas*) *cf.* Aul Gell., iii. 10. 1 "M. Varro in the first of the books entitled *Hebdomades* or *De Imaginibus* says that the virtues and powers of the number 7, which the Greeks call ἑβδομάς are many and various": *cf.* iii.11.3, *M. Varro in primo de Imaginibus, uter* (Homer or Hesiod) *prior sit natus, parum constare dicit;* ibid. 6. M. Varro in the first book, *de Imaginibus*, placed them under the portrait of Homer this epigram: *Capella Homeri candida haec tumulum indicat Quod hac Ietae mortuo faciunt sacra* (This shining she-goat indicates the tomb of Homer, because it is with a she-goat that the Ietae sacrifice to the dead).

4. On literature and the history of literature he wrote a series of treatises, *e.g., De poematis, De compositione saturarum, De Poetis* (Aul Gell., i 24,3; xvii 21, 43 and 45), *De originibus scaenicis, De comoedis Plautinis* (Aul Gell., iii 3 9 seq), *Quaestionum Plautinarum libri V.* In this connection it is to be noted that Varro established the canon of the genuine plays of Plautus, the 21 so-called *Fabulae Varronianae, i e.*, the 21 plays now extant (the *Vidularia* only partially).

5. *Antiquitatum rerum humanarum et divinarum libri XLI.* Of this work the first 25 books dealt with *res humanae*, the second part in 16 books, dedicated to Caesar, dealt with the gods. For the first part, *cf.* Aul Gell., i 16, i.25, iii.2, v 4, xi.1, xii.12, xiii 13, xiii 17, xvii 3; for the second part *cf.* Aul. Gell., i.18, iii.16, x.15, xv.30, xviii 12. Other works in this sphere written by Varro were *De gente populi Romani libri IV, De vita populi Romani, De familiis Troianis, Tribuum liber, Rerum urbanarum libri III, Aetia* (so called after the Αἴτια of Callimachus).

6. Historical works: *De Pompeio libri III., Annalium libri III., De sua vita, Legationum libri III.*

7. Encyclopaedic works: *Disciplinarum libri IX.* (*cf.* Aul. Gell.,

i.20, x.1, xviii 15), dealing with the liberal arts, grammar, rhetoric, music, medicine, etc., *De forma philosophiae libri III.*

8. Legal work: *De jure civili libri XV.*

9. Geographical works: *De ora maritima, De aestuariis, Ephemeris nivalis.*

10. Grammatical works: *De lingua Latina libri XXV.*, of which books 2–4 were dedicated to P. Septimius, the rest to Cicero; *cf* Aul. Gell., ii 25, vi 11, x.21, xvi 8 Bks. 5–10 are extant in a somewhat mutilated condition. The work was divided into three parts, the first dealing with the etymology of Latin words, the second with inflexion, the third with syntax. Other works in this sphere by Varro were *De sermone Latino ad Marcellum libri V.* (*cf.* Aul. Gell., xi 6, xii 10, xvi.12, xviii 12); *De similitudine verborum; De utilitate sermonis; περὶ χαρακτήρων; De antiquitate litterarum; De origine linguae Latinae.*

11. *Epistolicae Quaestiones* (Aul Gell, vi.10, xiv.7, xiv 8) dealing with a variety of subjects

12. *Rerum rusticarum libri III.*, written when Varro was in his 80th year. (*Cf.* the opening words, "If I had leisure, Fundania, I would have written for you more conveniently what I will now set forth as best I can, considering that I must make haste, since, as the saying goes, if man is a bubble, still more so is an old man. My 80th year warns me that I must collect my baggage before I depart from life.") This work (for which *cf.* Aul. Gell, ii. 20) is extant practically entire.

Estimate of Contemporaries.—It is a very remarkable fact that Livy nowhere in his extant work alludes to Varro, or gives any evidence of acquaintance with his writings. But the reputation which he enjoyed, both in his own day and in later times, is abundantly testified: Cic., *Acad post.*, i.3. "You have revealed to us the age of our fatherland, its chronology, the laws of its religion and priesthoods, the plan of our home and foreign administration, the position of our territories and districts, the titles and descriptions of all things Divine and human, with the duties and principles attaching to them, and you have shed a vast amount of light on our poets and on Latin literature in general and on the Latin vocabulary, while you have yourself composed picturesque and choice poems in almost every metre, and in many passages have touched upon philosophy, so far as to arouse interest, but not sufficiently for full treatment."

Bibliography.—*De lingua Latina*, edit. C. D. Muller, L. Spengel re-edited by his son (1885); *Res Rusticae*, edit. Keil (Leipzig, 1884). On Varro's language and style, Norden, *Rheinisches Museum*, xlvii (1893); F. Germann, *Die Sogenannten Sententiae Varronis* (1900); M. Schanz, *Gesch. der rom. Litteratur*, vol. I pt. II. (3rd ed., Munich, 1909); J. W. Duff, *Literary Hist. of Rome* (1909); R. J. B. Walker, *Les Catalogues varroniens* (1927). (A. W. Ma.)

VARTHEMA (Barthema, Vertomannus, etc.), **LUDOVICO DI**, of Bologna (*fl.* 1502–1510), Italian traveller and writer, left Europe near the end of 1502; early in 1503 he reached Alexandria and ascended the Nile to Cairo. From Egypt he sailed to Beirut and thence travelled to Tripoli, Aleppo and Damascus, where he managed to get himself enrolled, under the name of Yunas (Jonah), in the Mamelukе garrison—doubtless after adopting Islam. From Damascus he made the pilgrimage to Mecca and Medina as one of the Mamelukе escort of the Hajj caravan (April–June 1503); he describes the sacred cities of Islam and the chief pilgrim sites and ceremonies with remarkable accuracy, almost all his details being confirmed by later writers. With the view of reaching India, he embarked at Jidda and sailed down the Red sea and through the Straits of Bab-el-Mandeb to Aden, where he was arrested and imprisoned as a Christian spy. He gained his liberty—after imprisonment both at Aden and Radaa—through the partiality of one of the sultanas of Yemen, made an extensive tour in south-west Arabia (visiting Sana, etc.), and took ship at Aden for the Persian Gulf and India. On the way he touched at Zaila and Berbera in Somaliland; he then (early in 1504?) ran across to the Indian port of Diu in Gujarat, afterwards famous as a Portuguese fortress. From Diu he sailed up the Gulf of Cambay to Gogo, and thence turning back towards the Persian Gulf made Julfar (just within the entrance of the gulf), Muscat and Ormuz. From Ormuz he seems to have journeyed across Persia to Herat, returning thence south-west to Shiraz, where he entered into partnership with a Persian merchant, who accompanied him during nearly all his travels in South Asia.

After an unsuccessful attempt to reach Samarkand, the two returned to Shiraz, came down to Ormuz, and took ship for India. From the mouth of the Indus Varthema coasted down the whole west coast of India, touching at Cambay and Chaul; at Goa, whence he made an excursion inland to Bijapur, at Cannanore, from which he again struck into the interior to visit Vijayanagar on the Tungabudra; and Calicut (1505?), where he stopped to describe the society, customs and institutions of Malabar, as well as the topography and trade of the city. Passing on by the "backwater of Cochin," and calling at Kulam (Quilon), he rounded Cape Comorin, and passed over to Ceylon (1506?) Though his stay here was brief (at Colombo?), he learnt a good deal about the island, from which he sailed to Pulicat, slightly north of Madras, then subject to Vijayanagar. Thence he crossed over to Tenasserim in the Malay peninsula, to Banghella, perhaps near Chittagong, at the head of the Bay of Bengal, and to Pegu, in the company of his Persian friend and of two Chinese Christians (Nestorians?) whom he met at Banghella. After some successful trading with the king of Pegu, Varthema and his party sailed on to Malacca, crossed over to Pider (Pedir) in Sumatra, and thence proceeded to Bandan (Banda).

From the Moluccas he returned westward, touched at Borneo, and there chartered a vessel for Java, the "largest of islands," as his Christian companions reckoned it. He notes the use of compass and chart by the native captain on the transit from Borneo to Java, and preserves a curious, more than half-mythical, reference to supposed Far Southern lands. From Java he crossed over to Malacca, where he and his Persian ally parted from the Chinese Christians; from Malacca he returned to the Coromandel coast.

Varthema was now anxious to resume Christianity and return to Europe; after some time he succeeded in deserting to the Portuguese garrison at Cannanore (early in 1506?). He fought for the Portuguese in various engagements, and was knighted by the viceroy Francisco d'Almeida, the navigator Tristan da Cunha being his "sponsor." For a year and a half he acted as Portuguese factor at Cochin, and in 1507 (?) he finally left India for Europe by the Cape route. Sailing from Cannanore, Varthema apparently struck Africa about Malindi, and (probably) coasting by Mombasa and Kilwa arrived at Mozambique, where he notices the Portuguese fortress then building, and describes the negroes of the mainland. He finally arrived safely in Lisbon.

Varthema's work (*Itinerario de Ludovico de Varthema Bolognese . . .*) was first published in Italian at Rome in 1510 (*ad instãta de Ludouico de Henricas da Corneto Viterbino*). Other Italian editions appeared at Rome, 1517, at Venice, 1518, 1535, 1563, etc. The first English translation was of 1576–77 (in Richard Eden's *History of Travayle*); an extract from Varthema was inserted in Samuel Purchas's *Pilgrimage* (1625–26); and in 1863 appeared the Hakluyt Society edition by J. W. Jones and G. P. Badger (*Travels of Ludovico di Varthema*). (C. R. B.)

VARUNA, in Vedic Hindu mythology the associate of Mitra, whose individuality faded while Varuna's gained ground by a process still obscure. In contrast to Indra, the war-god, who was supreme, Varuna has no myths related of him. But in post-Vedic myth Varuna sinks to the position of a departmental god—of the waters—being replaced by Prajāpati as the supreme.

VASA (Vaasa or Nikolaistad), a seaport of Finland in 63° 6′ N., 21° 36′ E., on the east coast of the Gulf of Bothnia. Pop. (1940) 34,083. It is the chief town of a department of the same name. Vessels enter from the sea at Rönnskär, 26 mi. distant, and the channel is safe for vessels drawing 22 feet. The exports are timber, tar, etc., and the imports coal and salt, and there is a ship-repairing yard. The town was founded in 1606, and after its destruction by fire in 1852 was rebuilt nearer the shore.

VASARI, GIORGIO (1511–1574), Italian painter and architect, whose main distinction, however, rests on his valuable history of Italian art, was born at Arezzo on July 30, 1511. At a very early age he became a pupil of Guglielmo da Marcilla, a very skilful painter of stained glass. At the age of thirteen he went to Florence, where he studied under Michelangelo, Andrea

del Sarto and Baccio Bandinelli aided by the patronage of the Medici princes. In 1531 he visited Rome in the suite of Cardinal Ippolito de Medici and studied the works of Raphael and others of his school The paintings of Vasari were much admired. Vasari's principal works are at Florence, Rome, Naples, Arezzo, Bologna, Bosco (near Alexandria), Lucca, Monte Sansovino, Pisa, Perugia, Pistoja. Many of his pictures still exist, the most important being the wall and ceiling paintings in the great hall of the Palazzo Vecchio in Florence, and his frescoes on the cupola of the cathedral He died at Florence on June 27, 1574, and was buried in the chapel of S Giorgio in the Pieve of Arezzo

Personally Vasari was a man of upright character, always ready to appreciate the works of others: in spite of the very different taste of his time, he expresses a warm admiration of the works of Giotto, which is very remarkable. As an art historian of his country he must always occupy the highest rank. His great work *Delle Vite de' più eccellenti pittori, scultori, ed architettori*, was first published in 1550, and afterwards partly rewritten and enlarged in 1568 It was dedicated to Cosimo de' Medici, and was printed at Florence by the Giunti; it is a small quarto illustrated with many woodcut portraits. This *editio princeps* of the complete work is usually bound in three volumes, and also contains a very valuable treatise on the technical methods employed in all branches of the arts, entitled *Le Tre Arti del disegno, cioè architettura, pittura, e scoltura*. His biographies are written in a very pleasant style, interspersed with amusing stories With a few exceptions Vasari's judgment is acute and unbiased. The work in any case remains a classic, however it may be supplemented by the more critical research of modern days.

Vasari gives his own biography at the end of his *Vite*, and adds further details about himself and his family in his lives of Lazzaro Vasari and Francesco Salviati. The first edition of his *Vite* was issued by the Torrentino Press (1550). The best edition is that published at Florence by Milanesi (1878–1882), which embodies the valuable notes in the earlier edition by Le Monnier (1846). The *Lives* has been translated into French, German and English.

See Sir D Colnaghi, *Dict. of Florentine Artists* (1928); on his literary works *see* W. Kallab, *Vasaristudien* (Vienna, 1908); and J. Schlosser, *Die Kunstliteratur* (Vienna, 1924), which also contains an account of his life.

VASCO DA GAMA: *see* GAMA, VASCO DA.

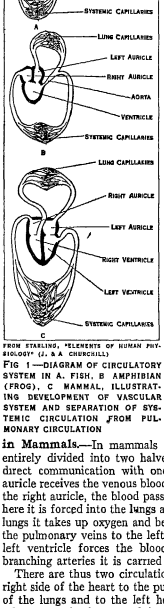
VASCULAR SYSTEM. The unicellular organism receives all the supplies necessary for its growth and maintenance directly from its environment, either by diffusion of substances held in solution, or by direct intake of foodstuffs, which undergo chemical disintegration in vacuoles containing liquid into which the necessary enzymes are secreted. In the multicellular organism, such direct intake of foodstuffs by diffusion by every individual cell is impossible, for only the outer layer of cells is in contact with the environment, and this layer is usually protected by some form of membrane which is impermeable to water and food substances.

The vascular system has been developed to convey nutrient materials, etc, to the various parts of the organism, and the blood serves as intermediary between the environment and the organs of the body. This function can be fulfilled only if the blood is in continuous circulation, carrying nutrient materials and oxygen to the tissues, and conveying the waste products of metabolism from the tissues to the places where they are excreted. The heart is the organ which provides the necessary energy for this circulation, and the blood vessels are the channels which convey the blood to and from the tissues.

In the case of most invertebrate animals, the blood or analogous fluid is not all enclosed in blood vessels, and the various tissues lie freely in the fluid; which is kept in constant motion. In the higher animals, however, the blood is entirely enclosed in a system of tubes, and the nutrient substances, etc., are brought into contact with the cells only after their diffusion through the thin walls of the finest blood vessels. By the force of the cardiac contraction, the blood is driven through the tissues by way of thick-walled tubes, the arteries, and back to the heart by a system of thinner-walled vessels, the veins. In the tissues, the blood passes through a fine meshwork of capillaries, the walls of which consist of a single layer of delicate cells, which allow a free interchange of material to take place between the blood within and the tissue fluids outside the vessel.

THE HEART

In fishes (fig. 1, A) the heart consists of one auricle and one ventricle The blood is received from the great veins into the auricle. By the contraction of the auricle the blood is forced into the ventricle and this, when it contracts, sends the blood on to the bulbus arteriosus The blood passes through the branchial arteries into the gills, where it takes up oxygen, and then flows on into the aorta, by which it is distributed to the organs of the body. From the capillaries of these organs the blood is collected by the veins and is carried once more back to the auricle. The fish heart is thus entirely on the venous side of the vascular system



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG 1.—DIAGRAM OF CIRCULATORY SYSTEM IN A, FISH. B AMPHIBIAN (FROG). C MAMMAL, ILLUSTRATING DEVELOPMENT OF VASCULAR SYSTEM AND SEPARATION OF SYSTEMIC CIRCULATION FROM PULMONARY CIRCULATION

In amphibia, such as the frog, the heart consists of two auricles and one ventricle (fig 1, B) The right auricle receives venous blood from the body and forces it by its contraction into the ventricle From the ventricle the blood passes into the aorta, whence it is carried partly by the pulmonary artery to the lungs, partly by other arteries to the different organs of the body. The blood, which has passed through the lungs and been arterialised, flows through the pulmonary veins to the left auricle, whence it passes into the ventricle and mixes with the venous blood which is arriving from the right auricle. The pulmonary circulation is thus merely a branch of the general or systemic circulation The bulbus aortae in the frog is divided into two parts by means of a spiral valve, by which a partial separation of the blood coming from the right and left auricles is effected, and the venous blood from the right auricle is directed especially into the pulmonary artery.

Course of the Circulation in Mammals.—In mammals and birds, the heart has become entirely divided into two halves, right and left, which have no direct communication with one another (fig. 1, C). The right auricle receives the venous blood from all parts of the body From the right auricle, the blood passes to the right ventricle, and from here it is forced into the lungs along the pulmonary artery In the lungs it takes up oxygen and becomes arterial, and is returned by the pulmonary veins to the left auricle and to the ventricle. The left ventricle forces the blood into the aorta, whence by the branching arteries it is carried to all parts of the body.

There are thus two circulations—the one *pulmonary*, from the right side of the heart to the pulmonary artery and the capillaries of the lungs and to the left heart by the pulmonary veins; the other *systemic*, from the left side of the heart, by the aorta, to the arteries and capillaries of the body tissues and organs, from which by the veins to the right side of the heart. A schematic representation of the circulatory system is given in fig. 2 The muscular walls of the right ventricle are much thinner than those of the left ventricle. This is so because the energy required of the left ventricle must exceed that of the right ventricle, as resistance in the systemic circuit exceeds that in the pulmonary circuit.

The heart becomes filled with venous blood during its relaxation or *diastole*, and forces the blood into the arteries during its contraction or *systole*. The large arteries are of less capacity than the corresponding veins, and their walls are essentially extensile and elastic. The small arteries and *arterioles* are essentially muscular tubes and can vary considerably in diameter. The arterioles open into the capillaries, and these are so numerous

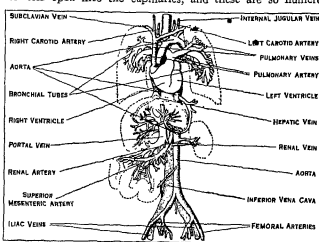


FIG. 2.—GENERAL COURSE OF CIRCULATION AND SOME OF THE PRINCIPAL VESSELS

that each organ may be regarded as a sponge full of blood. The skeletal muscles and the muscular walls of the viscera at each contraction express the blood within them and materially influence the circulation. The whole muscular system must therefore be regarded as an accessory pump to the vascular system. The veins are of larger calibre than the corresponding arteries, and have tough and inextensile walls. The veins are not, as a rule, distended with blood to their full potential capacity. The latter is so great that the whole blood of the body can collect within the veins.

The heart and lungs are placed within the thoracic cavity, the floor of which is formed by the muscular diaphragm; the heart is itself enclosed in a tough inextensile bag, *the pericardium*, the function of which is to check over-dilatation of the heart. Below the heart, the pericardium is fixed to the central tendinous part of the diaphragm; above, it is suspended by the mediastinum. On account of this fixed position of the pericardium, the heart is prevented from oscillating.

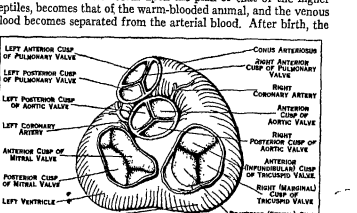
The Valves of the Heart.—As regards the valves of the heart (fig. 3), the tricuspid guards the right auriculo-ventricular opening, and consists of three flaps of fibrous tissue covered, like all the internal surfaces of the heart, with the smooth shining membrane, *the endocardium*. The flaps are continuous at their base, forming an annular membrane surrounding the opening. The bicuspid or mitral valve consists of two cusps, and guards the left auriculo-ventricular opening. The under surface and free edge of each cusp of these valves are attached by chordae tendinae to two papillary muscles; these are pillars of muscle which rise up from the inner surface of the ventricles.

The papillary muscles and chordae tendineae pull down the diaphragm formed by the closed valves (the floor of the auricles), thus expanding the auricles and enabling the valvular as well as the muscular parts of the wall of the ventricles to approach together and force out the blood. The ventricles are never completely emptied, for some blood remains in contact with the auriculo-ventricular valves up to the end of systole and ensures their closure. The aortic and pulmonary valves consist of three semilunar, pocket-shaped cusps. A fibrous nodule is placed centrally in the free edge of each cusp, whence numerous tendinous fibres radiate to the attached borders of the cusp. Opposite the cusps are bulgings of the aortic walls—the sinuses of Valsalva. From the anterior one arises the right coronary artery, and from the left posterior the left coronary artery; these vessels supply the substance of the heart with blood.

Foetal Circulation.—The foetus has no independent respiration or digestion and therefore depends entirely on the oxygen and nutritive substances which diffuse through the placenta from the mother's blood. The arterial blood flowing from the placenta along the umbilical vein is partly conveyed to the vena cava ascendens by means of the ductus venosus and partly flows through two trunks which unite with the portal vein returning the blood from the intestine into the liver, thence to be carried back to the vena cava by the hepatic veins. The arterial blood flowing from the placenta becomes mixed in the vena cava with the venous blood which has returned from the trunk and the lower extremities. In the right auricle it would also become freely mixed with the venous blood returning from the head and upper extremities were it not for a special arrangement which impedes but does not entirely prevent this mixture.

On account of the presence of special valves (Eustachian valves), the upward arterial stream is directed into the left side of the heart through the foramen ovale—an opening in the intra-auricular septum—whilst the venous current from the superior vena cava is directed into the right ventricle. When the ventricles contract, the arterial blood contained in the left ventricle is expelled into the ascending aorta and thence to the head and upper extremities, while the venous blood of the right ventricle is expelled into the pulmonary artery and then through the ductus arteriosus (which branches off from the pulmonary artery before it passes into the lungs) into the descending aorta. This separation of the two streams is not perfect, but it is responsible for the fact that the upper parts of the foetus receive blood which contains more oxygen than that received by the lower parts. This is possibly the reason why the head and the arms of the foetus are always considerably more developed than the pelvis and legs. A portion of the blood flowing through the descending aorta enters the two umbilical arteries and is conveyed to the placenta, where it is re-oxygenated.

At birth, the course of circulation undergoes changes. As soon as the lungs become distended by the first respiration, a portion of blood is diverted from the pulmonary artery into the lungs. As the pulmonary circulation increases, the ductus arteriosus becomes gradually obliterated, and finally disappears. The foramen ovale between the auricles also becomes closed. The circulation, which was carried out in the foetus upon the plan of that of the higher reptiles, becomes that of the warm-blooded animal, and the venous blood becomes separated from the arterial blood. After birth, the



FROM YOUNG AND ROBINSON IN CUNNINGHAM, "TEXTBOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 3.—THE BASES OF THE VENTRICLES OF THE HEART, SHOWING AURICULO-VENTRICULAR, AORTIC AND PULMONARY ORIFICES AND VALVES

umbilical arteries and vein shrink and close up and form the ligaments of the bladder, and the ligamentumteres of the liver. The ductus venosus disappears.

Physiological Properties of the Heart.—The cardiac muscle must be regarded as endowed with four fundamental properties, viz., *Rhythmicity*, the function of originating its impulse; *Conductivity*, the function of transmitting the impulse; *Irritability*, the function of responding to stimuli; and *Contractility*, the function of developing tension which may be utilized for performing the work of circulating the blood.

Rhythmicity.—The cause of the heart beat has naturally been one of the most continued subjects of inquiry. H. Allen in 1757 was the first to show that the activity of the heart is not dependent on its connections with the nervous system. The heart is controlled and influenced by the nervous system, but this control is not essential for life The excised heart of a frog continues to beat rhythmically for days, provided that it is supplied with oxygen and prevented from drying. In the case of the warm-blooded animal, the heart is similarly capable of continuing its rhythmic contractions for some time after excision.

(1) *The Amphibian and Reptilian Heart.*—The frog's heart consists of a sinus venosus which receives the venous blood from the body, two auricles, the ventricle and the bulbus arteriosus, which divides into the two aortae. The frog's heart in the body, or after excision from the body, beats regularly, the contractions starting in the sinus, then travelling to the auricles, ventricles and bulbus.

At one time the rhythmic contraction of the heart was attributed to the action of groups of nerve cells in the sinus that were discovered by Robert Remak in 1848 Some experimental support for this theory, which is known as the "neurogenic" theory of the heart beat was given by Stannius, who demonstrated that the auricle and ventricle of the frog's heart cease to beat for some time if the sinus is tied off with a ligature, while the sinus goes on beating regularly. Further experiments have shown however that the beat of the heart cannot be ascribed to the rhythmic activity of these ganglion cells, for every strip of the heart muscle is capable of rhythmic action, whether it contains nerve cells or not. In the developing chick, the heart contracts by the 24–28th hour of incubation, while the nerves do not grow into the heart before the 6th day The inherent power of rhythmic contraction belongs to the cardiac muscle itself (the "myogenic" theory of the heart beat).

Furthermore, it belongs to every part of the heart, but there is a descending scale of this automatic power, from the sinus where it is highest to the lower parts of the ventricle where it is very slight (Gaskell) The normal sequence of contraction of the four parts is determined by the natural rhythm of these parts, but in the whole heart it is impossible for the ventricle to contract at its own rhythm because before it is ready to beat again, after a preceding contraction, it receives an impulse from the auricle. In the same way, the auricle never beats at its own rhythm; it is always subordinated to the faster rate of impulses coming from the sinus. If, however, the ventricle is electrically stimulated at a rate slightly faster than the beat of the sinus, the normal sequence of contractions becomes reversed, the ventricle now contracting first and the sinus last. All recent experiments tend to confirm the myogenic theory of the heart beat.

(2) *The Mammalian Heart.*—Although the mammalian heart has no sinus venosus, its contractions are as regular, and as independent of the nervous system as those of the lower vertebrates. Both in the heart *in situ* and in the excised heart the two auricles contract together, and after a short interval there follows the contraction of the two ventricles

In the mammalian heart, within the region where the superior vena cava opens into the right auricle, there lies a club-shaped formation known as the *sino-auricular* or the *S-A node;* functionally it is identical with the sinus of the amphibian and reptilian heart. The node is composed of slender fusiform cells with little striation It can be considered as definitely proven that, in the normal heart, the sinus serves as the centre in which the stimulus for the cardiac contraction originates The *S-A* node is, however, by no means the only place in which the impulses for the heart can originate The seat of these rhythmically recurring impulses may shift to some other portion of the heart since, as in the frog's heart, the function of rhythmicity is potentially present in every part of the heart, and the *S-A* node governs the rate of the whole heart only in virtue of its faster rate of discharge of these impulses. On this account the *S-A* node has often been described as the "pace-maker" of the heart. Other centres in which the impulses sometimes originate, and which in certain cases may gain mastery over the whole heart, are known as *ectopic* centres

It has been shown that a very distinctive system of muscle fibres lies enclosed within its own sheath beneath the endocardium. This system is known as *the conduative system* of the heart. It begins as a few strands of fibres in the region of the coronary sinus; these strands converge in a thickening which is known as the *aurículo-ventricular* or the *A-V node;* it is composed of the same type of cells as the *S-A* node. The two nodes are not connected with each other, but are divided by the ordinary contractile elements of the auricle From the *A-V* node, a thin bundle of tissue passes through the auriculo-ventricular septum towards the ventricle. This bundle was first described by His, and is known as *the A-V bundle* On penetrating the intra-ventricular septum, the bundle divides into two branches, which pass to the right and left ventricle respectively. The two branches in turn divide and subdivide, forming an extensive arborization on the inner surface of the ventricles (fig. 4).



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 4.—THE CONDUCTING SYSTEM OF THE HEART

Left ventricle, laid open to show Interventricular system, on which the course of the Auriculo-ventricular Bundle and its ramifications are shown in black (after Tawara)

Various parts of the conductive system may become centres of ectopic rhythms. If the *S-A* node is destroyed or injured, or if the irritability of the *A-V* node is increased, the latter assumes the rôle of initiating the heart beat Many nervous and other influences may modify the relative irritability of the two nodes, and a shift of the pace-maker from one to the other may occur temporarily even under normal conditions. Destruction of the His bundle is equivalent to a complete functional separation of the ventricles from the auricles The ventricles develop a rhythm of their own, *the idio-ventricular rhythm* Both ventricles however continue to contract together, the centre for their activity being localized in the higher part of the bundle It is probable that still lower centres may assume a rhythmicity, but it is doubtful whether these can ever dominate the rhythm of the whole heart. Their significance consists rather in the fact that they serve to disturb some other dominant rhythm.

Thus we see that every part of the heart may serve as a centre of origin of an impulse. The natural rate of the discharges of these centres is in the following descending order: the *S-A* node, the *A-V* node, the bundle, its branches and muscle. If several centres are active simultaneously, the rate of the heart as a whole will be dominated by that centre which discharges most frequently.

The "Normal" Heart Rate.—The normal heart rate presents considerable variations in different individuals and in different species of animals. For man it may be estimated at 68 to 76 beats per minute, and for woman 74 to 80; but the normal rate for some individuals may be much lower (50) or much higher (90). Small animals as a rule have a higher heart rate than large animals, *e.g.*, elephant 25–28, horse and ox 36–50, sheep 60–80, dog 100–120, rabbit 150–180, mouse 700; small birds like the canary have the extremely high rate of 1,000 beats per minute. Usually in man, under normal conditions, the heart rate declines with age. While at birth it is about 140, it is 100–110 at the age of 5; in childhood it is about 90, and in the adult about 70. In old age it accelerates slightly and becomes about 80.

Conductivity.—The impulses which originate in the *S-A* node spread along the ordinary muscular tissue to every part of the auricles. The rate of conduction in the auricle ranges from 600–1,200 mm. per second. In its fan-like spread, the excitation wave reaches the *A-V* node There is no indication of a preferential path of conduction between the two nodes, so that the impulse travels at the same rate over the auricle and reaches the *A-V* node about 0·03 second after the origin of the impulse. In the *A-V* node, the rate of conduction is considerably slower, the impulse passing the node at about 150–200 mm. per second Once it has passed the node, the impulse travels rapidly down the

bundle and its ramifications at the rate of about 5,000 mm per second.

The slow conduction in the *A-V* node and the rapid conduction in the bundle tissue ensure two important features of cardiac activity. On account of the former, auricular contraction is given time to end before the onset of the ventricular contraction, and on account of the latter the impulse arrives at every part of the ventricle at approximately the same time. Thus the whole ventricular muscle contracts approximately at the same time, which is a condition necessary for the development of a high pressure in the ventricular cavities.

Irritability.—When a skeletal muscle is stimulated by an increasing strength of electrical stimulus, it responds by an increasing strength of contraction, until a certain maximum is reached. A heart under the same conditions gives a contraction which is maximal for a given condition of the heart in response to the first effective stimulus; further increase in the strength of the stimulus does not lead to an increase in the strength of the response Thus difference between the skeletal and the cardiac muscle is not due to fundamentally different properties, but depends on the fact that in cardiac muscle the muscle fibrils are in free inter-communication with each other, and in this way a stimulus which originates in one part spreads over the whole of the organ, in the skeletal muscle, however, the contractile fibrils are collected into muscle fibres which are separated by the homogeneous coat of the sarcolemma. Since the threshold value of a stimulus which will evoke contraction is different for the different muscle cells, it is only to be expected that a greater number of these cells will contract in the skeletal muscle when the stimulus is strengthened, the result being a stronger total effect of contraction of the muscle. In the heart, when a stimulus evokes a contraction of a few fibres, this contraction will spread over the whole heart, so that with increase in the stimulus there is no further strengthening of the contraction. This behaviour of the heart is known as the *All or None Law.* It is most evident in the cardiac muscle, but is not peculiar to it.

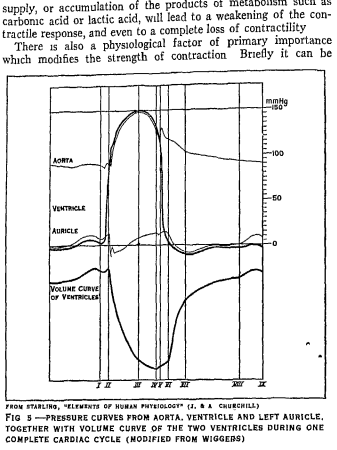
The Refractory Period.—The irritability of the heart undergoes rhythmical variations which are determined by the heart beat itself. Like all excitable tissues, the heart exhibits the phenomenon of the *refractory period*, which is a period of loss of irritability following each impulse which evokes a contractile response. In the heart this period is extremely prolonged. It lasts as long as the contraction of the heart. If a second stimulus is applied to the heart during the contraction which is evoked as a response to the first stimulus, it is found that it has no effect. In the skeletal muscle, on account of the fact that the refractory period is shorter than the time occupied by the contraction, a second stimulus evokes a second contraction, or a summation of the two contractions. The period of complete loss of irritability is followed by gradual recovery, after which there is a phase of super-normal irritability before it returns to the normal.

The length of the refractory period depends in the first place on the strength of the contraction of the heart. Thus drugs and physiological conditions which strengthen the heart beat also increase its refractory period. Of greater significance, however, is the relation of the refractory period to the rate of the heart beat. Lewis found that the duration of the refractory period of mammalian auricular muscle contracting 100, 150 and 250 times per minute was 0·2, 0·15 and 0·01 sec. respectively.

It is obvious that as a result of the shortening of the refractory period the heart is able to respond to more rapid rates of excitation than would otherwise be possible. As soon, however, as stimuli occur at intervals which are shorter than the refractory period alternate stimuli will fail to evoke any response, the heart beating at a *half-rhythm* or 2:1 response. The change from a 1:1 to a 2:1 response does not occur abruptly. Between these rates there exists a phase in which large and small beats alternate; with further acceleration of the stimulation, some beats are dropped, and with a still further acceleration a regular 3:1 rate sets in. This stage of irregular response is due to the fact that apparently all the parts of the cardiac muscle have not the same minimal refractory period, and consequently at some definite rate of excitation parts of the heart will contract in response to every stimulus, while other parts will respond by a 2:1 rate.

Contractility.—The strength of contraction of the heart is independent of the strength of the stimulus It is, however, highly dependent on the condition of the cardiac muscle. Any interference with the nutrition of the heart, inadequacy of the oxygen supply, or accumulation of the products of metabolism such as carbonic acid or lactic acid, will lead to a weakening of the contractile response, and even to a complete loss of contractility

There is also a physiological factor of primary importance which modifies the strength of contraction Briefly it can be



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG 5.—PRESSURE CURVES FROM AORTA, VENTRICLE AND LEFT AURICLE, TOGETHER WITH VOLUME CURVE OF THE TWO VENTRICLES DURING ONE COMPLETE CARDIAC CYCLE (MODIFIED FROM WIGGERS)

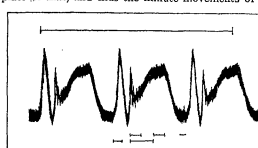
stated that, other conditions being equal, the greater the filling of the heart during diastole, the stronger is the following systole. This dependence of strength of contraction is so marked and is of such importance for the whole circulation that Starling named it the "Law of the Heart." It must be remembered, however, that it is not a feature peculiar to the cardiac muscle alone; it belongs to all contractile tissues, whether heart, skeletal muscle or plain muscle, but in the heart it is of a greater immediate vital importance. The practical significance is obvious; it enables the heart to eject the amount of blood which it receives during diastole whether small or large, and thus enables the heart to adapt its beat to considerable variations of the blood flow without changing its rate. A dog's heart weighing 50 grams, can put out 100 or 3,000 cc. of blood per minute without changes of the heart rate.

This remarkable adaptation is due to the fact that the larger the output, the more the heart will be filled during each period of relaxation (diastole), and hence its contraction (systole) will be stronger, so that the heart will empty itself of the extra amount of blood. When a heart is in good condition, it performs a given amount of work with a smaller diastolic volume than when the contractility of the heart becomes impaired. The same work may be performed in both cases, but in the second case in order to do the work the heart has to dilate, because at the previous diastolic volume its contractions would be too weak. The dilation of the heart at constant work is thus the first sign of impairment of its functions.

Sequence of Events in the Cardiac Cycle.—The time relation between the different events occurring during a cardiac cycle can be most satisfactorily determined by measuring pressure changes in the different cavities of the heart and in the aorta.

The apparatus almost universally used for this purpose is known

as the optical manometer. It consists of a small glass or metal tube which can be introduced directly into one of the cavities of the heart. The tube is filled with fluid, and the outside opening is sealed with a thin rubber membrane, which carries an excentrally placed small and light splinter of a mirror. A beam of light reflected from the mirror is made to play on a moving photographic plate or film, and thus the minute movements of the membrane,



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 6.—CURVES OF PRESSURES IN LEFT AURICLE OF CAT (AFTER STRAUB)

which are of course proportional to the pressure changes, are greatly magnified without the danger of increasing the inertia of the apparatus.

The pressure changes in the heart (fig. 5) have been described by Starling as follows:—

"The cardiac cycle begins with the contraction of the auricles, which may or may not give rise to a slight rise of pressure in the ventricles. As the auricular contraction dies away, the ventricular contraction begins at I. This causes a very rapid rise of pressure. Almost immediately after the beginning of the rise, the auriculo-ventricular valves close. The pressure then rises rapidly in the ventricular cavity. During this period, the contraction of the ventricular muscle is isometric. It is raising the pressure within the ventricles without causing any change in its contents, or in the length of the muscle fibres. Directly the pressure exceeds that in the aorta, the aortic valves open at the point marked II., and the aortic pressure thereafter rises with the ventricular pressure. During the whole duration of the ventricular contraction, the aortic pressure remains somewhat below the ventricular pressure, showing that the blood is flowing continuously from the ventricle into the aorta. The ejection of blood is at first rapid, so that the pressure in the ventricles continues to rise. As the heart gets smaller, the amount of blood ejected into the aorta becomes less than that flowing out in the unit of time through the peripheral branches, so that the pressure begins to fall in the aorta and ventricle, even though the outflow of blood is still going on.

"The ejection period may therefore be divided into two phases, that of maximum ejection and that of reduced ejection. The ventricular muscle suddenly relaxes at the point marked IV., causing a sudden fall of pressure in the ventricle and a slight fall in the aorta. The latter is, however, arrested almost at once by the closure of the aortic valves, marked by the sharp depression, the *dicrotic notch*, in the aortic tracing. The pressure in the ventricle continues to fall until at the point VI. it drops below that in the auricle and the auriculo-ventricular valves open, allowing the inflow of blood from the pulmonary veins and auricles. Between V. and VI. the relaxation is isometric, since all the valves guarding the orifices of the ventricles are closed.

"The pressure in the ventricles then continues to fall more slowly until it reaches the line of zero pressure, and remains at or near this line during the greater part of diastole. With a big inflow there may be a slight rise towards the end of diastole, which may be accentuated by the auricular contraction. If the chest is opened the pressure in the ventricle never sinks below zero during any part of diastole. In the closed chest the pressure in the heart cavities during diastole will be negative, on account of the negative pressure within the thorax."

The duration of the separate phases of the heart beat depends naturally on the rate of the beat. In all cases of change of heart rate, the period of diastole is affected relatively much more than the period of systole. Owing to the absence of valves between the auricles and the large veins, changes of pressure within the auricle will be transmitted along the veins.

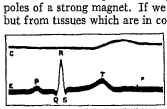
In every case the auricular pressure tracing exhibits the following features (fig. 6): (1) The first positive wave, which occurs during auricular systole. (2) The second positive wave, which is due to the sharp closure of the auriculo-ventricular valves. (3) The third positive wave, which is due to the filling of the auricles while the auriculo-ventricular valves are closed. (4) A negative wave, which is due to the rapid emptying of the auricle after the opening of the auriculo-ventricular valves. The chief function of the auricle is not to propel blood into the ventricle by its contraction, but to serve together with the big veins as a reservoir for the blood which flows in from the body but which cannot enter the ventricle while the latter is in a state of contraction.

The Apex Beat.—The pulsation which is felt over the region of the heart is known as the "apex beat," and was formerly thought to be due to the twisting forward of the apex at each systole. Its origin is, however, different. During diastole, the ventricles form a flabby flattened cone, lying against the chest wall and slightly depressed by the latter. In systole, the ventricles become hard and rigid, and assume the form of a rounded cone. This sudden change in shape and hardening of the ventricular wall pushes out that part of the chest wall which is in immediate proximity to the ventricle, giving rise to the "apex beat."

The Sounds of the Heart.—When the ear is applied to the chest above the cardiac region, two sounds may be heard; the first, which is heard most intensely over the apex, is a duller and longer sound than the second, which is heard best over the base of the heart. The first and second sounds resemble the syllables *lubb dup–lubb dup*. The first sound is of twofold origin. It arises from the sudden closure of the auriculo-ventricular valves, and from the contraction of the thick muscular wall of the ventricles. The second sound is due to the sharp closure of the auricular and pulmonary valves.

When fluid escapes through a narrow orifice, vibrations are set up in the fluid giving rise to various sounds. Under normal conditions, when the valves of the heart are closed completely, sounds produced in this way are either absent or negligible; in abnormal conditions, *e.g.*, after disease affecting the orifices of the heart or the valves, these vibrations may become loud enough to be easily heard. These murmurs or *bruits* as they are called are of great importance, for they enable the physician to judge the condition of the valves, and to determine which valve is affected.

The Electrocardiogram.—The contractions of the different cavities of the heart are accompanied by electrical changes which can be recorded if any two parts of the heart are connected to a sensitive galvanometer. The apparatus which is generally used for this purpose is the string galvanometer, in which a very delicate thread of silvered quartz or of platinum is stretched between the poles of a strong magnet. If we lead off, not from the heart itself, but from tissues which are in contact with the heart, we shall still obtain the electrical changes at each heart beat. An electrocardiogram so obtained is reproduced in fig. 7.



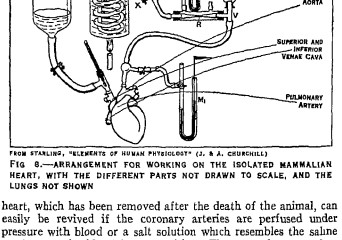
FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 7.—ELECTROCARDIOGRAM OF MAN, OBTAINED BY LEADING OFF FROM THE TWO HANDS TO A STRING GALVANOMETER. C THE CAROTID PULSE TRACING

The deflection P is due to the auricular contraction and QRS marks the beginning of the ventricular contraction. Thus the P-R interval represents the period between the auricular and ventricular contractions. The total duration of the excitatory state of the ventricle is measured by the distance between Q and T. A case of *A-V* block, as for instance in Adams-Stokes' disease, is shown at once on the electrocardiogram by the dissociation of the normal relations between the auricular and ventricular deflections. A delay in conduction of the excitatory wave is accompanied by a prolongation of the P-R interval, while a beat originating from the *A-V* node instead of the *S-A* node is immediately shown by a

shortening or even disappearance of the P-R interval. The exact origin of the T wave is not known. The electrocardiogram has become an important aid in the study and diagnosis of abnormal heart activities.

The Isolated Mammalian Heart.—The nutrition of the mammalian heart is carried out by means of the coronary arteries, which leave the aorta at the place of its origin. A mammalian



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 8.—ARRANGEMENT FOR WORKING ON THE ISOLATED MAMMALIAN HEART, WITH THE DIFFERENT PARTS NOT DRAWN TO SCALE, AND THE LUNGS NOT SHOWN

heart, which has been removed after the death of the animal, can easily be revived if the coronary arteries are perfused under pressure with blood or a salt solution which resembles the saline medium of the blood in composition. This procedure was first introduced by Ludwig for the frog's heart, and by Langendorff for the mammalian heart. Sydney Ringer first determined the exact amount and type of salts necessary for the most successful survival of the frog's heart, and Locke modified Ringer's solution for the mammalian heart. With the use of such a solution, a mammalian heart can be restored to activity as long as 7 days after death. The beat of the isolated heart of a child can be restored 20 hours after death from pneumonia. The excised heart of a cat can be kept beating for 4 days. The heart of a monkey was restored after freezing the dead body of the animal.

Conditions Essential for the Heart Beat.—For perfusion experiments, a cannula is tied in the aorta pointing to the heart. The pressure of the column of fluid closes the aortic valves and the only way of escape is through the coronary arteries; after having passed through the heart muscle, the fluid flows out of the coronary veins. In this manner it is possible to study the influences directly affecting the heart beat and the coronary blood vessels.

The first and most essential condition for reviving a heart is an abundant supply of oxygen; the second is the maintenance of the perfusion fluid at a reaction similar to that of blood, *i.e.*, slightly on the alkaline side of neutrality (sodium bicarbonate is usually added for this purpose).

A third important factor is the maintenance of the temperature within physiological limits. An increase in temperature causes an increase in heart rate but at about 44° C to 45° C the beat ceases entirely. At temperatures ranging from 13°–19° C the beat ceases, but on rewarming the co-ordinated contractions are re-established. In all these cases the effect of temperature is primarily on the S-A node, and warming or cooling the node duplicates the effect of warming or cooling the perfusion fluid, except that at some stage the lower rhythm centre of the heart will begin to be dominant, whereas in the cooling of the whole heart the rhythm of all the centres becomes depressed.

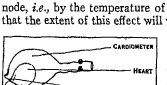
The main purpose of the sodium chloride in the fluid is to keep the osmotic pressure of the fluid the same as that of blood. Calcium and potassium have however a direct influence on the contractility of the heart. After a short perfusion with a fluid that lacks calcium and potassium, the heart soon stops beating altogether. Addition of calcium salts will immediately evoke contractions, which will grow in force, but the heart will soon fail to relax completely and will gradually stop in systole. On addition of potassium salts, the heart resumes a normal beat. Excess of calcium salts leads to a systolic standstill, and excess of potassium salts leads to a diastolic standstill. The normal activity can proceed only if salts of both calcium and potassium are present in the proper proportions.

The Heart-lung Preparation.—A great advance in the study of the heart was made when Starling succeeded in investigating the heart under conditions like those of the perfused heart, but with the great advantage that the heart performed work and pumped blood in exactly the same way as in the whole animal. The arrangement of the method is shown in fig. 8.

Artificial respiration being maintained, the chest is opened under an anaesthetic. Cannulae are placed in the brachiocephalic artery and the superior vena cava. All other blood vessels going to and from the heart are tied off. The blood emerging from the heart is made to flow against an artificial variable resistance (R), through a glass spiral immersed in warm water, into a reservoir. From the reservoir the blood flows through the superior vena cava into the heart. The aortic blood pressure can be varied in this preparation by changing the artificial resistance against which the heart is made to work.

The output of the heart can be measured at any time by opening the tube X, clamping tube Y, and allowing the blood to flow into a graduated cylinder. The volume changes of the heart at each beat can be measured by the so-called cardiometric method. A glass cardiometer of the shape shown in fig. 9 is fitted over the beating heart. The opened pericardium is tied around the lip of the cardiometer, which is then connected with a tambour with a slack rubber membrane. The movements of this membrane are recorded by a lever on the smoked surface of a revolving drum. The difference between the diastolic and the systolic volume thus recorded is obviously equal to the amount of blood put out by the two ventricles during a single heart beat.

This preparation enabled Starling and his co-workers to study the main features of the physiological activity of the heart. It was found that the heart itself cannot modify the blood flow and that, within wide variations of the heart rate and of the arterial resistance against which the heart beats, the output remains constant provided the inflow is not changed. This means that the heart will adapt the strength of its beat within very wide limits, and will perform the work required if it is within the functional capacity of the organ. If the inflow into the heart is say 1,000 cc. a minute, this output will be maintained if the heart rate is 100 or 200 beats per minute, or if it has to beat against a pressure of 60 or 160 mm. of mercury. Increase in the heart rate does not modify the output, but it increases the maximum amount of blood which the heart is able to expel, since at the faster heart rates the inflow of blood can be increased without causing over-distension of the ventricles. Another important observation made by Starling was that, in the heart-lung preparation, the heart rate is independent of the pressure against which the heart works and of the output. The heart rate is here determined by the temperature of the S-A node, *i.e.*, by the temperature of the circulating blood. It is clear that the extent of this effect will vary from heart to heart, depending on the natural rhythmicity of the node.



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 9.—HENDERSON'S GLASS CARDIOMETER.

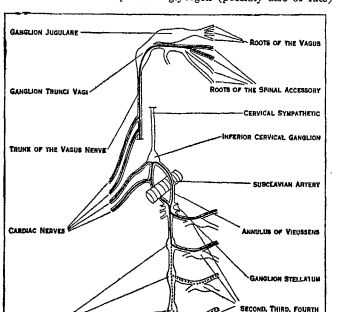
The Work of the Heart.—The energy of the contraction of the heart is expended (*a*) in forcing a certain amount of blood against a certain resistance presented by the arterial pressure, and (*b*) in imparting a certain velocity to the blood. The work done by each ventricle can be calculated from the formula:

$$W = Mr + \frac{Mv^2}{2g}$$

Where W is the work done, M is the mass of blood expelled at each beat, r is the mean arterial pressure, v is the velocity at the root of the aorta, and g the factor of acceleration. The work of the right ventricle is approximately $\frac{1}{3}$ of that of the left. The work of both ventricles in the human heart at rest is about 100 gram-

meters per beat, which is equivalent to about 10,000 kilogram-meters in 24 hours. During very strenuous muscular exercise when the output is considerably increased, the work of the heart per beat is about 400 gram-meters, or 80,000 kilogram-meters in 24 hours This rate of work could probably be maintained for not more than a few minutes

The energy required for the cardiac contraction is derived from the oxidation of the deposits of glycogen (possibly also of fats)



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 10.—DIAGRAM OF CARDIAC INHIBITORY AND ACCELERATOR FIBRES IN THE DOG (FROM FOSTER)

within the heart itself. It was found by Lovatt Evans that, on increasing the arterial pressure from 80–140 m.m. of mercury, the oxygen consumption of a heart was increased from 228 to 404 cc. per hour; and on increasing the output from 9·3 to 92 litres per hour, it increased from 155–649 cc. per hour. The maximum efficiency of the heart is of the same order as that found for skeletal muscle, namely 20–28%.

The Nervous Regulation of the Heart Beat.—In the vertebrates, the heart is supplied with two sets of nerve fibres; those which pass from the central nervous system in the vagus nerve, and those which pass in the sympathetic nerves (fig. 10). The cardiac fibres of the vagus terminate around nerve cells situated in the heart itself (preganglionic fibres); the ganglionic cells serve as relays from which new fibres (postganglionic fibres) emerge and run directly to the cardiac muscle and to the *S-A* node. The sympathetic fibres leave the spinal cord by the anterior roots mainly of the second and third dorsal nerves, run in the white *rami communicantes* to the Stellate ganglia where they end; from the Stellate ganglia, postganglionic fibres begin, which go to the various parts of the cardiac muscle.

The Vagus Nerve.—In 1845 the brothers Weber made the important discovery that stimulation of the vagus nerve retards or even arrests the heart beat. The cardio-inhibitory nerves have since then been found in all classes of vertebrates and in many invertebrates. During a stimulation of the vagi, the heart beat is considerably retarded or stops altogether, and as the result of this the arterial blood pressure falls. Blood accumulates on the venous side of the heart and is not forced out in sufficient amount to maintain the blood pressure. If the stimulation of the vagus is prolonged, the heart often begins to beat again with a slow rhythm; this beat is seen to be confined to the ventricles only, the auricles still remaining at a standstill. We speak of such a beat as an "escape." The ventricle is really beating at its own idio-ventricular rhythm in response to impulses originating within itself.

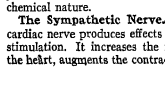
A detailed study of the effect of vagus stimulation on the heart has shown that it affects all the four fundamental properties of the heart muscle (fig. 11). By inhibiting the S-A node, it depresses the rhythmicity, by affecting the conductive system, it retards the propagation of the impulse in the auricular muscle and in the A-V bundle; by affecting the muscle proper, it diminishes its contractility and each beat becomes weaker, in consequence of which the refractory period of the heart is shortened; and finally it diminishes the irritability of the heart. Whether the vagus has a direct action on the mammalian ventricle is still doubtful.

If both vagi are cut, the heart immediately begins to beat faster, showing that under normal conditions a continuous stream of impulses passes down the cardio-inhibitory nerves, which do not allow the heart to beat at its full independent rate.

For obvious reasons, section of the vagi cannot be performed in man, but we have at our disposal a drug which paralyses the peripheral nerve endings of the postganglionic vagal fibres, namely atropine, an alkaloid obtained from belladonna.

The question as to what controls the normal tone of the vagi has been the subject of many researches, and at present we know of several factors that are concerned. Amongst them we must mention first the blood pressure. Marey was the first to show that, other conditions being equal, the vagus tone increases with increase in the blood pressure. This effect is probably not due to the direct stimulation of the vagus centre in the medulla, but to stimulation by high blood pressure of special sensory endings in the aorta, in the ventricles, and in some of the blood vessels going to the brain. The sensory impulses reflexly retard the heart by stimulation of the vagus centre. Changes in the composition of the blood and various drugs may also affect the vagus centre. Asphyxia, and the action of morphine may be mentioned as such centrally acting stimuli; they retard the heart, but only if the vagi are intact. Reflexes from various sensory nerves may stimulate or inhibit the vagus centre; for instance, inflation of the lungs diminishes vagus tone (the Hering Breuer reflex); increase in the output of the heart has the same effect (Bainbridge reflex). Stimulation of the respiratory passages, as in the case of inhalation of an irritant volatile substance, retards the heart, and high intracranial pressure has the same effect. There are also stimuli which may excite the peripheral nerve endings of the vagi in the heart itself, *i.e.*, substances which will act even after section of the vagi, but not after injection of atropine—for instance bile salts, which enter the general circulation in the case of jaundice.

The intimate mechanism by means of which the vagus produces its effect on the heart has been a field of intense experimentation and theorisation. It has been suggested that the vagus impulses produce "interference" waves with the impulses originating in the S-A node; that the vagus is a nerve which abolishes the katabolism or disintegration processes associated with activity, and leads to anabolism or reconstruction processes; that on account of similarity in the effect of stimulation of the vagus with that of potassium salts, the vagus possibly liberates free potassium from a colloidal combination or from an adsorbed state from the proteins. According to Loewi, the vagus acts by producing some chemical substance (of the choline type) which is the active factor.



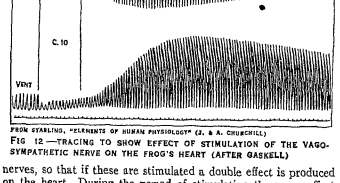
FROM STARLING "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG. 11.—BLOOD PRESSURE TRACING FROM CAROTID OF A DOG SHOWING EFFECT OF EXCITATION OF VAGUS (BETWEEN THE ARROWS)

His experiments support the theory most brilliantly. If a perfused frog's heart is stopped by stimulation of the vagus, and if the perfusion fluid is collected from the heart and transferred to a beating frog's heart, the second heart will show all the effects of vagus stimulation. The chemical substance responsible has been extracted and dried, but has not yet been obtained in a sufficiently pure form to establish its chemical nature.

The Sympathetic Nerve.—Stimulation of the sympathetic cardiac nerve produces effects which are the reverse of the vagus stimulation. It increases the rate by raising the rhythmicity of the heart, augments the contractions, increases the rate of conduc-

tion of the impulse, and raises the irritability of the heart. On account of the increased strength of contraction, the refractory period becomes somewhat more prolonged than that normally associated with the given heart rate. The sympathetic nerves are much less easily tired than the vagus fibres and have a longer after-effect. In most animals the inhibitory and the accelerator fibres, which were discovered by Cyon, become mixed in the cardiac



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG 12.—TRACING TO SHOW EFFECT OF STIMULATION OF THE VAGO-SYMPATHETIC NERVE ON THE FROG'S HEART (AFTER GASKELL)

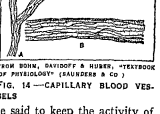
nerves, so that if these are stimulated a double effect is produced on the heart During the period of stimulation the vagus effect predominates, but after the end of stimulation the sympathetic effect becomes apparent, and the heart accelerates and the beat increases in strength (fig. 12).

Stimulation of either set of fibres before they are mixed together produces effects typical of one or the other only. In the dog, whose normal heart rate is about 100 beats per minute, stimulation of the accelerator nerves may increase it to 260 beats, and at the same time the strength of each contraction will be increased. The latter effect is most marked in hearts which have begun to fail and which are therefore dilated.

The question whether, under normal conditions, the accelerator fibres are in a state of tone like that of the inhibitory fibres of the vagus is not definitely settled. It is customary to assume the existence of such a tone, but to consider it as less pronounced than that of the vagus. In most experiments, extirpation of the Stellate ganglia leads to a retardation of the heart Many observers have shown that the tonic conditions of the two centres stand in a reciprocal relation to one another. Whenever the tone of the inhibitory fibres is increased, that of the accelerator fibres is diminished; thus the final effect on the heart will be an algebraical summation of the two influences. The tone of the accelerator centre is greatly increased in asphyxia, in cerebral anaemia, in the case of various sensory stimuli (especially painful stimuli), and probably in the case of muscular exercise. In the first two states, which are pathological, the tone of both nerves is increased simultaneously. Thus, in the absence of the sympathetic nerves, asphyxia produces retardation of the heart by stimulating the vagus, and in the absence of the vagus it produces an acceleration. In the presence of both nerves, it first retards the heart and may even arrest it until the vagi become paralysed, after which the heart greatly accelerates above the normal, because of the co-existent stimulation of the sympathetic centre.

The Suprarenal Gland.—It has already been mentioned that the influence of the vagus can be modified by stimuli affecting the centre, or by substances which stimulate or paralyse the peripheral nerve endings of the vagus within the heart itself. In the case of the sympathetic innervation, the organism normally produces a chemical substance which stimulates all the sympathetic nerve endings.

The production of this substance is the function of the suprarenal (or adrenal) gland, and the substance has not only been obtained in a chemically pure state, but has also been synthesised. It is known as *adrenaline* or suprarenin. Adrenaline is active in very small amounts, concentrations of one in one hundred millions producing a strongly exciting effect. Under normal conditions, however, the quantities entering the blood are probably too small to have any physiological effect. The liberation of adrenaline is under the influence of the splanchnic nerves, section of which diminishes the secretion, while stimulation greatly increases it Certain drugs, asphyxia, various emotions such as fear or anger lead to an excessive production of adrenaline Directly the adrenaline reaches the heart, even when its connections with the nervous system are all severed, the contractions become considerably faster and extremely energetic, and the heart becomes able to cope with a greater strain (either in the shape of arterial resistance or increased venous inflow) than it could do without the stimulus of adrenaline



FROM BOHM, DAVIDOFF & HUBER, "TEXTBOOK OF PHYSIOLOGY" (SAUNDERS & CO.)

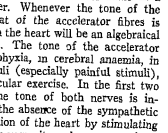
FIG. 14.—CAPILLARY BLOOD VESSELS

To summarize, we may state that the heart beat is a property of the heart itself, and as such it is independent of the nervous system The latter may however be said to keep the activity of the heart under constant supervision, moderating its action by means of the vagus, and increasing it by means of the sympathetic nerves, thus adapting it to the general requirements of the body. Under conditions of great physical strain, the organism is able to make use of its store of adrenaline, which assists the nervous regulation of the heart beat. Thus, even after complete denervation of the heart, a certain amount of adaptation of its activity is still possible.

THE BLOOD VESSELS

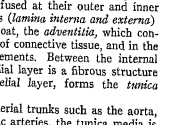
Structure of the Blood Vessels.—The haemodynamic conditions in the various parts of the vascular system are very different, and it is not surprising to find that the structure of the various blood vessels is accordingly different. A cross-section of a blood vessel shows several coats. The inner consists of flattened endothelial cells and is common to all vessels. The second coat, the *tunica media*, varies greatly in thickness; it contains most of the contractile elements of the arterial wall (smooth muscle fibres) and a variable amount of elastic fibres The latter have in general a circular arrangement; they are fused at their outer and inner surfaces to form elastic membranes (*lamina interna and externa*) Outside the media, lies the third coat, the *adventitia*, which consists in the arteries almost entirely of connective tissue, and in the veins principally of contractile elements. Between the internal elastic membrane and the endothelial layer is a fibrous structure which, together with the endothelial layer, forms the *tunica intima*.

The Arteries.—In the great arterial trunks such as the aorta, the pulmonary, the carotid and iliac arteries, the tunica media is divided by elastic fibres and membranes into a large number of concentric layers containing (especially in the aorta) only a few muscle fibres. The adventitia of the large arteries is also composed of fibro-elastic tissue, but its structure is looser and the fibrous tissue is more abundant. The medium-sized arteries differ in structure from the larger ones in that the elastic elements of the intima and media are replaced to a considerable extent by non-striated muscular fibres (fig 13) To this type belong the majority of the arterial vessels.



FROM BOHM, DAVIDOFF & HUBER, "TEXTBOOK OF HISTOLOGY" (SAUNDERS & CO.)

FIG. 13.—TRANSVERSE SECTION THROUGH ONE OF THE SMALLER OF THE MEDIUM SIZED HUMAN ARTERIES



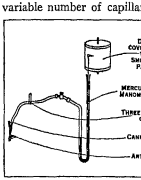
FROM BOHM, DAVIDOFF & HUBER, "TEXTBOOK OF HISTOLOGY" (SAUNDERS & CO.)

FIG 15.—TRANSVERSE SECTION THROUGH A SMALL HUMAN VEIN

The Capillaries.—These (fig. 14) consist solely of a single layer of endothelial cells, which present little resistance to the passage of substances dissolved in the blood, such as oxygen, carbon dioxide, sugar and salts. According to some observers, the cells forming the capillary wall are contractile; according to others, the actual contractile elements are special Stellate cells which encircle the capillaries. But whatever the mechanism, the

contractility of the capillaries is unquestionable, and must play a considerable part in regulating the blood flow through an organ The average length of capillaries is between 0·4 and 0·7 m.m.; in most organs they freely anastomose with each other, forming a more or less loose network.

The Veins—The smallest veins result from the fusion of a variable number of capillaries. They assume a connective tissue coat, the adventitia (fig. 15), and with increase in size muscle-fibres appear in the form of a badly defined media. Some of the larger veins, such as the brachial and subcutaneous veins, have a better developed muscular layer, while in others (the jugular, the subclavian, the veins of the dura and pia mater) the media is entirely lacking. Generally speaking, the muscular and elastic elements are much less prominent in the veins than in the arteries, and they contain a preponderance of inelastic connective tissue fibres. In many veins the adventitia shows an inner longitudinal muscular layer All subcutaneous veins and some internal veins are supplied with valves which restrict any possible back flow. The valves of the veins are reduplications of the intima, and the greater part of the valvular structure consists of fibrous connective tissue and elastic fibres.



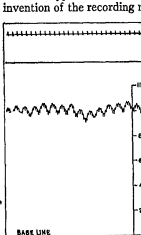
FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG 16 —APPARATUS FOR TAKING BLOOD PRESSURE TRACING

The Blood Pressure.—It has long been known and can easily be demonstrated that the blood is under different pressures in the various parts of the vascular system. When an artery is cut, blood flows out with great force in a series of jerks which are synchronous with the heart beat. When a large vein is cut, the blood also flows out rapidly, but the stream has very little force.

The first measurement of arterial pressure was made by the Rev. Dr. Stephen Hales. ("Statical Essays, containing Haemastaticks" 1733.)

Since Hales' work, the chief improvements in the method have been the application of the mercury manometer by Poiseuille, the invention of the recording manometer and the kymograph by Ludwig (figure 16), and the introduction of the more accurate membrane manometer by Hürthle and Frank.



FROM NOWELL, "TEXTBOOK OF PHYSIOLOGY" (SAUNDERS & CO.)

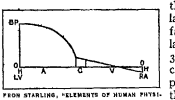
FIG. 17 —A RECORD OF ARTERIAL BLOOD PRESSURE TAKEN WITH A MERCURY MANOMETER FROM THE CAROTID ARTERY OF THE RABBIT, RECORDED IN SECONDS

The manometer of Ludwig consists of a U-tube which is half-filled with mercury. On the surface of the mercury of one limb is a float from which a stiff light rod projects, bearing on its upper end a writing point which is made to write on the smoked surface of a revolving drum The other limb of the manometer is connected by means of a glass or metal cannula to the artery? The tube between the artery and the manometer is filled with a solution of some anticoagulant salt (sodium citrate, magnesium sulphate).

The mercury manometer allows a direct reading of pressure, but on account of its inertia it does not accurately record rapid changes in the pressure. The membrane manometer, which is merely a tube filled with fluid and sealed at one end with a stretched rubber membrane, records rapid changes in pressure more accurately, but each membrane requires special calibration if absolute values are desired The venous pressure is recorded by a similar method, but with a water manometer or a manometer with a lightly stretched membrane.

The highest pressure, which occurs while the blood is passing from the heart into the aorta, is called the *systolic arterial pressure*, and the pressure at the end of diastole is the *diastolic pressure*; the range between these two extremes is known as the *pulse pressure* In the dog, with a mean arterial pressure of about 120 mm of mercury, the systolic pressure may be as high as 160 mm., and the diastolic pressure as low as 65 mm.; here the pulse pressure would be 95 mm. of mercury. By taking the pressure at different parts of the vascular system, we obtain a result which is diagrammatically represented in figure 18.

Close to the heart, the mean arterial pressure is about 100–120 mm. It falls only slowly in the large arteries, but between the smaller arteries and the capillaries there is a very extensive fall of pressure, so that the capillary pressure is only about 10 to 30 mm. of mercury; from the capillaries to the veins the blood pressure falls steadily, until in the large veins near the heart it may be negative



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG 18 —BLOOD PRESSURES IN VARIOUS PARTS OF VASCULAR SYSTEM

A. In the arteries, C. capillaries, and V. in the veins

The arterial blood pressure in man is determined by means of the Riva Rocci sphygmomanometer (figure 19), which consists of a rubber bag that can be strapped round the upper arm. The bag is connected with a manometer, and the pressure in the bag is raised by pumping air into it The pressure at which all pulsations disappear in an artery below the place of compression represents the systolic pressure. The diastolic pressure can also be determined by the same apparatus.

To determine the venous pressure in man, an apparatus is used which is constructed on the same principle as the sphygmomanometer. The skin is greased, and an annular rubber bag is placed over a vein and cemented over with a glass plate (figure 20). On blowing air into the bag, the pressure can be determined at which the vein collapses. The blood pressure in the capillaries is usually determined by the von Kries method (figure 21). A small glass plate is placed over the skin; attached to this plate is a small scale pan on which weights are placed until the pressure is just sufficient to blanch the underlying skin.

The mean blood pressure in the circulatory system of a young adult man in the horizontal position was found to be as follows:

Large arteries . . .	90 mm. mercury (65–110)
Medium arteries . . .	85 mm
Capillaries . . .	10–30 mm.
Small veins	9 mm.
Large veins	0–8 mm.

From this we see that the largest drop in pressure occurs between the small arteries and the small veins This shows that the main resistance of the vascular system is situated in the arterioles The arterioles are always in a semi-contracted state (tone), partly determined by impulses coming from the central nervous system, and partly by the properties of the plain muscles of which they are composed Since the total vascular bed of the capillaries is very much larger than that of the arterioles, the main drop in the pressure must occur just past the arterioles. The mean arterial pressure depends on two factors: (a) the total resistance to the outflow of blood from the arterial system, *i.e.*, the state of constriction of the arterioles; (b) the output of the heart in a given time, which depends on the inflow of blood.

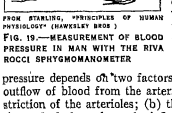

FROM STARLING, "PRINCIPLES OF HUMAN PHYSIOLOGY" (HAWKSLEY BROS.)

FIG. 19.—MEASUREMENT OF BLOOD PRESSURE IN MAN WITH THE RIVA ROCCI SPHYGMOMANOMETER

The Arterial Pulse—Owing to the elasticity of the arteries, every systolic rise of the blood pressure produces an expansion of their walls, which can be felt by placing a finger on any superficial artery It is obvious that the nearer the artery is to the

heart, the more pronounced will be the pulse The rate of transmission of this pressure wave will depend on the elasticity of the arteries If they were rigid, no pulse could be recorded. The more elastic the arteries, the slower will be the transmission of pressure along them Under normal conditions, the pulse wave in man is transmitted at the rate of about 7 meters per second, but if the arteries are initially stretched by high pressure their walls will tend to approximate to rigidity, and therefore the propagation of the pulse wave will be faster. It is important not to confuse the velocity of the pulse wave, which is simply a transmission of pressure along the tubes, with the velocity of the blood flow. The latter is of the order of about 0 5 meters per second in the aorta, and considerably less in the smaller blood vessels



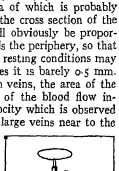
FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG 20 —APPARATUS FOR DETERMINATION OF VENOUS PRESSURE

The elasticity of the arterial system determines another important feature of the blood flow; it is the cause of the continuity of the blood flow (except for slight increases during systole and decreases during diastole), in spite of an intermittent ejection of blood by the heart into the aorta A sufficient amount of blood is accommodated in the arterial system to maintain a flow into the capillaries during the whole period of diastole. In the capillaries the pulse disappears, and the blood flow is continuous. Arterial pulse tracings recorded by means of sphygmographs (a system of levers which can be placed on a pulsating artery, the pulsation of which is thus registered on a moving plate with blackened surface) show various secondary undulations, either in the ascending part of the wave (anacrotic pulse), or in the descending (catacrotic pulse). These are partly due to extra vibrations set up in the arterial wall by the inrushing blood, and partly to pressure waves reflected from the periphery

The Velocity of the Blood Flow.—This depends on the relation between the bore of the blood vessel and the amount of blood passing through it in a unit of time. The total area of the cross sections of the arterial system gradually increases from the aorta to the periphery. The increase in area is especially great when the arteries break up into capillaries, the area of which is probably over a thousand times larger than that of the cross section of the aorta. The velocity of the blood flow will obviously be proportionately reduced the further we go towards the periphery, so that while in the aorta the mean velocity under resting conditions may be about 500 mm per second, in capillaries it is barely 0·5 mm. per second As the capillaries join to form veins, the area of the vascular bed diminishes and the velocity of the blood flow increases; however, it never reaches the velocity which is observed in the aorta since the cross section of the large veins near to the heart is about double that of the aorta.

Intensity of the Circulation.—The amount of blood received by the heart from the veins and passed to the arteries in a unit of time, cannot be measured directly. However, a knowledge of the cardiac output is of considerable importance because it controls the amount of oxygen carried to the tissues and the rate of the removal of various products of metabolism from the tissues. The great value of the study of the cardiac output of man and animals has only been realised comparatively recently, and there still remains much to be done; nevertheless methods of sufficient precision have been worked out, and the main factors governing the cardiac output are gradually being disclosed



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J & A CHURCHILL)

FIG. 21 —APPARATUS OF VON KRIES FOR MEASURING CAPILLARY BLOOD PRESSURE

Zuntz calculated the output by comparing the difference in the oxygen content of the arterial and venous blood with the amount of oxygen consumed in a given time. For instance in a horse weighing 360 kilo , 2,735 cc. of oxygen were consumed per minute; the arterial blood contained 10·33% more oxygen than the venous. Since every 100 cc. of blood that passed through the lungs had taken up 10 33 cc of oxygen, 2,733 cc of oxygen had been taken up in the course of one minute by $\frac{100 \times 2733}{10\ 33} = 26{,}457$ cc of blood.

Krogh modified this method by making the animal or man breathe a gas which was harmless and easy to detect, viz , nitrous oxide He knew how much of the gas could be absorbed by 1cc of blood, and was therefore able to calculate the cardiac output by determining the amount of gas taken in during one minute Recently other methods have been introduced which are claimed to be more exact In one of them, ethyl iodide is the gas absorbed, and in another the principle of Zuntz is modified and the output is calculated by comparing the carbon dioxide content of the arterial and venous blood with the amount of carbon dioxide given off in a unit of time

Cardiac Output in Man.—In man, under conditions of rest, the cardiac output varies in different individuals between about 3½ and 6 litres of blood per minute, that is between 60 and about 110 cc for each heart beat The cardiac output, *i e* , the inflow of blood into the heart, as in the heart-lung preparation, is within wide limits independent of the heart rate It primarily depends on (a) how freely the blood passes from the arterial system through the tissues into the venous system, *i.e* , on the peripheral resistance; and (b) the power of the heart to pump the inflowing blood into the arteries; and (c) the capacity of the vascular system relative to the amount of blood When the arterioles dilate, the blood passes quickly through the organs and, since the capacity of the vascular bed will be changed but little, the blood will reach the heart during the next few beats in a larger amount The heart will therefore force more blood into the arterial system, and thus within limits prevent a fall of arterial blood pressure, which would have taken place if the arterioles dilated without causing an increase in the blood flow

If we turn now to the second way in which the output may be increased, namely the strengthening of the heart beat, it is clear that, if the pumping action of the heart becomes inadequate, blood will stagnate on the venous side, and the output will diminish. If the heart beat is improved by nervous or pharmacological agencies, there will be better emptying of the venous side, and a consequent increase in the circulation rate.

The third factor governing the output is the capacity of the vascular bed relative to the amount of blood. This factor can be appreciated by considering the tremendous capacity of the capillary system Krogh has shown that $\frac{1}{20}$ to $\frac{1}{70}$ of a muscle is made up of capillaries, and in the heart there is at least one capillary to every muscle fibre If all these capillaries lost their tone, the animal would literally bleed into them, the arterial and venous system would become empty, and the output of the heart would fall to vanishing point

The amount of blood in the circulation and the capacity of the vascular bed should not be considered as rigidly fixed for any individual The vascular system is in a perpetual state of variation on account of the continuous changes of the vasomotor tone. It is obvious that unless vasoconstriction is compensated for by a simultaneous vasodilation elsewhere it will lead to a change in the resistance as well as a change of capacity. Arterial vasoconstriction will chiefly affect the resistance, while even small changes in the tone of the enormous capillary bed will mainly affect capacity. Thus on account of these changes of capacity more or less blood may be in active circulation, and more or less blood may be left behind to fill the vascular bed

Spleen, Lungs and Other Factors.—There are however two organs which play a predominant rôle as reservoirs of blood, namely the spleen and the lungs, the difference being that the spleen seems to change its capacity mainly as the result of active contraction and relaxation, while the lungs play a purely passive rôle and act only because of the very great elasticity of their blood vessels. With every increase in the pulmonary blood pressure or with a certain decrease in the intrathoracic pressure, the pulmonary blood vessels contain more blood, and therefore less blood is available for the systemic circulation. On the other hand, the capacity of the spleen is to a much greater extent independent

of the blood pressure, the changes in its vascularity being due to active contractions of its muscular frame. These contractions seem to be specially adapted to meet the requirements of the whole organism Whenever, for instance, more blood is needed in circulation, as when the animal loses blood or when blood goes to fill widely dilated vascular areas of other organs, the spleen contracts. This also happens in anoxaemia following diminution of the oxygen supply, or during diminution of the oxygen-carrying power of the blood as in the case of carbon monoxide poisoning

As we have already seen, the vascular resistance, the fitness of the heart and the vascular capacity are the three main factors which determine the blood flow in the whole animal There are however accessory factors, the chief of which are the respiratory movements and the contractions of the skeletal muscles. Any increase in respiratory movements leads to a more negative pressure in the thorax, and therefore to a better aspiration of blood from the periphery into the large veins and the heart. This is probably the main cause of the so-called respiratory variations of the blood pressure, during inspiration the inflow into the heart is increased, and after a certain lag the output is also increased. The rhythmic contractions of the skeletal muscles press the blood from the capillaries to the veins, the back-flow of blood being prevented by the valves of the veins.

The Nervous Control of the Blood Vessels.—During increased activity, an organ requires more oxygen Theoretically this could be accomplished by an increased degree of de-oxygenation of the blood without a change in the blood flow, or by an increase in the blood supply without any change in the degree of deoxygenation. The organism uses both methods, but the first in preference. In some cases the increase in the blood supply is such as to overcompensate the need, so that, although the oxygen consumption of the organ is increased, the blood supply is so great that each cubic centimeter of blood gives to the tissues less oxygen than usual. Increased blood supply to an active organ is due either to an increase of the general circulation rate which increases the blood flow through all the organs, or to changes in the distribution of the blood between the various organs, more blood being diverted to the active and less to the resting organs

Our knowledge of the nervous control of the blood vessels dates from Claude Bernard's discovery that nerve fibres run in the sympathetic chain which maintain the vessels in a state of tonic constriction. Section of these nerves leads to a considerable vasodilation and therefore to an increased blood flow; stimulation of them causes vasoconstriction. A few years after this discovery it was found that there are also vasodilator nerve-fibres which are antagonistic in function to the vasoconstrictor nerves, and that these nerve-fibres also have in many cases a constant influence on the blood vessels, section of them slightly diminishes the blood flow, and stimulation greatly increases it. The blood vessels are therefore, like the heart, under the influence of double innervation The tonic state of the blood vessels does not itself depend on nervous control, and it does not completely vanish after section of all the nerves going to an organ. The function of the vasomotor nerves is merely to increase or decrease this tone.

It can easily be shown that the continuous stream of impulses descending to the blood vessels along the vasoconstrictor fibres originates in the central nervous system If the spinal cord of a dog is divided below the medulla, the blood pressure falls from about 120 mm. of mercury to about 50 mm. Stimulation of the divided spinal cord immediately causes an increase in blood pressure, which may be as high as 280 mm. or more. Section of the central nervous system above the medulla has no lasting effect on the blood pressure. As the result of these experiments we may say that the vessels of the body are kept in a state of increased tone by impulses arising in the medulla. The portion of the medulla concerned with sending out these impulses is spoken of as the *vasomotor centre*. The activity of this centre is constantly under the influence of various afferent stimuli originating within the various organs of the body or as the result of excitations of higher or lower parts of the central nervous system.

The Vasoconstrictor and Vasodilator Fibres.—The vasoconstrictor fibres leave the spinal cord in the thoracic region. They have a cell station in the ganglia of the sympathetic chain, and are then distributed along various nerves, to the organs. The most important vasoconstrictor nerve is the splanchnic nerve, which supplies all the abdominal organs.

The typical vasodilator nerves take their origin from various parts of the central nervous system Thus the vasodilators to the salivary glands and tongue are distributed with the cranial nerves, and probably originate from the nervus intermedius between the seventh and eighth cranial nerves The nervi erigentes going to the genitalia leave the lower end of the cord by the anterior roots of the second and third sacral nerves. The vasodilator fibres going to some of the abdominal organs and to the extremities have the same origin and course as the ordinary sensory nerves Since the vasodilator impulses pass along these nerves in a direction opposite to that taken by the normal sensory impulses, they have been termed *antidromic* impulses. This appears to be one of the few cases in mammals in which the same nerve fibre performs two different functions.

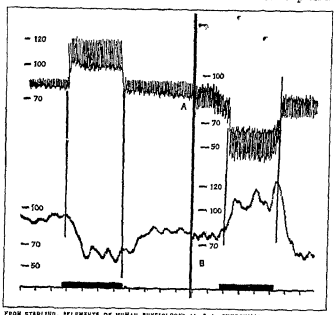
The vasodilator and vasoconstrictor fibres are generally mixed in common trunks innervating an organ, and it is only by special means that they can be functionally separated.

Peripheral Tone of the Blood Vessels.—It has been mentioned above that the function of the vasomotor nerves is only to change the tonic condition of the blood vessels; the tone itself does not disappear, however, even after complete denervation. This peripheral tone of the blood vessels is considerably influenced by the composition of the blood, especially the oxygen tension, the degree of alkalinity, and the presence of vasoconstrictor substances which are normally secreted by the pituitary and the suprarenal glands. Whether the nerves are intact or severed, the capillaries of the body are never all open at the same time The capillary bed seems to be, at least in some organs, in a perpetual state of variation. Capillaries constantly close and open so that blood flows through various channels. Whenever the oxygen tension of the blood diminishes, the blood vessels dilate, a large number of capillaries open, and the blood flow through the organ increases; excess of carbon dioxide has the same effect.

On the other hand, an increase of the pituitary secretion or of adrenaline in the blood increases the tone of the blood vessels and capillaries. Some authors regard these two substances as being primarily responsible for the peripheral tone of the blood vessels in general. Superimposed upon these perpetual variations of the peripheral tone is the effect of the vasomotor nerves, and it often happens that agencies which would affect the peripheral tone in some definite direction are prevented from doing so on account of antagonistic influences from the vasomotor centre. For instance in the case of increased carbon dioxide tension of the blood, the carbon dioxide acting peripherally tends to dilate the blood vessels, but it is also a strong stimulus to the vasomotor centre and excites the vasoconstrictor fibres to such an extent that the blood vessels constrict; the blood pressure then rises until the central nervous system succumbs to the toxic effect of the carbonic acid.

The Vasomotor Centre.—Besides being sensitive to carbon dioxide and to the acid products of metabolism which accumulate in consequence of lack of oxygen, the vasomotor centre is constantly influenced by impulses arriving from the sense organs on the surface of the body and from various other organs. Amongst these, impulses originating in the vascular system are the most important, and are practically the only ones which have been studied. The afferent stimuli may be of two kinds. First are those which affect the vasomotor centre in such a way as to cause vasoconstriction either in some definite organ or in many organs; in the latter case the general vascular resistance increases and the arterial pressure rises. These afferent impulses are described as *pressor impulses*. On the other hand, impulses may reach the vasomotor centre which will lead to a vasodilation; this again may be restricted to a small area or may involve sufficient blood vessels to bring about a fall in the arterial blood pressure. These are known as *depressor impulses*.

Pressor reflexes can be evoked by stimulation of almost any of the sensory nerves of the skin, the digestive tract or other abdominal viscera. The chief depressor nerve originates in the heart and in the first part of the aorta. In the rabbit this nerve runs in a separate and easily accessible trunk. Stimulation of the central end of the depressor produces such a large dilation of most of the blood vessels that the arterial blood pressure



FROM STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY" (J. & A. CHURCHILL)

FIG 22.—BLOOD PRESSURE TRACINGS TO SHOW INFLUENCE OF CHANGES IN THE CIRCULATION THROUGH THE BRAIN ON THE ACTIVITY OF THE VASOMOTOR CENTRE

falls to a very low level. In the intact animal the physiological stimulus which brings this depressor mechanism into operation is the high blood pressure in the aorta. Distension of the aorta by pressure stimulates the depressor nerve and leads to a compensatory dilation of arterioles and to a fall in pressure. The nerve can be regarded as a safety valve which prevents excessive rises of blood pressure.

It is highly probable that in the case of an excessive fall of pressure another reflex mechanism comes into action, a pressor reflex which also originates in the heart and aorta and which tends to antagonize the fall. Recently it has been shown that the carotid artery at the point of its division into the internal and external branch is also sensitive to pressure. Increase of pressure in this part leads to a reflex vasodilation, and fall of pressure leads to a vasoconstriction. Besides these two influences, it seems that the vasomotor centre itself can be excited or inhibited by variation in the blood pressure. Fig 22 gives an example of the effect on the general blood pressure of changes in the pressure of the brain (which was perfused through the carotid arteries).

Thus we see that the organism possesses several mechanisms by means of which it can keep the blood pressure constant and counteract any influences which would tend to raise or lower it. In the case of haemorrhage, a considerable amount of blood may be removed from the body, but the blood pressure soon returns to the normal. Blood may be withdrawn from the system slowly to the extent of about 4%, or rapidly to the extent of about 2% without lowering the arterial pressure, owing to the compensatory constriction of the arterioles. Such withdrawal of blood, though it does not affect the blood pressure, will greatly diminish the intensity of the circulation and will reduce the output of the heart. Conversely, injection of salt solution (0·9%) or transfusion of blood will not, within certain limits, affect the arterial blood pressure owing to compensatory vasodilation. Transfusion will, however, increase the circulation of blood and thus lessen the harmful consequences of haemorrhage. Considerable haemorrhages will not be effectively compensated and will therefore lead to fall of blood pressure, and transfusion will be absolutely necessary to save the animal from death.

Since most blood vessels are innervated by vasoconstrictor and vasodilator fibres, it is obvious that a pressor or depressor reflex could be carried out by several means. Vasodilation could for instance be produced by means of a reflex inhibition of the vasoconstrictor tone, or by a stimulation of the vasodilator fibres which would depress the tonic state of the blood vessels. What actually happens is that the two sets of fibres in all known cases act in a reciprocal fashion. Thus a depressor reflex involves a simultaneous diminution of the vasoconstrictor influence and increase of the vasodilator influence, and vice versa in the case of a pressor reflex.

Chemical Factors.—In recent years there has been a considerable accumulation of facts which show that various chemical factors affecting the blood vessels, apart from any nervous influence, are of great importance for the regulation of the circulation, and that these factors can exercise their action either on the arterioles or on the capillaries.

It is known for instance that in many conditions, *e.g.*, pain, asphyxia, the physiological state that accompanies emotion, there is a considerable rise in the production of adrenaline by the suprarenal glands. Adrenaline, as has been mentioned before, stimulates the nerve endings of the sympathetic nervous system, and it therefore also stimulates the nerve endings of the vasoconstrictor nerves. Thus, in all cases associated with increased production of adrenaline, there is widespread vasoconstriction and a rise in the blood pressure, this vasoconstriction is independent of the integrity of the vasomotor nerves. In the case of activity of an organ, vasodilation occurs in most cases not on account of concurrent depressor reflexes but on account of the production of chemical substances within the organ. These substances mainly affect the tone of the capillaries, and in their presence a great number of hitherto closed capillaries open or dilate widely. It has been shown that in the case of a contracting muscle the capillaries may be increased from 2% to 15% of the total volume of the muscle.

There is, however, one substance which may possibly be produced in the organism under normal conditions, and which is known to have a powerful capillary dilator effect. This substance is histamine, a product of the amino-acid histidine, which is a normal constituent of most proteins. It has been suggested that the production of histamine plays an important part in giving rise to the symptoms of "surgical shock." In this condition there is a universal dilation of the capillaries, and therefore a fall of blood pressure and a diminution of the amount of blood in circulation which finally leads to death. This condition, which occurs after laceration especially of muscles, can easily be reproduced by injection of large doses of histamine.

The mechanism of adaptation of the circulation in various organs to their needs must at present be regarded as in part dependent on the delicate balance of the nervous vasodilator and vasoconstrictor influences, which modify the tone chiefly of the arterioles, and also on chemical substances produced locally as the result of activity, which modify the tone of the capillaries.

The Portal Circulation.—The portal circulation is peculiar in that the blood passes through two sets of capillaries. Arterial blood is conveyed to the capillary networks of the stomach, spleen, pancreas and intestines by branches of the abdominal aorta. The portal vein is formed by the confluence of the mesenteric veins with the splenic vein, which together drain these capillaries. The portal vein breaks up into a second plexus of capillaries within the substance of the liver. The hepatic veins carry the blood from this plexus into the inferior vena cava. The portal circulation is largely maintained by the action of the respiratory pump, the peristaltic movements of the intestine and the rhythmic contractions of the spleen; these agencies help to drive the blood through the second set of capillaries in the liver. Obstruction in the right heart or pulmonary circulation at once affects the circulation in the liver. The increased respiration which results from muscular exercise greatly furthers the hepatic and portal circulation.

The Cerebral Circulation.—The circulation of the brain is

somewhat peculiar, since this organ is enclosed in a rigid bony covering. The limbs, glands and viscera can expand considerably when the blood pressure rises, but the expansion of the brain is confined. By the expression of venous blood from the veins and sinuses, the brain can receive a larger supply of arterial blood at each pulse. Increase in arterial pressure increases the velocity of flow through the brain, the whole cerebral vascular system behaving like a system of rigid tubes when the limits of expansion have been reached. The pressure of the brain against the skull wall is circulatory in origin; in the infant's fontanelle the brain can be felt to pulse with each heart-beat and to expand with expiration. The arterial supply to the brain by the two carotid and two vertebral arteries is so abundant, and so assured by the anastomosis of these vessels in the circle of Willis, that at least two of the arteries can be tied without grave effect. Sudden compression of both carotids may render a man unconscious, but will not destroy life, for the centres of respiration, etc., are supplied by the vertebral arteries. The vertebral arteries in their passage to the brain are protected from compression by the cervical vertebrae.

Whether the muscular coat of the cerebral arteries is supplied with vasomotor nerves is uncertain

The Coronary Circulation.—Extremely peculiar conditions exist in the coronary circulation, *i.e.*, the blood supply to the heart muscle itself. The coronary arteries originate at the root of the aorta. They turn back into the substance of the cardiac muscle and break up into a rich meshwork of capillaries which convey the blood into the coronary veins, the majority of which collect the blood into the coronary sinus, while some open on the inner surface of the chambers of the heart (Thebesian veins). During systole the heart muscle develops a pressure which must be higher than that in the aorta, as otherwise no ejection of blood from the ventricle into the aorta would be possible. The coronary arteries, which are at any time distended by the pressure prevailing in the aorta, are thus compressed, and during systole the inflow of blood into those of the left ventricle is stopped. The right ventricle by its weak contraction only affects the coronary circulation to a slight extent. While restraining the inflow of blood into the coronary arteries, the contraction of the heart greatly facilitates the outflow from the veins by mechanically expressing their contents. It is interesting to note that adrenaline, which greatly increases the strength of the cardiac beat, also produces a great dilation of the coronary blood vessels, so that a larger amount of blood is provided to meet the increased expenditure of energy. The coronary blood vessels are richly provided with vasodilator and vasoconstrictor nerves, the sympathetic supplies the vasodilator, and the vagus the vasoconstrictor fibres.

Since the coronary blood flow is so readily affected by the heart beat, great difficulties are encountered in the study of the regulation of the coronary circulation. A knowledge of all the influences affecting it is, however, extremely important because the activity of the heart, and therefore the fate of the organism, ultimately depends on the blood supply to the cardiac muscle. It is known that even temporary occlusion of the coronary blood vessels is fatal. The disease known as *Angina pectoris*, which usually leads to death, is most probably due to such occlusion as the result of arteriosclerosis or thrombosis of the arteries; it is highly probable that in some cases it may also be due to disorders of the nerves which regulate the tone of the coronary blood vessels. In most cases of weakening of the heart, the coronary flow increases. Lack of oxygen produces an enormous augmentation of the coronary circulation, thus ensuring the survival of the heart so long as there is a trace of oxygen left in the blood.

The Influence of Posture on the Circulation.—The circulation remains efficient not only in the horizontal but also in the erect position. Yet in a man standing six feet high the hydrostatic pressure of a column of blood reaching from the vertex to the soles of the feet is equal to 14 cm. of mercury. The blood, owing to its weight, continually presses downwards, and under the influence of gravity would sink if the veins and capillaries of the lower parts were sufficiently extensile to contain it. During the evolution of man, there have been developed special mechanisms by which the determination of the blood to the lower parts is prevented, and the assumption of the erect posture rendered possible. The abdominal viscera are slung upwards to the spine, while below they are supported by the pelvic basin and the wall of the abdomen, the muscles of which are arranged so as to act as a natural waistband. In tame hutch rabbits, with large pendulous abdomens, death may follow in from 15 to 20 minutes if the animals are suspended and immobilized in the erect posture, for the circulation through the brain ceases, and the heart soon becomes emptied of blood. If, however, the capacious veins of the abdomen be confined by an abdominal bandage, no such result occurs. Man is naturally provided with an efficient abdominal belt, although this is often rendered toneless by neglect of exercise or gross and indolent living. The splanchnic arterioles are maintained in tonic contraction by the vasomotor centre, and thus the flow of blood to the abdominal viscera is confined within due limits.

The veins of the limbs are broken into short segments by valves, and these support the weight of the blood in the erect posture. Every contraction of the skeletal muscles compresses the veins of the body and limbs, for these are confined beneath the taut and elastic skin. Guided by the valves of the veins, the blood is by such means driven upwards into the venae cavae.

Circulation During Muscular Exercise.—An attempt to understand the changes in the circulation during muscular exercise can only be made if every part of the complex regulation of the cardio-vascular system is kept in mind.

In muscular exercise, every available mechanism concerned in the regulation of the blood flow is brought into operation, everything being centred on the achievement of two objects, (*a*) to carry the all important oxygen to the muscles, and (*b*) to remove the excess of waste products as quickly as possible. In violent exercise the common effort of all the cardio-vascular mechanisms involved is often inadequate, but fortunately the muscles and other organs do not require an immediate supply of sufficient oxygen to fulfill their needs; fortunately also the muscles can withstand a certain degree of accumulation of waste products without much alteration of the intensity of the activity. In other words the muscles can to some extent run into debt as regards the oxygen supply. But the excess oxygen requirements must at some time be made good, or the activity will have to stop. The complete adaptation of the vascular and respiratory systems, when the oxygen supply and the removal of waste products entirely meets the demand, is achieved comparatively slowly. The first period of severe muscular activity proceeds under somewhat less favourable conditions than hold after complete adjustment has been attained. This is probably the explanation of the phenomenon of "second wind." The organism is better adapted to exercise, the more rapidly this state of adjustment is reached.

Since the arterial blood is normally about 95% saturated with oxygen, not much extra oxygen can be obtained by increasing the saturation of the haemoglobin. As already explained, the muscle obtains the required oxygen in two ways: (*a*) by increased utilization of the oxygen of the blood, *i.e.*, by a greater desaturation of the haemoglobin, and (*b*) by an increase in the blood flow. The first factor alone would be inadequate even if the muscles were able to remove all the oxygen from the blood. A simple example will serve to illustrate this. If we take the total blood flow as 4·5 litres per minute, even if we make the impossible assumption that the whole of the blood goes through the muscles, it will mean that the muscles will only be supplied with about 800 cc. of oxygen per minute. Now the normal oxygen requirements at complete rest are about 300 cc. per minute, and during severe exercise they may rise to 3,000 cc. per minute or more. Moreover, the desaturation of haemoglobin is never carried to completion, and even during severe muscular exercise the venous blood still contains some oxygen. Thus the increased oxygen demand can be met to only a limited extent by increasing the coefficient of the oxygen utilization.

The second factor, namely the increase in the output of the heart, is far more important. Amongst all the factors involved in this increase in the blood flow, we will first consider the heart. This organ plays only a subordinate rôle. The output of the

heart depends on the inflow and, under normal conditions, changes in the activity of the heart have little or no effect on blood flow. The main factor in the augmentation of the inflow concerns the peripheral blood vessels. Considerable changes in the heart beat must, however, take place in order to make it possible for the heart to cope with the larger inflow. The first effect of the larger inflow will be to increase the filling of the heart and therefore the output on account of the stronger beat. This is a purely automatic reaction of the cardiac muscle, and is independent of the central nervous system. The adaptation of a denervated heart stops at this point. The limit to this adaptation of the heart muscle is set by the pericardium The adaptation of the innervated heart does not, however, stop here The increase in the strength of contraction in this case is out of proportion to the inflow, so that the heart becomes able to give progressively stronger beats. It is not only more filled in diastole but it also empties better during systole This additional strengthening of contraction depends on the diminution of the influence of the vagus nerve, and on the excitation of the augmentor fibres of the sympathetic nerve.

But usually in addition to this increase in strength of the beat there is a quickening of the heart rate. This is also based in the first instance on a diminution of the vagus tone, and probably in most cases on an augmentation of the sympathetic tone. Further increase of the inflow is therefore met by a corresponding quickening of the heart beat The acceleration of the heart in muscular exercise is a purely reflex phenomenon, based (especially at the beginning of the exercise) partly on impulses descending to the cardiac medullary centres from the cortex of the hemispheres, which are probably conditioned reflexes. In part the acceleration is due to concurrent changes in the respiratory activity and to reflexes originating within the vascular system of the animal itself. We have seen that each inspiratory phase is accompanied by a diminution of the vagus tone and hence by an acceleration of the heart. Thus if there is a greater number of respirations per minute, the periods of acceleration become more frequent and finally fuse, so that the periods of retardation typical of the expiratory state have no time to develop.

Amongst the reflexes which affect the cardiac rhythm and which originate within the organs of the body itself, the reflexes from the heart should be considered first It has been shown by several observers that an increased inflow into the heart brings about a reflex acceleration of the heart beat. Changes in the activity of the heart should not be regarded as the cause of increased intensity of circulation, but as an adaptation which enables the increase to be performed.

The chief causes of increased total blood flow during muscular exercise can be grouped under the following headings:

1. The increase in the aspiration by the thorax;
2. The pumping action of the contracting muscles;
3. The increase in the amount of circulating blood;
4. The diminution of the total vascular resistance

To these should be added the factors which are not likely to affect the total blood flow, but which alter the distribution of the blood between the various organs These are:

1. The constriction of the splanchnic area;
2. The dilation of the blood vessels of the muscles.

These factors have all been discussed in the preceding pages and need only be mentioned shortly. The increased and more frequent expansion of the chest, which follows the deepening and acceleration of respiration, accentuates the negative pressure in the thorax, and tends to diminish the pressure in the large veins. These are therefore more quickly and more completely filled with blood from the periphery. The working muscles expel, by each contraction, blood from their capillaries to the veins, and thus actively help the propulsion of blood into the heart The spleen contracts and empties its blood into the vascular system, and an extra amount of blood thus becomes available. The dilation of the blood vessels in the muscles is so intense that the general resistance diminishes and the blood passes from the aorta into the venous system at a considerably faster rate. All these factors are helped by the contraction of the splanchnic vascular area, which diverts the blood to the muscles. The blood vessels in the muscle dilate, and the capillaries open so that the capillary bed in the muscles may increase 40 to 100 times during maximal activity. This dilation is chiefly if not exclusively due to the local production of vasodilator substances. It is not at present known how far the vasomotor innervation participates in this dilation.

Thus we see that during muscular exercise the organism meets the demand for an increased oxygen supply to the muscle by an intricate series of correlated mechanisms. The necessary adjustments involve the respiratory system and the whole cardio-vascular system, and probably afford one of the finest examples of co-ordination that has yet been discovered in the realm of physiology.

(G. An)

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